THE THREONINE REQUIREMENT OF STARTER MALE TURKEY POULTS

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ABSTRACT

Two experiments were conducted to determine the threonine requirement for maximum performance, breast and drum major muscle growth in male turkey poults raised from 0 to 2 and 3 to 5 weeks of age. A corn-peanut meal basal diet with 23.1% crude protein, 2962 Kcal metabolizable energy (ME)/Kg and 0.65% threonine was fed to poults in both experiments. Four increments of 0.15% L-threonine each were added to the basal diet. In the first experiment each treatment was randomly replicated among four cages with five poults in each cage. In the second experiment male poults were randomly distributed among grower cages with three poults in each cage and seven cages per experimental treatment. Maximum performance and gastrocnemius muscle weight of male turkey poults were supported by feeding a corn-peanut meal diet containing 0.80% threonine or 2.70 g threonine/Mcal ME from 0 to 2 and 3 to 5 weeks of age. The threonine requirement that supported maximum growth of the pectoralis major muscle could be estimated, however, it was considered to be lower than 0.65% of diet as well as the threonine requirement for maximum gastrocnemius muscle growth.

Keywords: turkey, threonine, pectoralis major muscle, gastrocnemius muscle

INTRODUCTION

Broiler chicken and turkey meat production was reported to be the biggest poultry meat production operations in the world (Moreng *et al*., 1985). Those researchers reported that the turkey bird could be raised for whole carcass, cut-up parts, and further processed meat. The protein requirement for maximum growth of the turkey bird is in general higher than that of the broiler chicken (NRC, 1994). The protein requirement of the broiler chicken during the first three weeks post hatch is 23% and that of male turkey poults raised from 0 to 4 weeks of age is 28%. Because of the higher protein requirement, practical turkey diets usually contain higher levels of soybean meal than broiler chicken diets (Moreng and Avens, 1985). In general, threonine is the third limiting amino acid for growth preceded by methionine and lysine, especially in practical diets with reduced protein content (Webel *et al*., 1996; Penz *et al*., 1997; Kidd *et al*., 1998).

It has been reported in a recent review on threonine nutrition of poultry that no research work has been conducted on estimating the threonine requirement of turkeys older than 3 weeks of age (Kidd and Kerr, 1996). Since then, several experiments have been conducted on the threonine requirement of turkeys from hatch to market age (Kidd *et al*., 1998; Lehmann *et al*., 1997; Waldroup *et al*., 1998). The threonine requirement for optimum performance was estimated for turkey toms raised from 0 to 4, 8 to 12, and 16 to 20 weeks of age (Lehmann *et al*., 1997). The results of this study showed that the threonine requirement for optimum weight gain and feed efficiency of male poults raised from 0 to 4 weeks of age was about 0.95% or 3.3 g threonine/Mcal ME.

Other studies were conducted to determine the requirement of threonine for turkey toms from hatch to 9 weeks of age (Kidd *et al*., 1998; Waldroup *et al*., 1998). It has been estimated that 0.93% or 3.21g threonine/Mcal ME and 0.97% or 3.34 g threonine/Mcal ME were adequate to support maximum weight gain and feed efficiency, respectively, of male poults fed a corn-peanut meal-soybean meal diet from 0 to 3 weeks of age (Kidd *et al*., 1998). The threonine required for maximum growth and feed efficiency from 3 to 6 weeks of age was 0.88% or 2.81 g threonine/Mcal ME.

With the exception of one study on turkeys (Lehmann *et al*., 1997). where the threonine requirement for optimum breast muscle weight at 20 weeks of age was estimated, the main focus was on body weight and feed intake responses (Kidd *et al*., 1998; Waldroup *et al*., 1998). In the current study the threonine requirement for maximum performance, breast major muscle and drum major muscle weights was estimated in male poults fed a corn-peanut meal diet from 0 to 2 and 3 to 5 weeks of age.

