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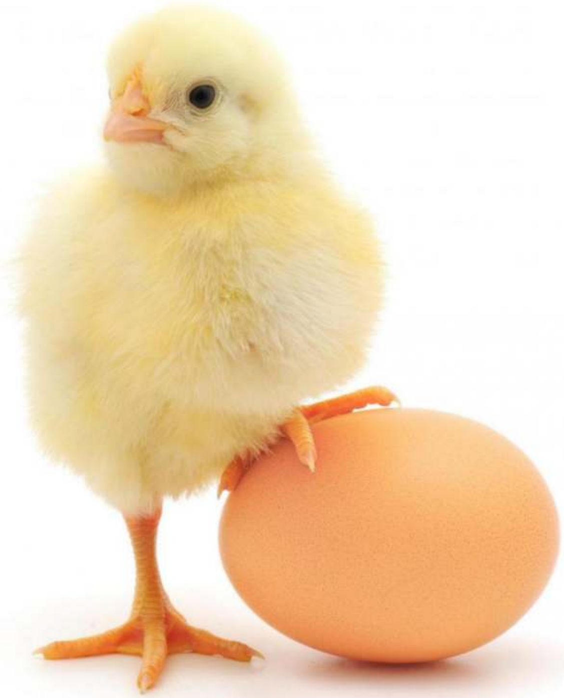

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Threonine Need of Growing Female Broilers[1,2]

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Abstract: A study was conducted to evaluate Thr responses in female broilers from 30 to 42 days of age. Commercial Ross x Ross 508 females were randomly placed into battery cages. A test diet was formulated to provide 0.55% total Thr; progressive increments of 0.05% Thr at the expense of a filler created the experimental diets, up to 0.80% Thr. A conventional-type control diet (0.70% total Thr) was formulated to validate the titration diet which was composed in part by peanut meal, which was necessary to generate a Thr deficiency. Performance of birds fed the control diet was similar ($P < 0.05$) to the titration diet containing equal Thr (0.70%). Deficiency effects of Thr were seen for most variables. Furthermore, linear or quadratic responses occurred for most parameters measured. Optimization of dietary Thr was feasibly calculated for body weight gain and feed conversion, reaching dietary optimums (95% of the asymptote) at 0.69 and 0.71%, respectively. Carcass as well as breast meat improved in a linear manner with increasing dietary Thr. A hypothetical sigmoidal response exhibited by plasma Thr is in close agreement with the Thr requirements extrapolated from live performance measurements. Threonine response estimates obtained in present experimentation are equal to or higher than those previously reported, perhaps as a consequence of the environment to which the birds were exposed to, possibly translating into modifications of associated maintenance and growth requirements for Thr. However, values obtained for the 30 to 42 day-time period are in close agreement with current NRC (1994) recommendations from 21 to 42 days of age.

Key words: Amino acids, carcass composition, live performance, threonine

Introduction

Since the development of feed grade amino acids such as methionine, lysine and threonine, flexibility towards a more balanced dietary protein level while decreasing associated costs has been achieved by nutritionists around the world. This has been convenient considering that these three amino acids are typically the most limiting in practical diets fed to broilers. Recently there has been extensive research in the area of dose-response studies in order to determine the need for a specific amino acid under different environmental conditions, particularly for these aforementioned amino acids. However, environmental conditions might result in different needs for specific amino acids as has been observed for Thr (Kidd *et al.*, 2003a).

Threonine has been well recognized for its maintenance characteristics associated with the digestive tract (Specian and Oliver, 1991; Stoll *et al.*, 1998; Van Der Schoor *et al.*, 2002) and virtues towards maximizing productivity (Kidd and Kerr, 1997; Penz *et al.*, 1997; Kidd *et al.*, 1999; Dozier *et al.*, 2000; Kidd *et al.*, 2003a; Kidd *et al.*, 2003b). However, there seems to be considerably less research focusing on the need for amino acids by females in comparison to males. Thus, this study focuses on Thr needs of commercial female broilers raised in a relatively clean environment (battery cages) during a time-frame (30-42 days) that has received less attention.

