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Digestible Lysine Requirement for Hen Turkeys from 0 to 6 Weeks of Age

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Abstract: Two floor pen trials were conducted to determine the digestible lysine requirement of female turkeys from 4 to 15 and 29 to 40 days of age. For the 4 to 15 day period, 480 four-day-old poults were weighed, sorted, and assigned to a treatment with 10 poults per pen. For the 29 to 40 day experiment, 384 poults, were weighed, sorted, and assigned to a treatment with 8 poults per pen. In both trials, poults were fed experimental diets with the digestible lysine levels ranging from 1.08 to 1.43% in the 4 to 15 day period and 0.88 to 1.30% in the 29 to 40 day period. The experiments were of a complete randomized block design with eight treatments and six replicates per treatment. The highest level of lysine received three treatments at the expense of the positive control groups, which were fed a standard corn, soybean meal, and porkmeal diet based on the NRC (1994) requirements. Experimental data were analyzed by analysis of variance and splined regression analysis. Digestible lysine requirement based on splined regression analysis for the 4 to 15 day period were found to be 1.29% for body weight gain. For the 29 to 40 day growth period, the digestible lysine requirement was determined to be 1.16% for body weight gain and 1.12% for feed conversion.

Key words: Turkeys, methionine, sulfur amino acids, digestible amino acids

Introduction

Over the past three decades there has been a dramatic increase in the number of turkeys produced in the United States. Nearly 40% of the total costs of a processed turkey are associated with feed (Firman, 1997). In order to decrease these costs of production, it becomes necessary to examine the areas where money can be saved. For example, one of the most expensive components in feed is protein or, more specifically, amino acids. The first- and second limiting amino acids in a corn and soybean meal diet are methionine and lysine, respectively (Warnick and Anderson, 1973). Feeding birds on a digestible amino acid basis has the potential to save feed costs through protein reductions. Digestible requirements are those based on the digestibility of each amino acid in each of the feedstuffs. Determining the digestible lysine requirement of turkey hens will allow the turkey industry to feed more precisely and hence lower production costs.

There is a significant amount of research on the lysine requirements of female turkeys during the starter period. Attempts at determining the lysine requirement for poults from 0 to 3 weeks of age have established the lysine requirement to be between 1.42 and 1.60% of the diet (Hurwitz *et al*., 1983; Tuttle and Balloun, 1974; D'Mello and Emmans, 1975; and Kummero *et al*., 1971). The most recent is that of Boling and Firman (1998) who found the digestible lysine requirement for female poults raised in battery cages to be 1.32% for optimal weight gain and 1.34% for optimal feed conversion.

Although there is a great deal of data on the male and female requirements for the 0 to 3 growth period, there is much less data on the 3 to 6 week period for female poults. Research by Kratzer *et al*. (1956) determined the 4 to 8 week requirement for male and female turkeys to be 0.96%, which appears to be rather low. Later, Balloun and Phillips (1957) found the lysine requirement for both males and females from 0 to 6 weeks to be 1.55% of the diet. The only other source cited by the NRC for the 3 to 6 week period is that of Hurwitz *et al*. (1983) who found the requirements for male turkeys based on carcass content, maintenance, and a mathematical model to be 1.42 and 1.12% for 0 to 4 weeks and 4 to 8 weeks, respectively. Each of these aforementioned requirements is based on total amino acid levels instead of digestible amino acid levels.

It is necessary to determine the digestible requirement of lysine in order to establish an ideal protein for turkeys. An ideal protein is defined as the exact balance of amino acids needed for maximal growth with no excesses or deficiencies (Baker and Han, 1994). Ideal protein has been well-defined in both chicks and swine, but little data exists on an ideal protein for turkeys. Baker and Chung (1993) have suggested that amino acid profiles for turkeys should be similar to broilers and that the addition of threonine, sulfur amino acids, and tryptophan would be necessary for turkeys between 16 and 20 weeks old.

Currently at the University of Missouri Research Station, the Missouri Ideal Turkey Protein is being developed (Firman and Boling, 1998). In order to determine the Missouri Ideal Turkey Protein, it becomes necessary to determine the digestible requirements for amino acids. Since an Ideal Protein is based upon lysine, it is very

important to determine the digestible lysine requirement as precisely as possible. Thus, the objective of the experiment was to determine the digestible lysine requirement for female turkeys from 0 to 6 weeks of age.