MATERIALS AND METHODS

British United Turkey day old Large White male poults were wing band, debeaked and placed in an electrically heated battery brooder with raised wire floors. At three weeks of age the birds were moved to floor pens with wood shavings. The birds were also fed a nutritionally balanced commercial corn-soybean meal diet. Toms used in the following threonine requirement experiments were selected from that batch.

In the first experiment one hundred male poults were randomly distributed among twenty electrically heated battery brooder cages. There were 5 poults in each cage and the average body weight was similar among all cages. The temperature in the cages at the start of the experiment was around 35°C. Temperature in the room was set at room temperature conditions. Also poults received 23 hours of light per day.

Wheat and/or peanut meal were used besides corn and soybean meal in most threonine requirement experimental diets on turkeys (Kidd *et al*., 1998; Lehmann *et al*., 1997; Waldroup *et al*., 1998; D'Mello, 1976; Rangel-Lugo *et al*., 1994). The diets in these experiments were usually supplemented with a mixture of amino acids. The experimental diets in the present study were similarly prepared. A corn-peanut meal basal diet containing 23.1% crude protein, 2962 Kcal ME/Kg and 0.65% threonine was prepared (Table 1). The crude protein content of the peanut meal was analyzed to be 45.0% (A.O.A.C., 1970).

TABLE 1
Composition of the Basal Diet Fed to Male Turkey Poults from 0 to 2 and 3 to 5 Weeks Post Hatch (Experiments 1 and 2)

Ingredients	Percent
Corn	56.1
Peanut meal	25.8
Soybean meal (48%)	5.50
Fish meal	2.60
Blended fat	2.70
Cellulose (Solka Floc)	0.50
Limestone	1.40
Dicalcium phosphate	1.13
Sodium phosphate monobasic	0.56
Potassium sulfate	0.33
L-lysine.HCl	0.86
DL-methionine	0.30
L-leucine	0.11
L-tryptophan	0.04
L-valine	0.12
Vitamin and Trace mineral premix[1]	2.00
Calculated composition	
Crude protein (%)	23.1
Metabolizable energy (Kcal/Kg)	2962
Threonine	0.65
Analyzed composition	
Crude protein (%)	23.1
Threonine[2]	0.65

[1] Vitamins and trace minerals were supplemented to meet or exceed their requirements for broiler chickens (NRC, 1994).
[2] Archer Daniels Midland, Decatur, Illinois 62525.

To the basal diet four increments of 0.15% L-threonine each were added. The levels of threonine in the experimental diets were 0.65, 0.80, 0.95, 1.10, and 1.25%. All nutrients other than protein and threonine in the basal diet met or exceeded the nutrient requirement of the starter turkey tom (NRC, 1994). Each experimental diet was distributed in a random manner among four cages. The birds were kept on experimental diets for 2 weeks.

The male poults were weighed individually at start and end of the experiment. Also feed was weighed per cage at start and end of the experiment. At termination poults were sacrificed by asphyxia in carbon dioxide and the pectoralis major and gastrocnemius muscles were dissected and weighed. Data was analyzed using One Way ANOVA of the GLM procedure (SAS Institute, 1991). When treatment means were significantly different ($P<0.05$), Duncan's Multiple Range test was used for mean comparison.

The second experiment was conducted to determine the threonine requirement of turkey toms for maximum performance and breast and drum major muscle growth from 3 to 5 weeks of age. The procedure and experimental diet used in this experiment were similar to those followed in Experiment 1. In the present experiment, however, the birds were raised in Petersime grower cages with three toms per cage. The total number of birds used in the present experiment was one hundred and five male poults. Each experimental diet was randomly distributed among seven cages. The left pectoralis major muscle and right gastrocnemius muscle were dissected and weighed.

RESULTS

In Experiment 1, threonine intake, body weight, weight gain, feed intake, and feed efficiency of turkey toms raised from 0 to 2 weeks of age in response to varying levels of threonine are shown in Table 2.

