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Digestible Lysine Requirements of Hen Turkeys from 6 to 12 Weeks of Age

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Abstract: Two floor pen trials were conducted to determine the digestible lysine requirement of hen turkeys from 46 to 57 days and 71 to 85 days of age, or what is more commonly referred to as the 6 to 12 week period. 2000 Nicholas White female poults were obtained and fed an NRC-type corn-soybean meal diet until the trials began. For the first experiment, 240 46-day-old birds were banded, weighed, computer sorted, and assigned a treatment with 8 birds per pen. In the second experiment, 240 71-day-old birds were weighed, banded, computer sorted, and assigned a treatment with 5 birds per pen. Birds in both trials were fed experimental diets with digestible lysine levels ranging from 0.85 to 1.21% in the 46 to 57 day period and 0.70 to 1.05% in the 71 to 85 day period. Two low protein diets were used and the levels of digestible lysine were obtained by titrating L-lysine HCl into the low protein diets. In order to obtain sufficient amino acid levels and nitrogen levels to support growth equal to the high protein positive control diet, synthetic amino acids were added back into the low-protein diet. Both experiments were of a complete randomized block design. For the first experiment, there were 7 treatments with 4 replicates per treatment. For the second experiment, there were 8 treatments with 6 replicates per treatment. In each experiment, the highest level of lysine was reduced to half of the replicates in order to provide space for the positive control groups which were fed a standard corn and soybean meal diet based on NRC (1994) recommendations. Experimental data were analyzed by analysis of variance and segmented analysis. Segmented analysis indicated that the digestible lysine requirements for the 46 to 57 day period to be 1.04% for body weight gain and 1.07% for feed conversion. In the second trial, the analysis indicated that the digestible lysine requirements for body weight gain and feed conversion to be 0.86% and 0.82%, respectively.

Key words: Turkey, lysine, digestibility

Introduction

In the past twenty-five years, there has been a dramatic increase in the amount of turkey consumed in the United States. As the industry has grown, it has tried to focus on maximizing profits while continually producing a quality bird. Unfortunately, nutritional research for turkeys has not advanced at the rate that the industry has grown. Given this fact, most of the industry is still overfeeding protein in order to ensure maximal growth. This overfeeding of protein leads to higher production costs as well as excess nitrogen excretion.

Research by a number of scientists has determined that it is possible to feed lower-protein diets supplemented by crystalline amino acids and still obtain maximal growth. Baldini *et al.* (1954) determined that poults fed a 20% crude protein diet supplemented with lysine and methionine attained growth similar to that of a 28% crude protein diet. Further research by Fischer *et al.* (1956) confirmed this data. This research is useful in that it demonstrates that turkeys have a requirement for amino acids instead of crude protein *per se*. Building on this knowledge, many researchers have begun to create ideal protein profiles for different animals.

An ideal protein is defined as the perfect balance of amino acids that exactly meets the animal's needs without any excesses or deficiencies (Baker and Han, 1994). It has been well established for both the pig and chick, yet very little research has focused on determining the ideal protein for the turkey. The benefits of an ideal protein are numerous. Perhaps the most compelling argument for an ideal protein is that it decreases overfeeding of protein and amino acids, leading to decreased feeding costs. Additionally, feeding ideal protein ratios will lead to less nitrogen excretion, which is becoming an important agricultural issue. Since the ideal protein profile is based on digestible lysine requirements, it also forces digestible formulation, which allows producers to more accurately meet the birds' requirements, simplifies feed formulation, and allows for more efficient pricing and utilization of feed ingredients (Firman and Boling, 1998).

In the attempt to define an ideal protein for turkey hens, it is first necessary to determine the digestible lysine requirement throughout the hen's life cycle. While a number of researchers have defined the total lysine requirement, very little work has been done on the digestible lysine requirement. In order to more closely determine the digestible lysine requirement, however, we must first look at the nondigestible requirement of lysine. In 1956, Kratzer and others determined the lysine requirement for Bronze turkeys of both sexes to be 0.96% for the 4 to 8 week period and 0.85% for the 8 to

12 week period. Research on Large White male turkeys by Tuttle and Balloun (1974) determined that the requirement is 1.4% and 1.12% lysine for the 4 to 8 and 8 to 12 weeks, respectively. Potter *et al.* (1981) research determined the same requirement, or 1.4% lysine, for both males and females during the 8 to 12 week period. Research on the digestible lysine requirement for male turkeys has determined the digestible requirement to be 1.11 and 0.87% for the 6 to 9 and 9 to 12 week periods, respectively (Baker *et al.*, 2003).

