ISSN 1682-8356
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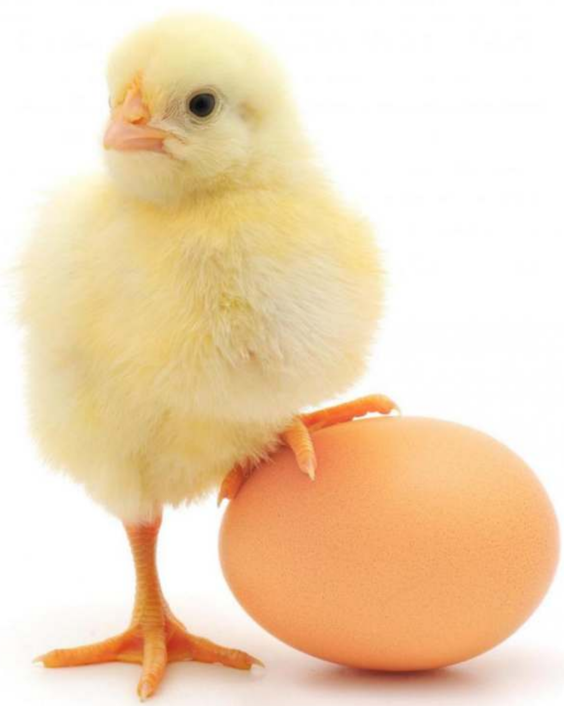

INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

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International Journal of Poultry Science 5 (8): 740-743, 2006
ISSN 1682-8356

Digestible Lysine Requirements for Maintenance in the Starting Turkey

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Abstract: Amino acid requirement data can be determined in multiple fashions. One method for determining amino acid requirement is through modeling. A portion of the data required for a comprehensive model is the maintenance requirement. The objective of these studies was to determine the digestible lysine requirement for maintenance in turkeys during the starter period. A low protein diet was formulated so that 8 different levels of lysine could be fed to young turkeys. Two experiments were conducted consisting of 8 treatments and 6 replicate pens of turkeys beginning at day 7. The maintenance requirements of lysine were 28.58 and 33.72 mg/bird/day in experiment 1 and experiment 2, respectively with an average requirement of 31.15 mg/bird/day. The requirements indicated by the two experiments did not agree completely, but the difference in predicted requirements was not large. This information, coupled with the amino acid requirements for growth, will allow for the construction of an effective model to predict amino acid requirements over a wide range of environment and physiological conditions.

Key words: Lysine, maintenance, prediction equation, turkeys

Introduction

Meeting the nutritional requirements for growing turkeys constitutes the majority of costs associated with turkey production. By reducing the level of protein in the diets of these birds, significant cost savings can be realized. Firman (1994) reported that a one percent decrease in protein level could yield significant cost savings. Although the use of ideal amino acid ratios and digestible formulation have the potential to reduce feed costs significantly, the combination of these concepts with other factors in a model offers the potential for the most efficient feeding program.

In order for a model of amino acid requirements to be most effective, amino acid requirements must be determined as precisely as possible. Since amino acid requirements can be partitioned into a requirement for maintenance and a requirement for growth, a comprehensive model must take each of these requirements into account to achieve maximum efficiency. While amino acid requirements for growth are rather easily defined as the amino acid level that produces maximal growth, defining a maintenance requirement is not as straightforward.

Maintenance can be defined as the point of static lean tissue content or static amino acid content. It has been demonstrated in broiler chicks that these two requirements are not the same (Baker *et al.*, 1996; Edwards *et al.*, 1997; 1999; Edwards and Baker, 1999). Regardless of which definition of maintenance is used, there has been little research into maintenance requirements of poultry. Leveille and Fisher (1959; 1960) and Leveille *et al.* (1960) performed balance studies to determine maintenance amino acid requirements in adult roosters, and maintenance requirements for some amino acids have been determined in broiler chicks (Baker *et al.*, 1996; Edwards *et al.*, 1997; 1999; Edwards and Baker, 1999). Currently, no experimentally obtained data on the maintenance amino acid requirements of turkeys in the starter period are available. The following experiments were designed to determine the digestible lysine requirement for maintenance in turkeys during the starter period.

Materials and Methods

Day-old poults were obtained from a commercial hatchery and fed an NRC corn and soybean meal diet until seven days of age. On day 7, after 10 hours of feed deprivation, birds were weighed, wing-banded, and randomly assigned to pens to ensure that each pen was of similar weight. Each trial contained 192 birds to provide for six replications of eight treatments. Ten birds with an average weight equal to that of the experimental pens were killed (CO_2 asphyxiation) and frozen to provide for initial body composition data.