TABLE 2
Performance of Male Turkey Toms Fed a Corn-Peanut Meal Diet with Different Levels of Threonine from 0 to 2 Weeks of Age. (Experiment 1)

Threonine level (%)	Threonine intake (g)[1]	Body weight (g)	Weight gain (g)	Feed intake (g)	Feed efficiency (g:g)
0.65	1.33[c]	182.6[b]	124.6[b]	204.9	0.61[c]
0.80	2.07[b]	236.2[a]	178.3[a]	258.6	0.69[ab]
0.95	2.37[b]	235.3[a]	177.2[a]	249.9	0.71[a]
1.10	2.77[a]	239.4[a]	181.0[a]	251.4	0.72[a]
1.25	3.06[a]	223.0[a]	164.6[a]	245.1	0.67[b]
SEM[2]	0.12	9.96	9.83	12.8	0.01

[1] Means within a column with different superscripts are significantly different ($P \leq 0.05$).
[2] Pooled standard error of the means.

There was a significant increase ($P<0.01$) in threonine intake, body weight, weight gain, and feed efficiency when the level of dietary threonine was increased from 0.65 to 0.80%. Feed intake was increased numerically when threonine level was increased to 0.80% ($P \leq 0.07$). However, increasing threonine level beyond 0.80% had no effect on body weight, weight gain, and feed intake. Threonine intake was increased ($P<0.01$) when the level of threonine was increased to 1.10%. Efficiency of feed utilization of male poults fed the corn-peanut meal diet with 1.25% threonine was less than that of poults fed the diets with 0.95% and 1.10% threonine ($P<0.01$). However, the same poults utilized feed more efficiently than those consuming the diet with 0.65%.

The response of the pectoralis major and gastrocnemius muscle weights and relative weights of male poults raised from 0 to 2 weeks of age to levels of threonine varying between 0.65 and 1.25% have been determined (Table 3). Pectoralis major muscle weight of 2-week-old turkey poults was not affected ($P>0.05$) by changes in dietary threonine between 0.65 and 1.25%. However, there was a decrease ($P<0.01$) in pectoralis major muscle relative weight in response to an increase in threonine from 0.65 to 0.95% and it stayed constant thereafter. The gastrocnemius muscle weight followed the same trend as performance in response to varying threonine levels. There was a numerical increase (P≤0.07) in gastrocnemius muscle percentage weight due to an increase in dietary threonine.

TABLE 3

Breast and Drum Major Muscle Weights and Relative Weights of Male Poults Fed a Corn-Peanut Meal Diet with Varying Levels of Threonine from 0 to 2 Weeks Post Hatch (Experiment 1)

Threonine level (%)	Body weight (g)[1]	Pectoralis major muscle weight (g)	Pectoralis major muscle relative weight (%)	Gastrocnemius muscle weight(g)	Gastrocnemius muscle relative weight (%)
0.65	182.6[b]	6.78	3.71[a]	0.58[b]	0.32
0.80	236.2[a]	8.08	3.40[b]	0.85[a]	0.36
0.95	235.3[a]	7.09	2.98[c]	0.85[a]	0.36
1.10	239.4[a]	6.80	2.82[c]	0.83[a]	0.34
1.25	223.0[a]	6.90	3.06[c]	0.77[a]	0.35
SEM[2]	9.96	0.43	0.09	0.01	0.01

[1] Mean values in the same column with different superscripts differe significantly (P≤0.05).
[2] Pooled standard error of the means.

The performance of toms fed the corn-peanut meal diet with varying levels of threonine from 3 to 5 weeks of age is shown in Table 4. There was a linear increase in threonine intake in response to increasing the level of dietary threonine from 0.65 to 1.25% (P<0.01). Body weight, weight gain, and feed efficiency of toms fed a corn-peanut meal diet with 0.80% threonine were found to be higher (P<0.05) than those of toms fed the 0.65% threonine diet. Feed intake was not affected (P>0.05) by the increase in threonine level from 0.65 to 1.25% in a corn-peanut meal diet.