Materials and Methods

A low protein basal diet deficient in lysine was created using corn, soybean meal, and porkmeal. (Table 1 and 2) All essential amino acid levels (except lysine) were met by the addition of synthetic amino acids to the levels estimated to be the digestible requirement for turkeys 0 to 3 or 3 to 6 weeks of age based on previous work in our lab (Firman and Boling, 1998; Moore *et al.*, 2001). With the exception of DL-methionine, each of the synthetic amino acids added were of the L-form. All sources of amino acids were pharmaceutical grade except lysine-HCl (78.5%), isoleucine (85%), and DL-methionine (99%), which were provided as feed-grade sources. The pharmaceutical-grade amino acids were free-base and assumed to be 100% digestible. Once the basal diet was prepared, L-lysine HCl was titrated into the diet to obtain the individual levels of lysine to be tested. Glutamic acid was titrated inversely to the lysine titrations to assure similar nitrogen levels between diets. All diets were isocaloric based on values determined in our lab.

Corn, soybean meal, and porkmeal were the only other protein constituents of the basal and NRC diets. (Table 1 and 2) Each of these feeds were analyzed for digestibility. Briefly, known quantities of each feed were tube-fed to cecectomized turkeys which had been off feed for 36 hours. After 48 hours, excreta were collected, weighed, dried, ground, and sent to the Experiment Station Chemical Laboratory to be analyzed for amino acid content. Amino acid content was determined at the Experiment Station Chemical Laboratory (University of Missouri) using the AOAC method 15:982.30. Norluecine was used as an internal standard in a Beckman 6300 AA Analyzer equipped with a high performance cation exchange resin column. Postcolumn ninhydrin derivatization was used to achieve amino acid detection. Endogenous or non-fed excreta was also collected and submitted for analysis. Digestibilities were calculated using each of these data. The positive control diet was based on NRC (1994) recommendations and formulated using corn, soybean meal, and porkmeal. For the 4 to 15 day period, the basal diet contained 20.6% intact crude protein and the levels of digestible lysine tested were 1.08, 1.12, 1.18, 1.23, 1.28, 1.33, 1.38, and 1.43%, respectively. For the 29 to 40 day period, the basal diet contained 19.3% intact crude protein and digestible lysine levels of: 0.88, 0.94, 1.00, 1.06, 1.12, 1.18, 1.24, and 1.28.

Table 1: Composition of basal and NRC based positive control diets for the 0 to 3 week period

Ingredients	Basal Diet	NRC Diet
Corn	55.62	40.65
Soybean Meal (48%)	29.01	46.64
Pork Meal	5.00	5.00
Surcrose[1]	5.00	0.00
Lard	1.81	4.25
Dicalcium Phosphate	1.54	1.40
Sodium Bicarbonate	0.75	0.75
Limestone	0.55	0.52
Salt (iodized)	0.25	0.25
Trace Mineral Premix[2]	0.10	0.100
Vitamin Premix[3]	0.075	0.075
Selenium Premix	0.03	0.03
Choline Chloride	0.147	0.072
Copper Sulfate	0.013	0.013
Avatek	0.05	0.05
Baciferm	0.05	0.05
L-Lysine HCl	0.00	0.0022
DL Methionine	0.00	0.152
Other Amino Acids	0.92	0.00
Calculated Analysis		
Crude Protien	20.63	28
ME, kcal/kg	3100	3100
Calcium	1.2	1.2
Phosphorous, available	0.60	0.60
Lysine	1.08	1.70
Sulphur amino acids	0.88	1.10
Threonine	0.80	1.05
Valine	0.90	1.47
Arginine	1.48	2.01
Histidine	0.54	0.77
Isoleucine	0.99	1.31
Leucine	1.67	2.35
Aromatic amino acids	1.63	2.41
Tryptophan	0.27	0.39

[1]Synthetic amino acids were added at the expense of sucrose so the basal diet would contain the total digestible amount of the following essential amino acids: lysine, 1.08%; threonine, 0.8%; valine, 0.9%; arginine, 1.48%; histidine, 0.54%; isoleucine, 0.99%; leucine, 1.67%; phenylalanine + tyrosine, 1.48%; tryptophan, 0.27%. The amino acids in the basal diet are on a digestible basis.