Diets for the trials were formulated on a digestible basis utilizing Brill® least-cost formulation software. Birds were fed semi-purified diets in order to achieve the low amino acid levels required to determine maintenance requirements. Corn and sucrose comprised the majority of the diets, with amino acids, vitamins, and other nutrients provide in purified form. Sand was included as filler in all diets. Other than crystalline amino acids, corn was the only amino-containing ingredient used in the experimental diets. Amino acid digestibility values for the corn were obtained through previous testing with cecectomized turkeys. Values were calculated based on

Table 1: Composition of Experimental Diets for Lysine Trials (%)

Lysine Treatment	0.114%	0.214%	0.314%	0.414%	0.514%	0.614%	0.714%	0.814%
Corn	51.965	68.32	78.913	75.363	72.809	70.222	68.099	65.678
Sucrose	27.293	10.905	0	0	0	0	0	0
Corn Oil	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Sand	3	3	3	3	3	3	3	3
Dicalcium Phosphate	2.955	2.885	2.841	2.856	2.866	2.877	2.886	2.897
Sodium Bicarbonate	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Limestone	1.191	1.229	1.253	1.245	1.239	1.233	1.227	1.222
Potassium Chloride	1.034	0.94	0.88	0.9	0.915	0.929	0.941	0.955
Vitamin A[1]	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007
Vitamin D[2]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Choline Chloride	0.246	0.226	0.214	0.218	0.221	0.224	0.227	0.23
Vitamin K[3]	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208
Isoleucine	0.076	0.1	0.136	0.204	0.27	0.335	0.4	0.466
Leucine	0	0	0.044	0.195	0.338	0.482	0.622	0.764
Phenylalanine	0.071	0.094	0.156	0.268	0.386	0.504	0.62	0.737
Trace Mineral[4]	0.065	0.059	0.055	0.057	0.058	0.059	0.059	0.06
Threonine	0.062	0.081	0.113	0.176	0.236	0.297	0.357	0.417
Vitamin Premix[5]	0.05	0.048	0.046	0.047	0.047	0.047	0.048	0.048
Arginine	0.048	0.063	0.098	0.181	0.26	0.34	0.419	0.498
Tryptophan	0.037	0.048	0.062	0.079	0.095	0.112	0.128	0.145
Selenium Premix	0.031	0.03	0.029	0.03	0.03	0.03	0.03	0.03
Valine	0.03	0.039	0.067	0.139	0.208	0.277	0.345	0.414
Glycine	0.028	0.036	0.064	0.139	0.211	0.064	0.353	0.423
Vitamin B_{12}	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
Histidine HCl	0.023	0.03	0.05	0.103	0.153	0.203	0.253	0.303
Vitamin E[7]	0.021	0	0	0 0	0	0	0	
Lysine HCl	0.02	0.106	0.206	0.339	0.595	0.601	0.731	0.862
DL Methionine	0.014	0.018	0.042	0.115	0.182	0.251	0.319	0.387
Cobalt Sulfate	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iodized Salt	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Glutamic Acid	0	0	0	2.607	4.137	6.168	7.193	8.722

A vitamin A source was created by diluting vitamin A with cornstarch to provide 563.41 IU/kg of vitamin A. A vitamin D source was created by diluting vitamin D with cornstarch to provide 220,000 ICU/kg of vitamin D. A vitamin K source was created by diluting vitamin K with cornstarch to provide 840 mg/kg of vitamin K. Trace Mineral Premix supplied the following per kg of diet: zinc, 140,000 mg; copper, 8,000 mg; manganese, 140,000 mg; iron, 130,000 mg. Vitamin Premix provided the following amounts per kg of diet: thiamin, 2,200 mg; niacin, 110,000 mg; folacin, 2,750 mg; vitamin B_{12}, 22 mg; riboflavin, 13,200 mg; pantothenic acid, 33,000 mg; pyridoxine, 4,400 mg; biotin, 440 mg. A vitamin B_{12} source was created by diluting vitamin B_{12} with cornstarch to provide 10,900mg/kg of vitamin B_{12}. A vitamin E source was created by diluting vitamin E with cornstarch to provide 2,750IU/kg of vitamin E.