TABLE 4
Growth Performance of Male Turkey Poults Fed a Corn-Peanut Meal Diet with Threonine Levels between 0.65 and 1.25% from 3 to 5 weeks of age. (Experiment 2)

Threonine level (%)	Threonine intake (g)[1]	Body weight (g)	Weight gain (g)	Feed intake (g)	Feed efficiency (g:g)
0.65	8.76[e]	1279[b]	702.1[c]	1348	0.52[d]
0.80	11.1[d]	1384[a]	807.4[a]	1385	0.58[ab]
0.95	13.2[c]	1392[a]	815.8[a]	1393	0.59[a]
1.10	14.9[b]	1342[ab]	765.8[ab]	1353	0.57[bc]
1.25	16.5[a]	1309[ab]	732.1[bc]	1322	0.55[c]
SEM[2]	0.23	27.93	19.49	25.97	0.006

[1] Means within the same column with different superscripts differ significantly (P≤0.05).
[2] Pooled standard error of the means.

Weight gain of male poults fed the 1.25% threonine diet was lower than those fed the 0.80% and 0.95% threonine, but similar to that of poults fed the diet with 0.65% threonine ($P<0.05$). Male poults consuming the corn-peanut meal diet with 1.25% threonine were found to have an efficiency of feed utilization higher than those fed the 0.65% threonine diet, but lower than those eating the diets with 0.80 and 0.95% ($P<0.05$).

The change in weight of the pectoralis major and gastrocnemius muscles in response to feeding toms a corn-peanut meal diet with varying levels of threonine from 3 to 5 weeks of age has been evaluated (Table 5). There was no change in the weight of the pectoralis major muscle in response to varying the level of threonine from 0.65 to 1.25% in a corn-peanut meal diet fed to toms raised from 3 to 5 weeks of age ($P>0.05$). But the relative weight of that muscle was decreased when the level of threonine was increased to 0.80% ($P\leq0.01$). The gastrocnemius muscle absolute and relative weights were increased when the level of threonine was increased from 0.65 to 0.80% ($P<0.05$).

DISCUSSION

There was a decrease in efficiency of feed utilization in male poults consuming corn-peanut meal diet with 1.25% threonine from 0 to 2 and 3 to 5 weeks of age (Tables 2 and 4). Also during the second period (3-5 weeks) there was a decrease in weight gain of male poults fed the diet with 1.25% threonine. Adding 4% L-threonine to a balanced corn-soybean meal diet reduced weight gain and feed intake without changing the efficiency in feed utilization of the broiler chicken (Edmonds and Baker, 1987). It was apparent in the current work that feeding turkey poults a corn-peanut meal diet with 1.25% threonine from 3 to 5 weeks of age created a mild amino acid imbalance that resulted in an intermediate reduction in weight gain and feed efficiency.

TABLE 5
Pectoralis Major Muscle and Gastrocnemius Muscle Weights and Relative Weights of Male Turkey Poults Fed a Corn-Peanut Meal Diet with Varying Levels of Threonine from 3 to 5 Weeks of Age. (Experiment 2)

Threonine level (%)	Body weight (g)[1]	Pectoralis major muscle weight (g)	Pectoralis major muscle relative weight (%)	Gastrocnemiu s muscle weight (g)	Gastrocnemius muscle relative weight (%)
0.65	1279[b]	68.83	5.40[a]	5.03[b]	0.39[b]
0.80	1384[a]	68.17	4.95[b]	5.77[a]	0.42[a]
0.95	1392[a]	71.93	5.17[ab]	5.82[a]	0.42[a]
1.10	1342[ab]	73.67	5.49[a]	5.68[a]	0.42[a]
1.25	1309[ab]	72.54	5.56[a]	5.48[a]	0.42[a]

The growth response data showed that the threonine requirement supporting maximum weight gain, feed efficiency and gastrocnemiuns muscle weight of male poults raised from 0 to 2 and 3 to 5 weeks of age was 0.80% or 2.70 g threonine/Mcal ME (Tables 2-4). The threonine requirement of male turkey poults raised from 0 to 4 weeks of age on a corn-soybean meal diet containing 2800 Kcal ME/Kg was reported to be 1.0% or 3.57 g threonine/Mcal ME (NRC, 1994). The threonine requirement determined in the current study was less than that estimated in an earlier work where a similar method of estimating threonine needs for maximum performance of male poults was used (D'Mello, 1976). In that study the threonine requirement for maximum performance from 1 to 3 weeks of age was 0.94% or 3.15 g threonine/Mcal ME.