Materials and Methods

Commercial Ross x Ross 508 broiler females were obtained from a local hatchery where they had been vaccinated for Marek's Disease virus, Newcastle Disease virus, and infectious bronchitis virus. Upon arrival at the Poultry Science Research Farm at Mississippi State University, chicks were placed into a broiler house with fresh pine shavings until 27 days of age. They were then transferred and randomly allocated into 42 cages (3 Petersime batteries; 6 cages/trt; 5 birds/cage), in a room having thermostatically controlled heating and ventilation. Each cage had one trough drinker and feeder. Lighting regimen consisted of 23 hours of light and 1 hour of darkness. All birds were provided common diets in mash form from 0 to 18 and 19 to 30 days of age, formulated to meet nutritional recommendations (NRC, 1994). Experimental diets were then fed to the birds from day 30 to 42. A titration diet composed primarily of corn, peanut meal and

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Table 1: Composition of experimental diets

Ingredient	(g/kg)	
	Titration diet	Control diet
Yellow corn	625.69	660.76
Peanut meal	185.45	-----
Soybean meal 48%	74.11	255.33
Poultry oil	60.29	40.63
Dicalcium phosphate	19.43	18.43
Limestone	10.56	10.81
Lysine sulfate	8.08	2.59
Sodium chloride	4.89	5.38
Filler[1]	3.00	0.50
DL-Methionine	2.56	2.09
Vitamin/mineral premix[2]	2.50	2.50
Choline chloride	1.41	0.67
L-Isoleucine	1.05	-----
L-Valine	0.59	------
Sodium bicarbonate	0.38	------
L-Threonine	------	0.31
Calculated composition[3]		
ME (Kcal/kg)	3150	3150
Crude protein (%)	18.0	18.0
Lysine (%)	1.05	1.05
Total sulfur AA (%)	0.80	0.80
Threonine (%)	0.55	0.70

[1]Filler represent inert space (sand) in the diet to which L-threonine was added at its expense. [2]The vitamin and mineral premix contained per kg of diet: retinyl acetate, 2,654 μg; cholecalciferol, 110 μg; dl-α-tocopherol acetate, 9.9 mg; menadione, 0.9 mg; B_{12}, 0.01 mg; folic acid, 0.6 μg; choline, 379 mg; d-pantothenic acid, 8.8 mg; riboflavin, 5.0 mg; niacin, 33 mg; thiamin, 1.0 mg; d-biotin, 0.1 mg; pyridoxine, 0.9 mg; ethoxiquin, 28 mg; manganese, 55 mg; zinc, 50 mg; iron, 28 mg; copper, 4 mg; iodine, 0.5 mg; selenium, 0.1 mg. Calculated and analyzed (in parenthesis) values are as follows: CP-titration, 18% (18.5%); CP-control, 18% (18.3%); Thr-titration, 0.55% (0.59%), 0.60% (0.65%), 0.65% (0.68%), 0.70% (0.73%), 0.75% (0.77%), 0.80% (0.83%); Thr-control, 0.70% (0.74%).

Table 2: Live performance of broiler females fed supplemented levels of threonine from 30 to 42 days of age

Dietary threonine %	BW gain (g)	Feed intake (g)	Feed:gain
Control (0.70%)	809[a]	1503	1.86[bc]
0.55	712[b]	1490	2.10[a]
0.60	832[a]	1571	1.89[bc]
0.65	821[a]	1554	1.89[bc]
0.70	808[a]	1544	1.91[b]
0.75	858[a]	1532	1.79[c]
0.80	828[a]	1525	1.85[bc]
SEM	26.9	32.7	0.040
Analysis of variance			
	------------ Probability	--------------	
Thr	0.020	0.62	0.001
Thr linear	0.017	0.87	0.001
Thr quadratic	0.070	0.16	0.055

[a-c]Means within a column not sharing a common superscript differ (P < 0.05). Cubic responses were not significant (P > 0.05).

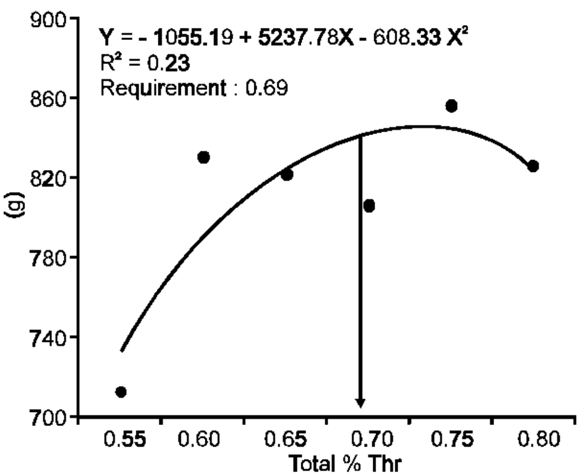

Fig. 1: Dietary threonine need for maximization of body weight gain (95% of upper asymptote) of broiler females from 30 to 42 days of age.