Although the previously mentioned research would suggest that male and female birds have similar requirements, that may not be the case. In 1957, Balloun and Phillips determined that even as early as the starter period, hens and toms had different protein requirements. They determined that male turkeys during the starter period required a 31% crude protein diet and that females required a 27% crude protein diet. Additionally, it was noted that males responded better to lysine additions than females. Continuing into the 6 to 12 week period, Balloun and Phillips found that males required 23% crude protein and 1.21% lysine while females had a crude protein requirement of 27% and a lysine requirement of 0.93%. For the later periods, it was determined that male turkeys had a crude protein requirement that was 2% higher than the requirement of the females. Potter and Shelton (1980) also found that the requirements of male turkeys were higher than those of the females, but they determined that the requirements were not significantly different until 8 weeks of age. The objective of these studies is to determine the digestible lysine requirement of female turkeys in the 6-12 week growth period.

Materials and Methods

A low protein basal diet deficient in lysine was created using corn, soybean meal, and porkmeal. All essential amino acid levels (except lysine) were met by the addition of back pure amino acids to the levels estimated to be the digestible requirement for turkeys 47 to 51 or 71 to 85 days of age based on previous work in our lab (Firman and Boling, 1998). With the exception of DL-methionine, each of the amino acids added were of the L-form. All sources of amino acids were pharmaceutical grade except lysine-HCl (78.5%), isoleucine (80%), 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 produced by the lab at University of Missouri.

Corn, soybean meal, and porkmeal were the protein constituents of the basal and NRC diets. Each of these was analyzed for total amino acid content 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. Amino acid digestibilities were determined by gavage feeding known quantities of each feed to cecectomized turkeys which had been off feed for 36 hours. After 48 hours, excreta were collected, weighed, dried, ground, and analyzed for amino acid content by the Experiment Station Chemical Laboratory. 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 46 to 57 day period, the basal diet contained 17.2% crude protein (Table 1) and the levels of digestible lysine tested were 0.85, 0.91, 0.97, 1.03, 1.09, 1.15, and 1.21%, respectively. For the 71 to 85 day period, the basal diet contained 15% crude protein (Table 2) and digestible lysine levels of: 0.70, 0.75, .080, 0.85, 0.9, 0.95, 1.00, and 1.05%.

Poults and feeding regimen: 2000 Nicholas White female poults were obtained from a commercial hatchery at one day of age. The poults were maintained on a standard corn and soybean meal-based NRC (1994) diet when not on trial. For the first experiment, 240 birds, 46 days of age, were individually weighed, banded, and sorted by computer to assure similar weight distribution among pens. For the second experiment, 240 birds, 71 days of age, were 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. The trial period lasted 11 days in the first experiment and 14 days in the second experiment.

The trials were devised as a randomized complete block design. In the first experiment, there were 4 blocks with seven treatments randomly assigned within each block. Each of the seven experimental levels of lysine were tested in four replicate pens. In the second trial, there were six blocks and eight treatments randomly assigned within each block. Each of the eight experimental levels of lysine were tested in six replicate pens. In both trials, the highest level of lysine was reduced to half of the original number of replicates in order to provide space for a positive control. 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 segmented analysis of SAS. (Robbins, 1986)

Table 1: Composition of basal and NRC based positive control diets for the 6 to 9 week period

Ingredients	Basal Diet[3]	NRC Diet[3]
Corn	64.58	55.946
Soybean Meal (48%)	19.597	31.479
Pork Meal	5	5
Sucrose	4	0
Lard	4.180	5.54
Dicalcium Phosphate	0.663	0.561
Sodium Bicarbonate	1	0.5
Limestone	0.249	0.0233
Salt (iodized)	0.2	0.2
Trace Mineral Premix[2]	0.1	0.1
Vitamin Premix[3]	0.075	0.075
Selenium Premix	0.03	0.03
Choline Chloride	0.051	0.037
Copper Sulfate	0.013	0.013
Avatek	0.05	0.05
Baciferm	0.05	0.05
L-Lysine HC1	0	0.096
DL Methionine	0.164	0.09
Other Amino Acids[1]	0.7534	0
Calculated Analysis		
Crude protein	17.21	22
ME, kcal/kg	3300	3300
Calcium	0.85	0.85
Phosphorous, available	0.42	0.42
Lysine[3]	0.83	1.35
Sulphur Amino Acids	0.71	0.88
Threonine	0.62	0.82
Valine	0.84	1.15
Arginine	1.17	1.54
Histidine	0.43	0.61
Isoleucine	0.77	1
Leucine	1.44	1.93
Phe + Tyrosine	1.33	1.87
Tryptophan	0.19	0.29