[2]The mineral premixes provided the following amounts per kilogram of diet: manganese, 110 mg; zinc, 110 mg; iron, 60 mg; iodine, 2 mg; magnesium, 27 mg; selenium, 0.18 mg.

[3]The vitamin premix provided the following amounts per kilogram of diet: vitamin A, 13,200 mg; vitamin D_3, 5,775 mg; vitamin E, 21 mg; niacin, 82.5 mg; d-pantothenic acid, 25 mg; riboflavin, 10 mg; vitamin B_6, 3.3 mg; menadione, 2.5 mg; folic acid, 2.1 mg; thiamin, 1.7 mg; biotin, 0.33 mg; vitamin B_{12}, 0.02 mg.

Poults and feeding regimen: Two thousand Nicholas White female poults were obtained from a commercial hatchery at one day of age. The poults were maintained on a standard corn, soybean meal, and porkmeal-based NRC (1994) diet when not on trial. For the first experiment, 480 poults, 4 days of age, were selected from the larger pool and individually weighed, banded,

and sorted by computer to assure similar weight distribution among pens. For the second experiment, 384 poults, 29 days of age, were selected, weighed, banded, and computer sorted. Poults were placed into 48 litter-covered floor pens in an industry-style curtain-sided building. The poults were allowed ad libitum water and feed intake and were subjected to 23 hours of light daily. In both experiments, trial periods lasted 11 days.

The trials were devised as a randomized complete block design with six blocks and eight treatments randomly assigned within each block. Each of the eight experimental levels of lysine were tested in six replicate pens. The highest level of lysine was reduced to three replicates in order to provide a positive control treatment. At the end of both trials, poults were weighed and feed disappearance was measured to determine feed intake. Mortality was recorded in order to make adjustments for feed efficiency. Data were analyzed by ANOVA and the lysine requirements were obtained using the splined regression analysis of SAS (Lamberson and Firman, 2002).

Results and Discussion

Results of the trial are presented in Table 3 and 4. Splined analysis of the data indicates that the requirement for optimal growth during the 4 to 15 day period is 1.29% digestible lysine (Fig. 1). No feed to gain differences were noted between the treatment groups. For the 29 to 40 day experiment, the digestible lysine requirement was determined to be 1.16% for optimal growth and 1.14% for optimal feed efficiency (Fig. 2 and 3). Birds fed the digestible lysine levels of 1.12% and above obtained weight gain equivalent to that of the positive control.

The 4 to 15 day requirement for growth determined in this experiment compares favorably with previous research by Boling and Firman (1998), who determined that turkey hens raised in battery cages needed 1.34% digestible lysine for optimal growth. More recent research in our lab on the digestible requirement of male turkeys grown in floor pens indicates the digestible lysine requirement to be 1.31%, which is similar to the requirement determined in this experiment (Baker *et al.*, 2003a,b; Firman, 2004).

The digestible lysine requirement of 1.16% obtained in the second experiment was also similar to the other comparable requirements determined for this period. Research by Baker *et al.* (2003a,b) and Firman (2004) indicates a digestible lysine requirement of 1.19% for optimal growth in male turkeys, which is similar to the data obtained in this experiment.

It is difficult to compare these data with other published data due to the fact that the majority of other data is based on total, or nondigestible, lysine requirements. If we are to compare these data to the NRC, we could assume a lysine digestibility of 85% in corn and soybean meal in order to obtain a digestible requirement (Firman, 1992). Thus, the digestible lysine requirements of the NRC (1994) diet obtained using this method would be 1.36% for the starter period and 1.28% for the 3 to 6 week period. These requirements are somewhat high when compared to the requirements that have been determined by our experiments.

