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# Digestible Threonine Needs of Straight-Run Broiler During the Growing Period

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**Abstract:** There is scanty of information on Threonine (Thr) requirements of mixed-sex broiler chickens during the grower period. An experiment was conducted to determine the digestible Thr requirements of straight-run Ross 308 broilers from 15-28 days of age. Basal diet consisting of wheat, triticale and corn gluten meal was formulated to meet or exceed the nutrient requirements except for Thr. Graduation levels of supplemental Thr were added to the basal diet at expense of corn starch generating six treatments to provide a range from 0.46-0.81% of digestible Thr. Both male and female birds were randomized across 48 floor pens (4 replicates and 12 birds per each replicate) in a completely randomized design and each pen was fed one of six amino acid levels from 15-28 days of age. Body weight gain, feed intake, feed conversion, digestible Thr intake and mortality were measured during the experimental period. Body Weight Gain (BWG) and Feed Conversion (FC), Feed Intake (FI) and daily Thr intake responded quadratically to graded levels of digestible Thr (0.46-0.81% of diet). Digestible Thr requirements were estimated using a linear broken-line and quadratic broken-line models. Based on broken-line linear model, digestible Thr requirement for straight-run Ross 308 broilers was determined to be 0.69 and 0.76% for BWG and FC, respectively. However, using broken-line quadratic model, digestible Thr was estimated at 0.79% for BWG.

**Key words:** Digestible threonine, straight-run, spline model, randomized, graduation level, quadratically

## INTRODUCTION

In order to least cost feed formulation usage of synthetic amino acids in the diet is of utmost important. Threonine is the third limiting essential amino acid behind Methionine (Met) and Lysine (Lys) in poultry diet and has profound effects on broiler performance and Lys utilization (Kidd, 2000) and increasing dietary Lys without an increase in Thr may limit breast meat yield (Dozier *et al*., 2008).

Threonie as a main constitute of gut secretions is the one of the most critical amino acids at the intestinal level and epithelial maintenance and increase in Thr requirement in gut due to microbial infections may be occurred (Corzo *et al*., 2007). Microbial contamination of gastrointestinal tract may results in higher secretion of mucin production and higher Thr needs of the birds (Corzo *et al*., 2007). On other hand, restriction of dietary Thr significantly impairs mucin synthesis in the gut and consequently reduces gut barrier function.

Variation existed in estimated Thr requirement is owning to sex, age, strain, dietary Crude Protein (CP), environmental conditions (Corzo *et al*., 2007; Dozier *et al*., 2000; Mack *et al*., 1999; Rosa *et al*., 2001). However, Barkely and Wallis reported that the age of the bird and dietary CP are highly significant determinants of Thr requirements.

Threonine needs of broilers will be decreased with age (NRC, 1994; Samadi and Liebert, 2006) suggesting that Thr may become more important in older birds, possibly because of higher maintenance requirement (Kidd and Kerr, 1996). On other hand, the Thr requirement of chicks fed the high-protein diet was significantly higher than the birds received low-protein diet (Kidd and Kerr, 1996).

Also amino acid need of the birds is affected by gender and male and female responded differently to dietary amino acid concentrations (Penz *et al*., 1997; Dozier *et al*., 2001). However, others showed that Thr estimates from male and female requirement were similar (Holsheimer *et al*., 1994; Thomas *et al*., 1995).

In Iran, most poultry producers rear mixed sex broiler chicks. The practice of feeding straight-run broilers may result in overfeeding nutrients to females and underfeeding nutrients to males. So the aim of this study was to determine Thr needs of straight-run broilers from 15-28 days of age.

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## MATERIALS AND METHODS

An experiment was conducted using Ross 308 broiler chickens from 15-28 days of age. Broiler chicks (288 birds: 144 males and 144 females) were obtained from commercial hatchery with both male and female chicks originating from the same breeder flock. The birds were fed common starter diets according NRC (1994) recommendations until Day 14 posthatching. At 15 days of age after overnight feed withdrawal, chickens were weighed; wing-banded and randomly allotted to pens (12 birds per pen) in order to have equal numbers of males and females and to have same average body weight between pens. Birds and feed were weighted on day 15 and 28 for the determination of BWG, FC, FI and digestible Thr intake per day. Lighting program was 23L:1D during the experimental period. The temperature at d 1 was 33°C and was decreased to 28°C by 14 days of age. The high and low temperatures for the 15-28 days period were 26 and 24°C, respectively.