Table 2: Nutrient Composition [1,2,3] of Experimental Diets for Lysine Trials

Lysine Treatment	0.114%	0.214%	0.314%	0.414%	0.514%	0.614%	0.714%	0.814%
Crude Protein, %	4.82	6.40	7.69	10.88	13.14	15.69	17.38	19.54
ME, kcal/kg	3656	3608	3576	3582	3588	3592	3595	3600
Calcium, %	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Available Phosphorous,	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

the amino acid analysis of corn and multiplied by the determined digestibility coefficients determined.

The treatment levels of percent lysine in the diets were as follows: 0.114, 0.214, 0.314, 0.414, 0.514, 0.614, 0.714 and 0.814. All other amino acids were maintained at 15% excess relative to lysine level based on the Missouri Ideal Turkey Ratio. Glutamic acid was added to the diets to prevent confounding of results due to a generalized nitrogen deficit. Other nutrients, with the exception of essential amino acids, were provided according to NRC (1994) recommendations. As the subject amino acid treatment level increased, essential amino acids were added according to the Missouri Ideal Turkey Ratio, with a 15% safety margin. At the time of diet formulation, the ratio was as follows: Lys 100%, TSAA 59%, Thr 55%, Val 61%, Arg 71%, His 36%, Ile 69%, Leu 124%, Phe+Tyr 105%, and Thr 16%.

Poults were housed in stainless steel batteries in a thermostatically controlled room with constant fluorescent lighting. Access to experimental diets and water was provided *ad libitum* for 7 days. Poults were deprived of feed for 10 hours to remove gut fill prior to being killed (CO_2 asphyxiation), weighed, and frozen for later analysis.

Frozen birds were ground, mixed and a sub-sample was retained for analysis. Samples were weighed and dried in a laboratory oven at 60°C until dry. Ground samples were analyzed by LECO® to determine nitrogen content.

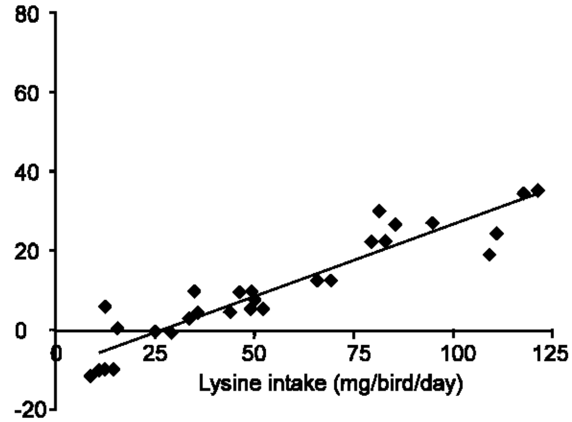

Fig. 1: Plot of Weight Gain (Y) as a Function of Lysine Intake (X), Experiment 1

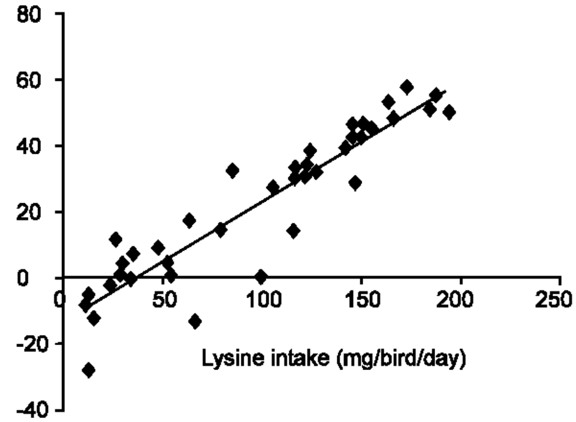

Fig. 3: Plot of Weight Gain (Y) as a Function of Lysine Intake (X), Experiment 2.

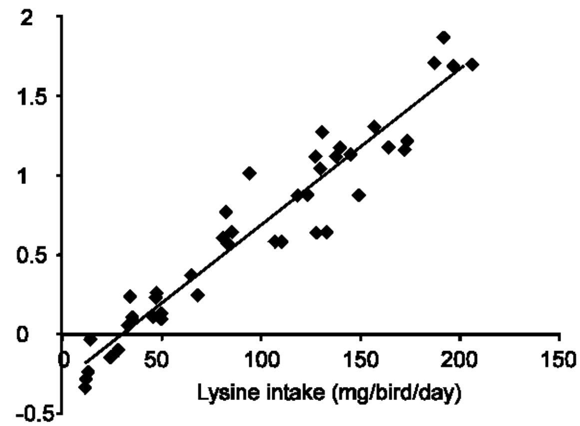

Fig. 2: Plot of Nitrogen Accretion (Y) as a Function of Lysine Intake (X), Experiment 1.