The threonine requirement for maximum feed efficiency was found to be similar to that for maximum weight gain in poults fed a corn-peanut meal diet from 0 to 2 and 3 to 5 weeks of age. Similarly, the threonine requirement for optimum weight gain and feed efficiency were similar for male poults raised from 0 to 4 weeks of age (Lehmann *et al*., 1997). Other studies, however, did not show the same trend with respect to weight gain and feed efficiency needs (Kidd *et al*., 1998; Waldroup *et al*., 1998). In one study, threonine requirement for maximum weight gain was lower than that for maximum feed efficiency of male poults raised from 0 to 3 weeks of age (Kidd *et al*., 1998). However, in the same study the threonine requirements for maximum weight gain and feed efficiency were similar for poults raised from 3 to 6 weeks post hatch.

In contrast the threonine level supporting maximum weight gain was higher than that supporting maximum feed efficiency of male poults raised from 3 to 6 weeks of age (Waldroup *et al*., 1998). Changes in factors such as source of dietary protein and statistical method of estimation may result in differences in the estimated amino acid requirement (Kidd *et al*., 1998; Waldroup *et al*., 1998; Barbour *et al*., 1993). Several other research works concerning threonine requirement of broiler chickens found that the requirement for maximum feed efficiency was either higher or similar to that supporting maximum weight gain (Webel *et al*., 1996; Penz *et al*., 1997; Kidd *et al*., 1997).

In previous studies on turkeys and chickens the response of carcass and cut-up parts to varying dietary threonine levels was mostly evaluated at market age (Lehmann *et al*., 1997; Kidd *et al*., 1997). In the current study, however, the threonine requirement for maximum breast and drum major muscle growth was determined at different ages during the starter period.

There was no change in pectoralis major muscle weight of male poults fed a corn-peanut meal diet from 0 to 2 and 3 to 5 weeks of age. But the percentage weight of that muscle was reduced while body weight was increased in response to varying the level of dietary threonine from 0.65 to 1.25%. Accordingly, the threonine requirement for maximum breast muscle growth of 2 and 5-week-old male poults can be estimated to be less than 0.65% of diet.

In an earlier experiment the interaction between threonine and lysine requirements of broiler chickens raised from 18 to 54 days of age and fed a diet containing wheat, corn gluten meal, soybean meal, and meat and bone meal was studied (Kidd *et al*., 1997). It was observed that varying dietary threonine level between marginal and adequate had no effect on breast muscle, thigh, drum, and wing absolute and relative weights.

The current research had shown that the threonine requirement for maximum growth of the pectoralis major muscle was less than that required for maximum performance.

Threonine requirement of toms raised from 0 to 20 weeks of age for optimum performance was found to be lower than that needed for optimum growth of the breast muscle (Lehmann *et al*., 1997). The threonine requirement for maximum proportional growth profile of the major breast muscle in male turkeys during the first five weeks of age might be different from that of older birds. In addition the gastrocnemius muscle requirement for threonine to achieve maximum growth at 2 and 5 weeks of age was found to be higher than that needed for maximum growth of the breast major muscle.

In conclusion the threonine requirement for maximum weight gain, feed efficiency, and gastrocnemius muscle weight of male poults raised from 0 to 2 and 3 to 5 weeks of age was found to be 0.80% or 2.70 g threonine/Mcal ME. The threonine requirement for maximum weight of the pectoralis major muscle could not be estimated in the current study, but it was considered to be less than 0.65% of diet.

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