Table 1: Chemical composition of Thr-deficient basal diet

| Ingredients | Percentage |
|---|---|
| Wheat, Red | 60.00 |
| Triticale | 11.95 |
| Corn gluten meal | 10.50 |
| Soybean meal | 5.00 |
| Sunflower oil | 5.00 |
| Corn starch | 1.85 |
| Dicalcium phosphate | 1.76 |
| Limestone | 1.21 |
| L-Lysine HCl | 0.71 |
| DL-methionine | 0.20 |
| L-Arg | 0.30 |
| L-Ile | 0.20 |
| L-Trp | 0.03 |
| NaCl | 0.10 |
| Sodium bicarbonate | 0.69 |
| Vitamin premix[1] | 0.25 |
| Mineral premix[2] | 0.25 |
| **Calculated nutrient content** | |
| ME (kcal $kg^{-1}$) | 3123.00 |
| CP (%) | 18.78 |
| SID Lys (%) | 1.00 |
| SID Met (%) | 0.48 |
| SID Met+Cys (%) | 0.76 |
| SID Thr (%) | 0.46 |
| SID Arg (%) | 0.98 |
| SID Ile (%) | 0.77 |
| SID Val (%) | 0.67 |
| SID Trp (%) | 0.17 |
| Ca (%) | 0.89 |
| AP[3] (%) | 0.46 |
| Sodium (%) | 0.22 |
| DEB[4] (mEq $kg^{-1}$) | 154.00 |

Mineral premix provided per kilogram of diet: Mn (from $MnSO4•H_2O$), 65 mg; Zn (from ZnO), 55 mg; Fe (from $FeSO_4•7H2O$), 50 mg; Cu (from $CuSO_4•5H_2O$), 8 mg; I [from Ca $(IO_3)2•H_2O$], 1.8 mg; Se, 0.30 mg; Co (from Co2O3), 0.20 mg; Mo, 0.16 mg; Vitamin premix provided per kilogram of diet: vitamin A (from vitamin A acetate), 11,500 IU; cholecalciferol, 2,100 IU; vitamin E (from dl-α-tocopheryl acetate), 22 IU; vitamin B12, 0.60 mg; riboflavin, 4.4 mg; nicotinamide, 40 mg; calcium pantothenate, 35 mg; menadione (from menadione dimethyl-pyrimidinol), 1.50 mg; folic acid, 0.80 mg; thiamine, 3 mg; pyridoxine, 10 mg; biotin, 1 mg; choline chloride, 560 mg; ethoxyquin, 125 mg; Available Phosphorus; Dietary Electrolyte Balance, represents dietary Na+K-Cl in m Eq $kg^{-1}$ of diet

Basal diet consisting of wheat, triticale, corn gluten meal and soybean meal (Table 1) was formulated to meet or exceed the requirements recommended by NRC (1994) containing different levels of dietary digestible Thr. Six graded levels of supplemental Thr were added to the basal diet at the expense of corn starch to generate six levels of digestible Thr that ranged from 0.46-0.81% in 0.07% increments. Standardized amino acid digestibility (SID) values were calculated using published digestible coefficients of raw materials (Lemme *et al*., 2004) and analyzed total amino acid content of the ingredients (method 985.28, 994.12; AOAC, 2006).

In this experiment, gradient treatment structure was conducted as a completely randomized design. The 6 dose-response diets for Thr were fed to each pen with 4 replicates. All data were subjected to Mixed procedure using linear and quadratic responses to explain potential effects of digestible Thr (SAS Institute, 2004). Differences among means ($p \leq 0.05$) were separated using LSMEANS option of (SAS Institute, 2004). Both broken-line linear and broken-line quadratic models were used for estimation of digestible Thr needs using NLIN procedure (Robbins *et al*., 2006).

## RESULTS AND DISCUSSION

Least square means comparison among treatments was significant for growth performance. And significant quadratic responses ($p<0.0001$) were observed for BWG, FC, FI and daily Thr intake to incremental levels of dietary Thr (Table 2). Based on broken-line linear model, digestible Thr requirement was estimated at 0.69 and 0.76% for BWG and FC, respectively (Table 3). The Thr requirement for BWG was obtained to be 0.79% using broken-line quadratic model (Table 3 and Fig. 1).

Broiler diets containing wheat, soybean meal and corn gluten meal typically result in Thr being the third limiting essential amino acid. In term of BWG, Kidd *et al*. (2004) and Mack *et al*. (1999) estimated the digestible Thr requirement of male broilers at 0.65 and 0.57%, respectively. Using linear broken-line model, we estimated the digestible Thr requirement of growing broilers at 0.69 and 0.76% for BWG and FC, respectively. The digestible Thr requirement for BWG was 0.79% of diet based on quadratic broken-line model. More recently, Corzo *et al*. (2007) evaluated the Thr needs of female broilers from 14-28 days of age. They estimated the digestible Thr requirement for BWG at 0.79% using quadratic broken-line model which was similar to this study. Many factors can influence the amino acid requirements of broiler chickens including age, sex, strain, response criteria and statistical model (Han and Baker, 1994; Rosa *et al*., 2001; Pesti *et al*., 2009). One of the main differences between previous results and the current study may related to gender. Kidd *et al*. (2004) and

