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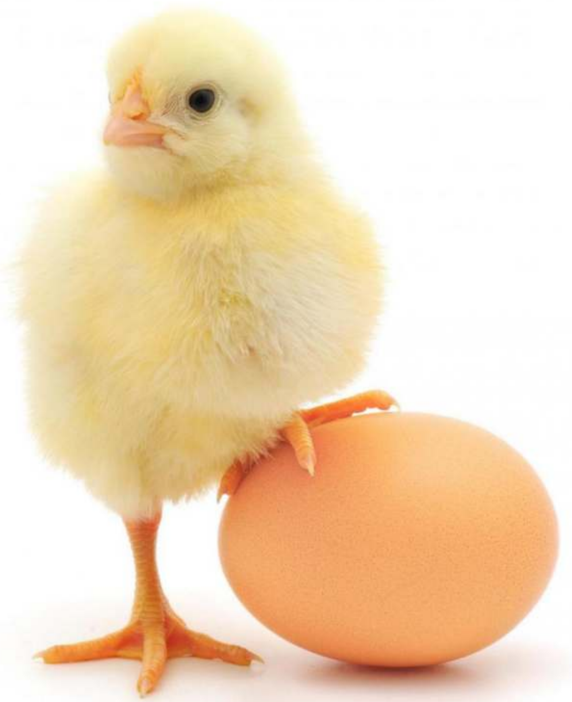

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Digestible Valine Requirements for Maintenance in the Starting Turkey

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Abstract: The objective of these studies was to predict the valine requirement for maintenance in starting turkeys for use in a future modeling system. Amino acid requirement data can be determined in multiple fashions. One method for determining amino acid requirements is through modeling. A portion of the data required for a comprehensive model is the maintenance requirement. Two studies were conducted to determine the maintenance requirement for valine during the starter period for turkeys. Day-old poults (192 birds) were randomly assigned to pens to provide for six replications of eight treatments in two trials and a low protein diet was formulated so that different levels of valine could be fed to young turkeys. The maintenance requirements of valine were approximately 31 and 43 mg/bird/day in experiment 1 and experiment 2, respectively. 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 environmental and physiological conditions.

Key words: Valine, 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 savings of five dollars per ton of feed. 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 the 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 requirements of valine in turkeys are available. The following experiments were designed to determine the digestible valine 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 (Table 1 and 2). 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 provided in purified form. Sand was included as filler in all diets. Other than crystalline amino acids, corn was the only amino acid-containing ingredient used in the experimental diets. Amino acid digestibility values for the corn were obtained through previous testing with cecectomized turkeys.

Table 1: Composition of Experimental Diets for Valine Trials (Experiments 1 and 2)

Valine Treatment, %	0.17	0.22	0.27	0.32	0.37	0.42	0.47	0.52
Corn	53.866	69.709	72.913	70.674	68.435	66.196	63.957	61.717
Sucrose	21.069	4.7	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	2.96	2.95	2.866	2.875	2.885	2.894	2.904	2.913
sodium Bicarbonate	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lime	1.2	1.187	1.239	1.234	1.229	1.224	1.218	1.213
potassium Chloride	1.023	0.932	0.914	0.927	0.94	0.952	0.965	0.978
Vitamin A[1]	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006
Vitamin D[2]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Choline Chloride	0.244	0.225	0.221	0.224	0.226	0.229	0.232	0.234
Vitamin K[3]	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208
Isoleucine	0.29	0.325	0.388	0.462	0.537	0.612	0.687	0.762
Leucine	0.328	0.333	0.435	0.577	0.72	0.863	1.005	1.148
Phenylalanine	0.351	0.378	0.468	0.585	0.703	0.863	1.005	1.148
Trace Mineral[4]	0.064	0.058	0.058	0.058	0.059	0.06	0.061	0.062
Threonine	0.21	0.231	0.28	0.34	0.401	0.462	0.523	0.582
Vitamin Premix[5]	0.049	0.047	0.047	0.047	0.047	0.048	0.048	0.048
Arginine	0.437	0.489	0.584	0.698	0.811	0.925	1.039	1.152
Tryptophan	0.081	0.093	0.108	0.126	0.142	0.159	0.177	0.193
Selenium Premix	0.031	0.031	0.03	0.03	0.03	0.03	0.03	0.03
Valine	0	0	0.04	0.097	0.154	0.211	0.268	0.325
Glycine	0.33	0.364	0.44	0.534	0.628	0.723	0.817	0.911
Vitamin B[6]	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
Histidine HCl	0.141	0.149	0.187	0.237	0.288	0.337	0.387	0.438
Vitamin E[7]	0.0054	0	0	0	0	0	0	0
Lysine HCl	0.614	0.703	0.822	0.954	1.086	1.217	1.349	1.481
DL Methionine	0.173	0.179	0.229	0.297	0.366	0.434	0.502	0.57
Cobalt Sulfate	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iodized Salt	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005
Glutamic Acid	1.794	2.176	2.99	4.283	5.57	6.862	8.152	9.441