Although it would be useful to compare the requirements

Table 2: Composition of basal and NRC based positive control diets for the 3 to 6 week period

Ingredients	Basal Diet	NRC Diet
Corn	66.11	42.96
Soybean Meal (48%)	21.22	42.13
Pork Meal	5.00	5.00
Lard	2.93	7.69
Dicalcium Phosphate	1.06	0.92
Sodium Bicarbonate	1.00	0.25
Limestone	0.38	0.33
Salt (iodized)	0.20	0.25
Trace Mineral Premix[2]	0.10	0.100
Vitamin Premix[3]	0.075	0.075
Selenium Premix	0.03	0.03
Choline Chloride	0.175	0.055
Copper Sulfate	0.013	0.013
Avatek	0.05	0.05
Baciferm	0.05	0.05
L-Lysine HCl	0.00	0.00
DL Methionine	0.229	0.109
Other Amino Acids[1]	0.92	0.00
Calculated Analysis		
Crude Protien	19.32	26
ME, kcal/kg	3200	3200
Calcium	1.0	1.0
Phosphorous, available	0.50	0.50
Lysine	0.88	1.55
Sulphur amino acids	0.80	1.00
Threonine	0.77	0.97
Valine	1.03	1.36
Arginine	1.39	1.86
Histidine	0.50	0.72
Isoleucine	0.94	1.21
Leucine	1.69	2.21
Aromatic amino acids	1.43	2.23

[1]Synthetic amino acids were added so the basal diet would contain the total digestible amount of the following essential amino acids: lysine, 0.9%; threonine, 0.77%; valine, 1.03%; arginine, 1.39; histidine, 0.5%; isoleucine, 0.94%; leucine, 1.69%; phenylalanine + tyrosine, 1.43%; tryptophan, 0.22%. The amino acids in the basal diet are on a digestible basis.

[2]The mineral premixes provided the following amounts per kilogram of diet: manganese, 110 mg; zinc, 110 mg; iron, 60 mg; iodine, 2 mg; magnesium, 27 mg; selenium, 0.18 mg.

[3]The vitamin premix provided the following amounts per kilogram of diet: vitamin A, 13,200 mg; vitamin D_3, 5,775 mg; vitamin E, 21 mg; niacin, 82.5 mg; d-pantothenic acid, 25 mg; riboflavin, 10 mg; vitamin B_6, 3.3 mg; menadione, 2.5 mg; folic acid, 2.1 mg; thiamin, 1.7 mg; biotin, 0.33 mg; vitamin B_{12}, 0.02 mg.

Table 3: Performance of hen poults fed graded levels of digestible lysine from 0 to 3 weeks of age

Digestible Lysine(%)	Weight gain(g)	Feed intake(g)	Feed:Gain
1.08	148.3[a]	241.3[a]	1.62
1.13	163.6[b]	283.5[bc]	1.73
1.18	172.4[bc]	265.8[ab]	1.54
1.23	178.9[cd]	290.7[bcd]	1.63
1.28	199.1[de]	325.1[e]	1.64
1.33	192.5[de]	316.7[de]	1.68
1.38	192.6[e]	311.5[cde]	1.62
1.43	204.2[e]*	318.6[de]	1.56*
PC	204.4[e]*	319.1[de]	1.60*
Significance	P<.0002	0.001	NS
Standard error[1]	5.99	13.74	0.104
	8.47*	19.43*	0.147*

[1]Standard error differs in treatments 1.43 and PC (n=3). Columns with differing letters are significantly (p>0.05) different

Table 4: Performance of hen poults fed graded levels of digestible lysine from 3 to 6 weeks of age

Digestible Lysine(%)	Weight gain(g)	Feed intake(g)	Feed:Gain
0.88	430.1[a]	946[a]	2.27[a]
0.94	449.3[ab]	987.8[ab]	2.21[bc]
1.00	451.1[abc]	992.1[ab]	2.16[cd]
1.06	462.4[bc]	1054.2[d]	2.10[d]
1.12	517.6[d]	1034.3[bcd]	2.02[e]
1.18	532.8[d]	1060.7[d]	1.98[e]
1.24	531.9[d]	1064.5[d]	2.01[e]
1.30	537.5[d]*	1068.6[d]*	1.99[e]*
PC	519.4[d]*	1038[d]*	2.03[e]*
Significance[1]	P<.0001	0.0001	0.0001
Standard error	11.36	21.13	0.027
	16.06*	29.8*	0.037*