[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 animo acids: lysine, 0.85%; threonine, 0.62%; valine, 0.84%; arginine, 1.17%; histidine, 0.4%; isoleucine, 0.77%; leucine, 1.38%; phenylalanine + tyrosine, 0.94%; tryptophan, 0.18%. 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 2: Composition of basal and NRC based positive control diets for the 9 to 12 week period

Ingredients	Basal Diet[3]	NRC Diet[3]
Corn	74.39	61.74
Soybean Meal (48%)	15.51	26.53
Pork Meal	2.98	3
Lard	3.74	6.4
Dicalcium Phosphate	0.93	0.805
Sodium Bicarbonate	1	0.5
Limestone	0.36	0.372
Salt (iodized)	0.2	0.2
Trace Mineral Premix[2]	0.1	0.1
Vitamin Premix[3]	0.075	0.075
Selenium Premix	0.03	0.03
Choline Chloride	0.07	0.026
Copper Sulfate	0.01	0.013
Avatek	0.05	0.05
Baciferm	0.05	0.05
L-Lysine HC1	0	0.0025
DL Methionine	0.074	0.058
Other Amino Acids[1]	0.466	0.043
Calculated Analysis		
Crude protein	15.07	19
ME, kcal/kg	3300	3300
Calcium	0.75	0.75
Phosphorous, available	0.39	0.38
Lysine[3]	0.71	1.08
Sulphur Amino Acids	0.58	0.76
Threonine	0.55	0.75
Valine	0.7	1
Arginine	0.94	1.31
Histidine	0.36	0.54
Isoleucine	0.64	0.87
Leucine	1.1	1.74
Phe + Tyrosine	0.94	1.63
Tryptophan	0.19	0.25

[1]Synthetic amino acids were added so the basal diet would contain the total digestible amount of the following essential amino acids: lysine, 0.72%; threonine, 0.55%; valine, 0.70%; arginine, 0.94%; histidine, 0.36%; isoleucine, 0.64%; leucine, 1.10%; phenylalanine + tyrosine, 0.94%; tryptophan, 0.19%. 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, 110mg; iron, 60mg; iodine, 2 mg; magnesium, 27 mg; selenium 0.18 mg.

[3-4]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.

Results and Discussion

Results of the trial are presented in Table 3 and 4. Segmented analysis of the data indicates that the requirement for optimal growth during the 46 to 57 and 71 to 85 day periods are 1.04% and 0.86% digestible

Table 3: Performance of hen poults fed graded levels of digestible lysine from 6 to 9 weeks of age

Digestible Lysine (%)	Weight gain (g)	Feed intake (g)	Feed: Gain
0.83	743.4[a]	2030.5[a]	2.73[a]
0.89	811.1[ab]	2070.6[ab]	2.55[ab]
0.95	849.7[abc]	2090.3[ab]	2.46[bc]
1.01	954.2[cd]	2238.6[d]	2.35[cde]
1.07	960.5[d]	2104.6[abc]	2.19[ef]
1.13	971.2[d]	2185.1[bcd]	2.25[def]
1.19	973.5[d]	2151.5[bcd]	2.21[ef]
PC	990.0[d]	2155.9[bcd]	2.20[ef]
Significance	P<.0001	0.0010	0.0051

Columns with differing letters are significantly (P>.05) different

Table 4: Performance of hen poults fed graded levels of digestible lysine from 9 to 12 weeks of age

Digestible Lysine (%)	Weight gain (kg)	Feed intake (kg)	Feed: Gain
0.71	1.12[a]	4.21	3.77[a]
0.76	1.17[ab]	4.13	3.53[b]
0.81	1.28[bc]	4.13	3.24[c]
0.86	1.37[de]	4.16	3.04[de]
0.91	1.32[cd]	4.15	3.14[cd]
0.96	1.34[cd]	4.11	3.06[de]
1.01	1.36[cde]	4.20	3.10[de]
1.06	1.39[de]*	4.27*	3.07[de]*
PC	1.41[e]*	4.21*	2.98[e]*
Significance	P<.0004	NS	0.0001
Standard error[1]	0.031	0.087	0.065
	0.044*	0.124*	0.092*

[1]Standard error differs in treatments 1.06 and PC (n=3). Columns with differing letters are significantly (P>.05) different.

lysine, respectively. The digestible lysine requirement based on feed to gain was 1.07% for the 46 to 57 day period and 0.82% for the 71 to 85 day period.