[1]A vitamin A source was created by diluting vitamin A with cornstarch to provide 563.41 IU/kg of vitamin A; [2]A vitamin D source was created by diluting vitamin D with cornstarch to provide 220,000 ICU/kg of vitamin D; [3]A vitamin K source was created by diluting vitamin K with cornstarch to provide 840 mg/kg of vitamin K; [4]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; [5]Vitamin Premix provided the following amounts per kg of diet: thiamin. 2,200 mg; niacin. 110,000 mg; folacin. 2,750 mg; vitamin B. 22 mg; riboflavin. 13,200 mg; pantothenic acid. 33,000 mg; pyridoxine. 4,400 mg; biotin. 440 mg; [6]A vitamin B source was created by diluting vitamin B with cornstarch to provide 10,900 mg/kg of vitamin B., [7]A vitamin E source was created by diluting vitamin E with cornstarch to provide 2,750 IU/kg of vitamin E

Table 2: Nutrient Composition[1,2,3] of Experimental Diets for Valine Trials (Experiments 1,2)

Valine Treatment, %	0.17	0.22	0.27	0.32	0.37	0.42	0.47	0.52
Crude protein, %	9.2	11.2	13.00	15.00	17.00	19.00	21.00	23.00
ME, kcal/kg	3642	3594	3584	3587	3591	3594	3597	3601
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

[1]Other nutrients, with the exception of essential amino acids, were provided according to NRC(1994) recommendations; [2]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%; [3]Values were calculated based on the amino acid analysis of corn and multiplied by the digestibility coefficients determined in turkeys

The treatment levels of percent valine in the diets were as follows: 0.17, 0.22, 0.27, 0.32, 0.37, 0.42, 0.47, 0.52. All other amino acids were maintained at 15% excess relative to valine 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.

Poults were housed in stainless steel batteries in a thermostatically controlled room with constant fluorescent lighting. Access to experimental diet 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.

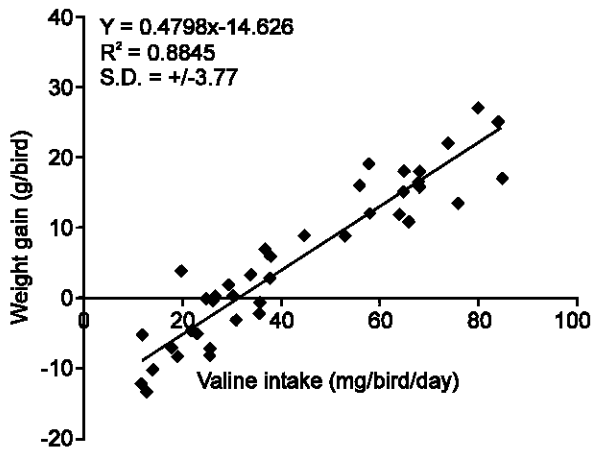

Fig. 1: Plot of Weight Gain (Y) as a Function of Valine Intake (X), Experiment 1

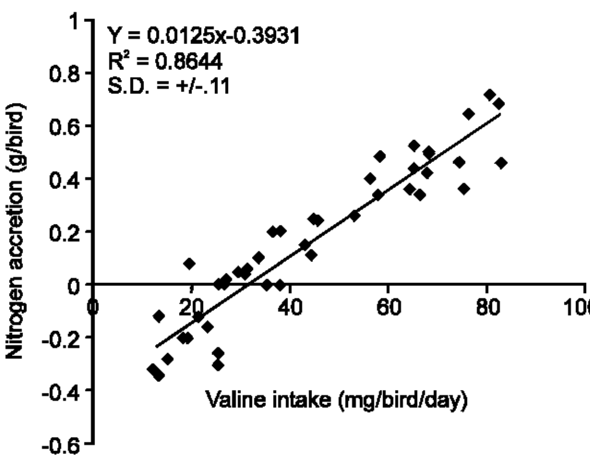

Fig. 2: Plot of Nitrogen Accretion (Y) as a Function of Valine Intake (X), Experiment 1