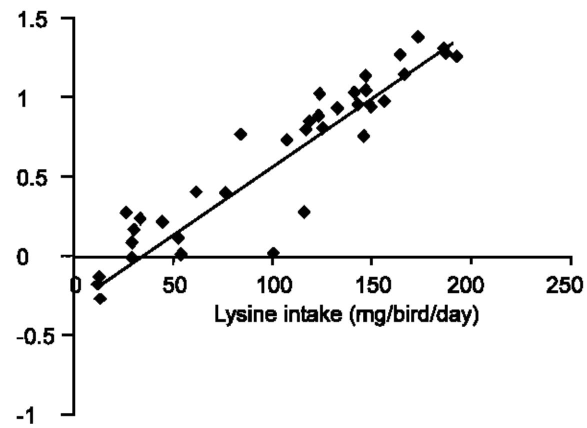

Fig. 4: Plot of Nitrogen Accretion (Y) as a Function of Lysine Intake (X), Experiment 2.

Analysis of data was performed using pen means as the experimental unit. The JMP® version of SAS® statistical software package was used to provide linear regression equations.

Results and Discussion

Two experiments were conducted to determine the digestible lysine requirements for maintenance in the starting turkey. Weight gain and nitrogen accretion responded linearly to lysine intake ($p<0.001$) in each of the trials.

In the first trial, the relationship of weight gain to lysine (Fig. 1) was described by a straight line: Y = 0.3794X - 10.843 (R^2 = 0.95). Based on this equation, the requirement for maintenance of body weight is 28.58 mg/bird/day of lysine; 233.02 mg/kg body weight/day or 59.61 mg/kg$^{.75}$/d when expressed on a metabolic body weight basis. The linear relationship of nitrogen accretion to lysine intake (Fig. 2) was described by the following equation: Y = 0.0098X - 0.2762 (R^2 = 0.94). Solving this equation yields a requirement of 28.18 mg/bird/day of lysine for nitrogen maintenance. When body weight is accounted for, the requirement is 229.76 mg/kg body weight/day or 59.01 mg/kg$^{.75}$/d when expressed on a metabolic body weight basis.

The linear relationships found in the first experiment were supported by the results of the second experiment. The linear regression equation describing the response of weight gain to lysine intake (Fig. 3) is as follows: Y = 0.3572X - 12.043 (R^2 = 0.84). This equation indicates a requirement of 33.72 mg/bird/day of lysine to maintain body weight. The requirement for maintenance of nitrogen content (Fig. 4), 32.83 mg/bird/day of lysine, was described by a straight line: Y = 0.0086X - 0.2823 (R^2 = 0.84). Including body weight in the above equations yields requirements of 317.81 and 309.43 mg/kg body weight/day, respectively or 75.27 and 73.78 mg/kg$^{.75}$/d when expressed on a metabolic body weight basis respectively.

In both of the experiments, linear responses were observed between weight gain and nitrogen accretion with lysine intake ($p<0.001$). Based on these results, it is probable that a linear response is also present between lysine accretion and lysine intake. The results of the experiment supported the use of the same dietary lysine levels for the second trial. The requirements indicated by the two experiments did not agree completely, but the difference in predicted requirements were small when compared to other research (Edwards *et al.*, 1999).

Although the levels indicated previously were sufficient to maintain body weight and nitrogen levels, it is possible that the birds were in a state of lysine deficiency based on ability to maintain lysine levels. Edwards *et al.* (1999) found that, in broilers, the level of lysine that was sufficient for maintenance of body weight and nitrogen content was insufficient for maintenance of lysine levels. Determining the lysine requirement for maintenance of body lysine levels in the starting turkey will require further research. When comparing daily needs for lysine to maintain nitrogen balance versus energy, these values were very similar. In the chick the comparable lysine levels for zero protein accretion ranged from 2.5 and 12 mg/d or 6.9 and 45 mg/kg$^{.75}$/d when expressed on a metabolic body weight basis (Edwards *et al.,* 1999). Dietary lysine requirements of the turkey are substantially higher than those of the broiler and maintenance values determined for the turkey in these studies are substantially higher than those published for the broiler (Edwards *et al.*, 1999). Using average values for both studies yields values for the turkey of approximately 4.2 times higher on a daily basis and 2.6 times higher when adjusted for metabolic body size. These data should be of value when modeling is used for determination of turkey requirements in the future.

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