[1]Standard error differs in treatments 1.30 and PC (n=3). Columns with differing letters are significantly (p>.05) different

determined in this study to other requirements determined by different researchers, it is difficult to do so. This is due to the fact that many of the experimental diets used in other trials were not based on corn and soybean meal. Therefore, we will not assume that the determined requirements can be applied to the 85% digestibility factor. Instead, we can convert the digestible requirement obtained in these trials into the total lysine requirement by assuming that the combined digestibilities of the corn and soybean meal are 85%. When applied to this method, the digestible requirement of 1.34% becomes 1.52% total lysine. This agrees with research by both Almquist (1952) and Tuttle and Balloun (1974), who determined the total lysine requirement to be 1.5% for the 0 to 4 week period. For the 4 to 8 week period, research by Tuttle and Balloun (1974) determined that birds needed 1.4% total lysine. Using mathematical models, Hurwitz *et al.* (1983)

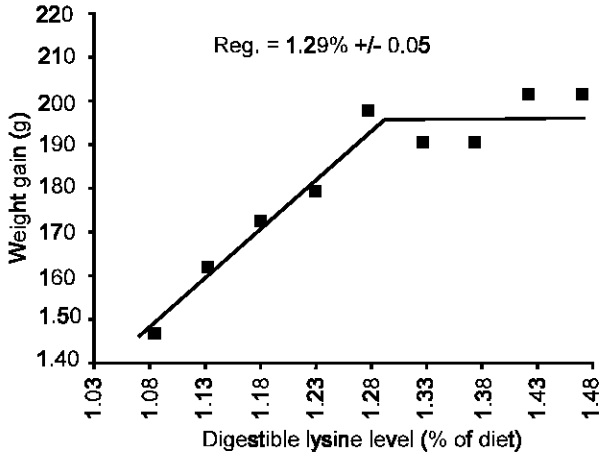

Fig. 1: Breakpoint Requirements Based on Gain of Hen Poults Fed Graded Levels of Lysine from 4 to 15 Days

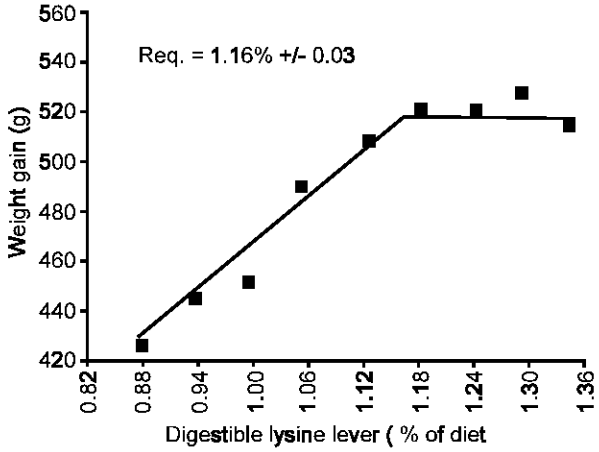

Fig. 2: Breakpoint Requirements Based on Gain of Hen Poults Fed Graded Levels of Lysine from 36 to 47 Days

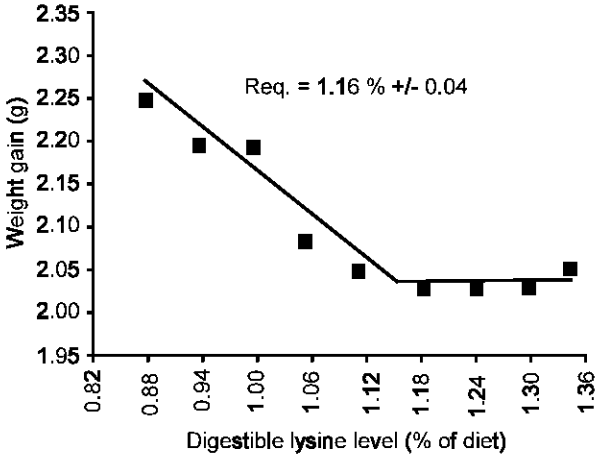

Fig. 3: Breakpoint Requirements Based on Feed:Gain of Hen Poults Fed Graded Levels of Lysine from 36 to 47 Days

suggested that the requirement is 1.42% total lysine for the 0 to 4 week period and 1.12% for the 4 to 8 week period.

Due to lysine's critical role as the reference amino acid for the ideal protein profile, it is necessary that we determine the digestible lysine requirement as precisely as possible. Based on the determined requirements for the 0 to 6 week period, it is now possible to formulate an ideal protein profile for hen turkeys. Further research in our lab on the digestible requirements of other essential amino acids will aid us in the development of this ideal amino acid ratio.

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