soybean meal (Table 1) was formulated to contain 0.55% Thr, to which progressive increments of 0.05% Thr were added to the diet in the form of L-Thr at the expense of a filler (sand) generating 6 experimental treatments. All other amino acids were formulated to provide a minimum of 105% of NRC (1994) recommendations. A diet simulating conventional-industrial parameters was formulated (0.70% Thr) and served as a control group. All experimental diets were analyzed for protein bound and supplemented amino acids to reaffirm expected amino acid levels (Llames and Fontaine, 1994). Weight gain and feed consumption were measured for the 30 to 42 day period.

Neither feed conversion nor consumption was corrected for mortality because 100% livability occurred.

One bird per cage was bled via intra-cardial puncture; collected blood samples were centrifuged at 4000 rpm for 10 minutes. Plasma was removed and frozen at -70 ^{o}C, and subsequently sent for amino acid analysis[1].

All remaining birds were placed into transportation

[1]USDA, National Swine Research and Information Center, Ames, IA 50011, USA.

Table 3: Carcass, abdominal fat, and breast meat of broiler females fed supplemented levels of threonine from 30 to 42 days of age

Dietary threonine %	Whole carcass		Abdominal fat		Breast meat	
	Weight (g)	Yield (%)	Weight (g)	%[1]	Weight (g)	%[1]
Control (0.70%)	1149	66.4	28[a]	2.4[a]	304	26.4
0.55	1130	66.5	35[b]	3.0[c]	289	25.5
0.60	1174	66.6	34[b]	2.8[bc]	305	25.9
0.65	1196	67.2	31[a]	2.5[ab]	319	26.7
0.70	1191	67.3	35[b]	2.9[bc]	316	26.5
0.75	1175	67.1	29[a]	2.4[a]	305	26.0
0.80	1207	68.3	35[b]	2.9[bc]	321	26.6
SEM	24.6	0.67	1.9	0.14	9.4	0.39
Analysis of variance						
	Probability					
Thr	0.32	0.46	0.02	0.001	0.21	0.32
Thr linear	0.04	0.05	0.51	0.17	0.04	0.15
Thr quadratic	0.30	0.68	0.16	0.064	0.21	0.26

[1]Values expressed as a proportion of the carcass. [a-c] Means within a column not sharing a common superscript differ (P < 0.05). Cubic responses were not significant (P > 0.05).

coops and taken to the Mississippi State University processing plant, where they were manually removed from coops, hung on shackles, stunned with electricity, and bled for 3 minutes after the jugular vein was severed. Birds remained on shackles and were dipped in a hot water scalder for 90 seconds. Birds were manually placed into a rotary picker and defeathered for 2 minutes. After hocks and heads were removed, birds were manually hung on an moving shackle line where they were washed and manually eviscerated. Abdominal fat and carcasses without giblets were weighed. Carcasses were then rewashed and allowed to chill in an ice bath for 4 hours. Breast muscles were removed from chilled carcasses on a manual deboning line and their weights recorded.

Cage was used as the experimental unit for analyses. The study was designed as a randomized complete block were battery served as block. All data were analyzed using the General Linear Model procedure of SAS (SAS, 1996). Differences among means (P<0.05) were separated with repeated t test using the LSMEANS procedure of SAS. Quadratic responses were measured using the General Linear Model procedure of SAS, and when quadratic responses occurred, optimization was calculated by extrapolating 95% of the asymptote.

Results and Discussion

Live performance was exceptional throughout the study characterized by 100% livability for all experimental treatments. Calculated composition for CP and Thr of the experimental diets were in close agreement with analyzed values (Table 1). The control diet composed of corn-soybean meal yielded birds of equal performance as those fed the titration diet, thus validating the dose-response-experimental-diet's ability to support growth. Both body weight gain and feed:gain showed dietary effects for Thr, and displayed linear and quadratic trends (Table 2). Even though the probability values for quadratic responses were close to being statistically significant for P < 0.05, the regression model and variables possessed reasonable fit. Fig. 1 displays the estimate for Thr optimization with regards to body weight gain (0.69% Thr). In close agreement with weight gain, feed conversion (Fig. 2) had a similar optimization point (0.71% Thr). However, no apparent effect was observed for feed consumption. The need for dietary Thr for maximization of live performance seemed to be somewhat higher than previously reported (Thomas *et al.*, 1995; Kharlakian *et al.*, 1996). It should be considered that former studies evaluated Thr need from 35 to 49 days, and not 30 to 42 days as did the present study. Based on recommendations by Kidd *et al.* (2003b) of 0.60 to 0.67% Thr for 42 to 56 day-old females, results are in close agreement considering that this study was held on female broilers at a younger age and that most amino acid requirements diminish with age. Results are also in agreement with recommendations made by Dozier *et al.* (2001) of 0.63% Thr for an older age.