These results are similar to those found by Baker *et al.* (2003), who determined the digestible lysine requirement in toms to be 1.09 and 0.87% for the 49 to 61 and 71 to 83 day periods, respectively. Unfortunately, other than this research, there is very little data on digestible lysine requirements in turkeys. Thus, it is difficult to compare the digestible lysine requirements of hens determined in this trial to other research.

If we are to assume that corn and soy have a combined digestibility of 85% (Firman, 1992), it is possible to compare the requirements determined in this trial to other requirements which are determined on a total lysine basis. However, it is important to remember that this number does not account for the synthetic lysine often added to experimental diets. The NRC (1994) recommends feeding 1.3% lysine for the 6 to 9 week period. On a digestible basis, that would be 1.11% lysine, which is slightly higher than the 1.07% digestible lysine determined in this trial. However, it is quite

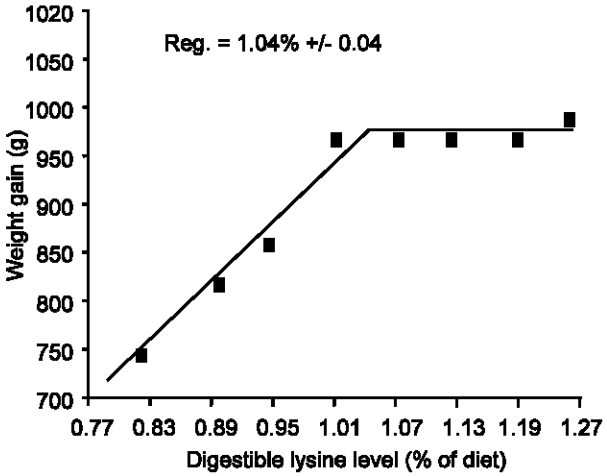

Fig. 1: Breakpoint Requirements Based on Gain of Poults Fed Graded Levels of Lysine from 46 to 57 Days

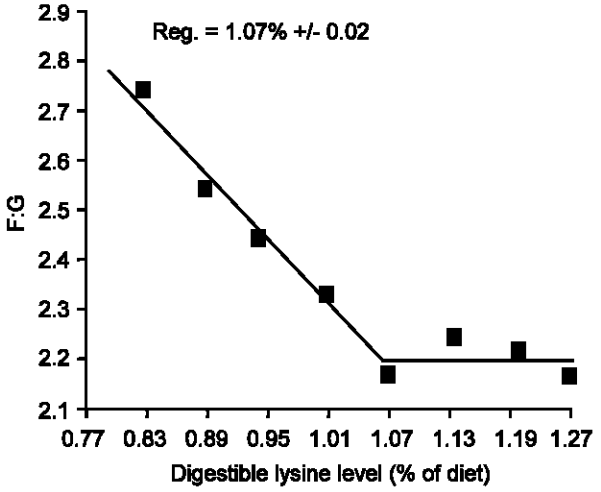

Fig. 2: Breakpoint Requirements Based on Feed:Gain of Poults Fed Graded Levels of Lysine from 46 to 57 Days

possible that the requirement was determined to be lower in our experiments due to the fact that hens were used instead of toms. For the 9 to 12 week period, the NCR (1994) recommends feeding 1.0% lysine, or approximately 0.85% when on a digestible basis. This number is comparable to the requirement of 0.87% digestible lysine determined in the 71 to 85 day trial.

It is difficult to compare the requirements determined in these trials to other requirements for two reasons. To begin with, most of the earlier research focuses on four week phases instead of three week phases. Additionally, it is difficult to apply the assumed 85% digestibility to other work because many of the trial diets used feed ingredients other than corn and soybean meal. Thus, it is necessary to convert the digestible

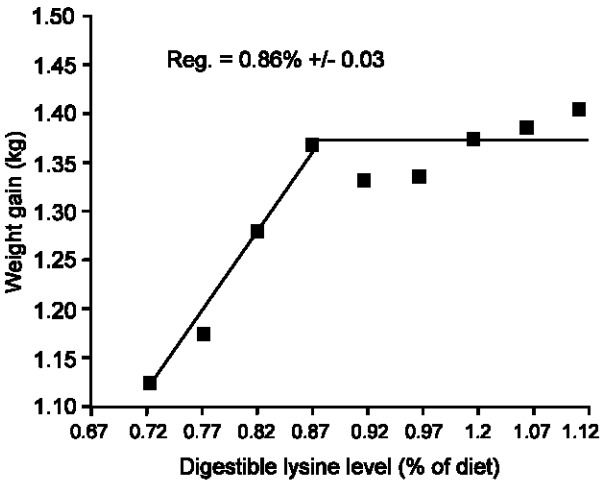

Fig. 3: Breakpoint Requirements Based on Gain of Hen Poults Fed Graded Levels of Lysine from 71 to 85 Days of Age