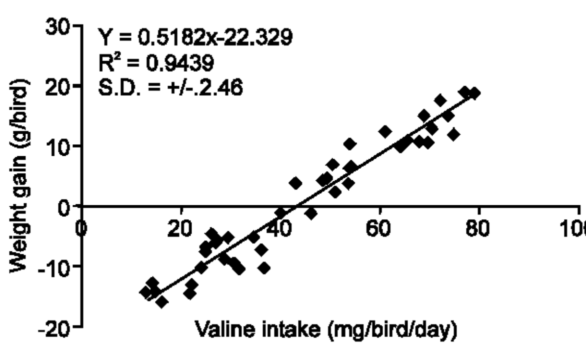

Fig. 3: Plot of Weight Gain (Y) as a Function of Valine Intake (X), Experiment 2

Frozen birds were ground and a sub-sample was retained for analysis. Samples were weighed and dried in a laboratory oven at 60°C for 48 hours. Dried samples

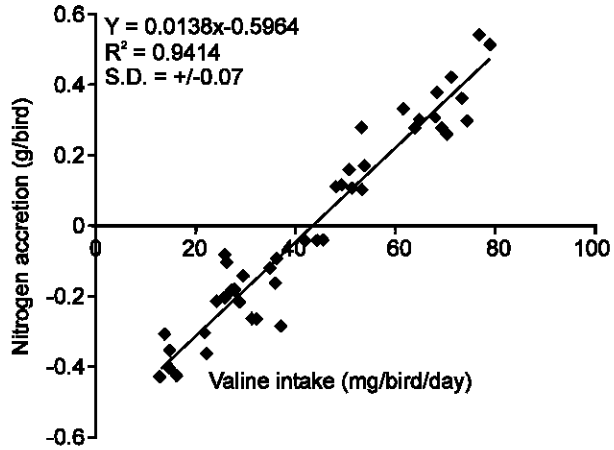

Fig. 4: Plot of Nitrogen Accretion (Y) as a Function of Valine Intake (X), Experiment 2

were weighed to determine dry matter content prior to being ground. Ground samples were analyzed by LECO® to determine nitrogen content.

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

Results and Discussion

Two trials were conducted to determine the digestible valine requirement for maintenance for turkeys during the starter period. Weight gain and nitrogen accretion responded linearly ($p<0.001$) to valine intake in both of the experiments.

In the first experiment, there was a straight-line relationship between weight gain and valine intake (Fig. 1) represented by the following equation: Y = 0.4798x-14.626 (R^2 = 0.89). The predicted requirement from this equation is 30.48 mg/bird/day, which is equivalent to 268.76 mg/kg body weight /day. The relationship of nitrogen accretion to valine intake (Fig. 2) was also described by a straight line: Y = 0.0125x-0.3931 (R^2 = 0.86). Solving this equation yields a requirement of 31.45 mg/bird/day valine for maintenance of nitrogen accretion. Accounting for body weight in the requirement for nitrogen accretion yields a requirement of 277.31 mg/kg body weight/day.

The results of the second trial also indicated linear relationships between weight gain and nitrogen accretion with valine intake. The linear relationship of weight gain to valine intake (Fig. 3) was described by the following equation: Y = 0.5182x-22.329 (R^2 = 0.94). Solving this equation provides a requirement of 43.09 mg/bird/day (378.38 mg/kg body weight/day). The linear regression equation describing the response of nitrogen accretion to valine intake (Fig. 4) is as follows: $Y = 0.0138x-0.5964$ ($R^2 = 0.94$). This equation indicates requirements of 43.22 mg/bird/day and 379.52 mg/kg body weight/day of valine for maintenance of nitrogen level.

Linear responses were observed between weight gain and nitrogen accretion with valine intake ($p<0.001$) in both experiments. Accordingly, there is most likely a linear relationship between valine intake and valine accretion. The same dietary valine levels were used in both experiments, as the levels were low enough to obtain an adequate number of data points above and below the maintenance level. Although there was a lack of continuity in the predicted numbers of the two trials relative to other amino acids we have tested, the requirements predicted by the first trial are probably more accurate based on the tighter fit of the lines obtained in this experiment ($R^2 = 0.94$).

The reason for the lack of agreement between the predicted requirements is difficult to determine. Since the maintenance requirements for amino acids are influenced by a multitude of factors, one can only speculate as to which factors may have had an effect. Mortality levels in the two trials were very similar, so it is doubtful that the difference had anything to do with a disease state. A difference in environmental conditions is the most likely cause for the discrepancy.

The valine requirement for maintenance of valine accretion is more than likely higher than the predicted requirement for maintenance of nitrogen accretion. Baker *et al*. (1996) conducted broiler studies that indicated that birds were in a negative valine balance when fed a level of valine that maintained nitrogen accretion.

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