Table 2: Growth performance of straight-run broilers fed graded levels of digestible Thr from 15-28 days of age

| Dietary dig. Thr | BWG (g) | Feed intake (g) | Thr intake (mg $d^{-1}$) | FCR (g:g) | Mortality (%) |
|---|---|---|---|---|---|
| 0.46 | 743$^{e}$ | 1321$^{c}$ | 434$^{f}$ | 1.78$^{a}$ | 3.15$^{a}$ |
| 0.53 | 800$^{d}$ | 1354$^{c}$ | 513$^{e}$ | 1.69$^{b}$ | 0.74$^{bc}$ |
| 0.60 | 861$^{c}$ | 1397$^{b}$ | 598$^{d}$ | 1.62$^{c}$ | 0.15$^{c}$ |
| 0.67 | 876$^{b}$ | 1345$^{c}$ | 644$^{c}$ | 1.53$^{d}$ | 0.58$^{c}$ |
| 0.74 | 899$^{a}$ | 1396$^{b}$ | 738$^{b}$ | 1.55$^{d}$ | 1.50$^{bc}$ |
| 0.81 | 899$^{a}$ | 1444$^{a}$ | 835$^{a}$ | 1.60$^{c}$ | 1.75$^{ab}$ |
| SEM | 4.79 | 11.53 | 5.08 | 0.01 | 0.50 |
| **Source of variation** | | | | | |
| Linear response | <0.0001 | 0.0011 | <0.0001 | <0.0001 | 0.0406 |
| Quadratic response | <0.0001 | 0.2020 | 0.6603 | 0.0002 | 0.0006 |

Means in each columns with different superscripts are significantly different ($p<0.05$)

Table 3: Digestible Thr requirement of straight-run broilers from 15-28 days of age fed graded levels of digestible Thr based on broken-line regression models

| Response criteria | Estimated requirement | 95% CI** | $R^2$ |
|---|---|---|---|
| **Broken-line linear model*** | | | |
| BW gain | 0.69±0.006 | 0.67-0.70 | 0.98 |
| Feed conversion | 0.76±0.02 | 0.71-0.80 | 0.93 |
| **Broken-line quadratic model*** | | | |
| BW gain | 0.79±0.02 | 0.75-0.82 | 0.98 |

*The linear broken-line model is $y = L+[U\times(R-x)]$ and the quadratic broken-line model is $y = L+[U\times(R-x)\times(R-x)]$ where L is the ordinate, U is the abscissa of the breakpoint and R is zero if x>R. Requirement estimates are presented with±SEM. **95% confidence interval of the digestible Thr requirement

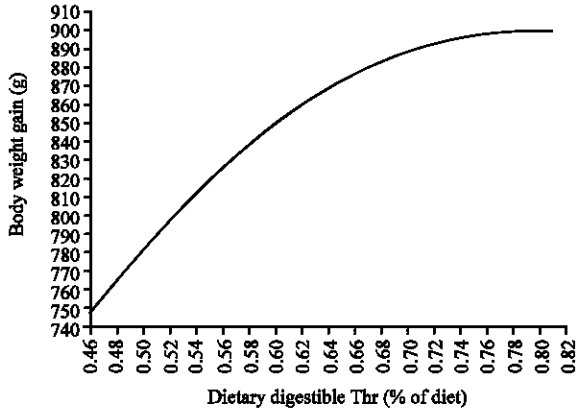


Fig. 1: Digestible Thr needs of straight-run broilers using broken-line quadratic model from 15-28 days of age

Mack *et al.* (1999) have used male broilers for their experiment and Corzo *et al.* (2007) used female broilers.

In this experiment we used straight-run broilers and the results were similar to Corzo *et al.* (2007) which used female broilers.

Statistical model to predict amino acid requirements can significantly affects the estimated value (Pesti *et al.* 2009).

In earlier experiments, the most researchers have used monomolecular model to predict amino acid requirements. However, it has been suggested that the spline models have advantages for estimation of amino acid needs (Pesti *et al.* 2009).

Although linear broken-line model is the appropriate tool for estimation of ideal ratio of amino acids (Baker *et al.* 2002), quadratic broken-line regression models diminishing marginal productivity until the level of the requirement is reached (Pesti *et al.* 2009). Most nutritional responses have a plateau portion and inflection point clearly define the classical concept of requirement for response variable. Second order polynomials such as monomolecular models are not able to define an objective point (Baker *et al.*, 2002; Pesti *et al.*, 2009), therefore the estimated requirement values resulted from second order polynomials may be questionable.

## CONCLUSION

In this study, Thr-deficient basal diet containing wheat, triticale and corn gluten meal are suitable for estimation of Thr requirement. According to this experiment, the digestible Thr requirement of straight-run broilers from 15-28 days of age was estimated from 0.69-0.79% of diet based on different response criteria and statistical model and further research is needed for estimation of amino acid requirements of mixed-sex broilers.

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