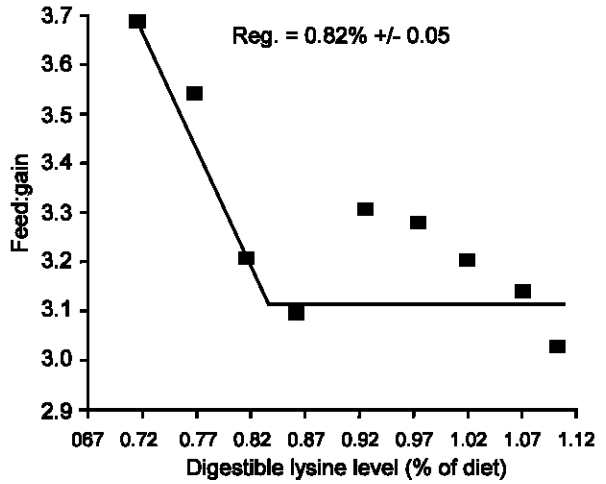

Fig. 4: Breakpoint Requirements Based on Feed:Gain of Hen Poults Fed Graded Levels of Lysine from 71 to 85 Days of Age

lysine requirements into total lysine requirements. Once converted, the total lysine requirements become 1.25% for the 46 to 57 day period and 1.02% for the 71 to 85 day period. On a total basis, Tuttle and Balloun (1974) found the lysine requirements for the 4 to 8 and 8 to 12 week periods to be 1.4% and 1.12%, respectively. Potter *et al.* (1981) determined the lysine requirements to be 1.4% for turkeys 8 to 12 weeks and 1.2% for turkeys 12 to 16 weeks. In contrast, Hurwitz *et al.* (1983) used a mathematical model along with carcass composition to determine the requirements for the 4 to 8 and 8 to 12 week periods to be 1.12% and 0.81%, respectively.

It should be noted that these trials were based on growth instead of breast meat yield. Research by Sibbald and Wolynetz (1986, 1987) found that the lysine requirement of turkeys differs based on assessed response criteria. During the course of their experiments, they determined that the lysine levels for optimum growth were less than the levels necessary for optimal breast meat yield. This is a fairly well-documented phenomenon, as many researchers have also found similar responses (Bixler *et al.*, 1969; Moran and Bilgili, 1990; Waldroup *et al.*, 1997) Breast meat yield is generally not of concern in female turkeys at this age.

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References

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

Baker, K., J.D. Firman, E. Blair, J. Brown and D. Moore, 2003. Digestible lysine requirement of male turkeys during the 6-12 week period. Int. J. Poult. Sci., 2: 97-101.

Baldini, J.T., H.R. Rosenberg and J. Waddell, 1954. The protein requirement of the turkey poult. Poult. Sci., 33: 539-543.

Balloun, S.L. and R.E. Phillips, 1957. Lysine and protein requirements of bronze turkeys. Poult. Sci., 36: 884-891.

Bixler, E.G., C.F. Combs and C.S. Shaffner, 1969. Effect of protein level on carcass composition of turkeys. Poult. Sci., 48: 261-265.

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.

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

Hurwitz, S., Y. Frisch, A. Bar, U. Eisener, I. Bengal and M. Pines, 1983. The amino acid requirements of growing turkeys. 1. Model construction and parameter estimation. Poult. Sci., 62: 2208-2215.

Moran, E.T. and S.F. Bilgili, 1990. Processing losses, carcass quality and meat yields of broiler chickens receiving diets marginally deficient to adequate in lysine prior to marketing. Poult. Sci., 69: 702-710.

National Research Council, 1994. Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, D.C.

Potter, L.M. and J.R. Shelton, 1980. Methionine and protein requirement of turkeys. Poult. Sci., 59: 1268-1274.

Potter, L.M., J.R. Shelton and J.P. McCarthy, 1981. Lysine and protein requirements of growing turkeys. Poult. Sci., 60: 2678-2686.

Sibbald, I.R. and M.S. Wolynetz, 1986. Effects of dietary lysine and feed intake on energy utilization and tissue synthesis for broiler chicks. Poult. Sci., 65: 98-105.

Sibbald, I.R. and M.S. Wolynetz, 1987. Effects of dietary fat level and lysine energy ration on energy utilization and tissue synthesis by broiler chicks. Poult. Sci., 66: 1788-1797.

Tuttle, W.L. and S.L. Balloun, 1974. Lysine requirements of starting and growing turkeys. Poult. Sci., 53: 1698-1704.

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