Free plasma Thr concentration displayed a strong linear effect with dietary Thr. Graphically, the plotted data (Fig. 3) exhibited a similar response to that previously described by Morrison *et al.* (1961), in which plasma free concentration of a fed amino acid from a deficient to an adequate diet acquires the characteristics of a third order polynomial line. It can be noted that a drastic increase occurred after 0.65% Thr suggesting that the requirement for Thr may be in the vicinity of 0.65%, in parallel to results obtained for body weight gain and feed conversion.

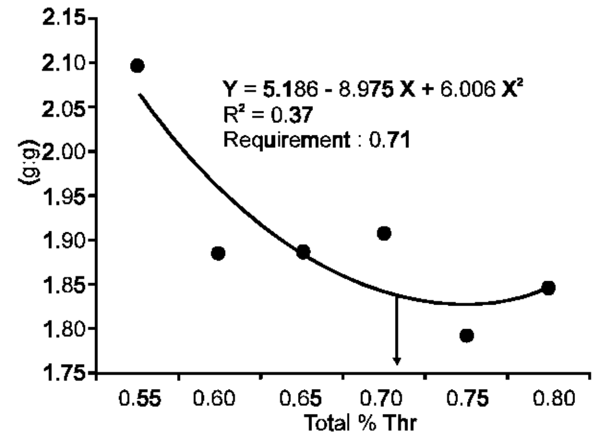

Fig. 2: Dietary threonine need for maximization of feed conversion (95% of lower asymptote) of broiler females from 30 to 42 days of age.

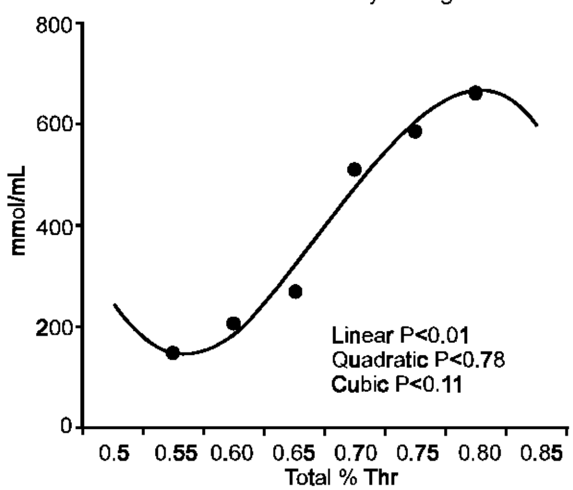

Fig. 3: Dietary threonine effect on plasma free threonine of broiler females at 42 days of age. Trend line is a hypothetical-adaptation of a 3rd order polynomial equation.

Carcass traits did not respond in a quadratic manner, however, a linear effect was observed for whole carcass as well as its proportion to the live weight (Table 3). Furthermore, results for breast meat weight were in parallel to those observed with the carcass, manifesting what seems to be a deficiency with the lower thr levels fed that was diminished with Thr supplementation. A linear effect was also seen for breast meat analogous to that displayed by the carcass. A treatment effect was observed for abdominal fat but no statistical trend was detected. An explanation for the irregular pattern exhibited by abdominal fat with Thr supplementation is elusive.

Environment has been shown to affect Thr needs of broilers (Kidd *et al.*, 2003a), so it is conceivable that a higher need for Thr may occur under more practical conditions where broilers would be exposed to microbial challenges, subsequently increasing maintenance requirements associated with intestinal functions where Thr is in vast demand. Furthermore, it is conceivable that petersime-battery cages resulted in a reduction of the energy requirement due to decrease bird activity, in turn affecting overall metabolism leading to an adjustment in Thr need for maintenance and growth. In conclusion, additional research is warranted to determine if the Thr requirement of females for this specific age differ under diverse environmental conditions.

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