Journal of Animal and Veterinary Advances 9 (4): 700-704, 2010
ISSN: 1680-5593

Dietary Tryptophan Effects on Growth Performance and Blood Parameters in Broiler Chicks

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Abstract: In order to study the effect of Tryptophan (Trp) on growth performance and blood parameters of broiler chickens, an *in vivo* experiment was conducted. A corn-soybean meal based diet containing different levels of Trp (0, 0.10 and 0.20) for the starter, (0, 0.07 and 0.15) for the grower and (0, 0.05 and 0.13) for the finisher was used. In a completely randomized design with three treatments of five replicates each and 10 chickens per replicate, 150 Cobb500 male broiler chickens from 0-49 days of age were subjected to Trp diet. Growth performance (body weight gain, feed intake and feed, gain ratio) and blood serum (albumin, total protein, glucose, cholesterol, triglyceride, urea, uric acid, aspartate amino-transferase, alanine amino-transferase, alkalin phosphatase, lactic dehydrogenase and creatine kinase) parameters were measured at 27 and 49 days of age. As the result showed the increase of dietary Trp elevated ($p<0.05$) body weight gain, feed intake, albumin, total protein, glucose, urea and uric acid and decreased ($p>0.05$) feed gain ratio, aspartate amino-transferase, lactic dehydrogenase, triglyceride and cholesterol. Therefore, we conclude that dietary Trp might have positive effects on health status of the broiler chickens.

Key words: Tryptophan, growth performance, blood parameter, broiler chicken, body weight, feed intake

INTRODUCTION

Tryptophan is an essential amino acid in poultry and is required for a wide variety of metabolic activities. Because its concentration in organisms is among the lowest of all amino acids, it can easily play a rate-limiting role in protein synthesis. Apart from being a structural component of all proteins it is a precursor for synthesis of two hormones, serotonin and melatonin. These hormones generally act in the classic check and balance mode with serotonin predominating during periods of activity (usually daylight) and melatonin predominating during periods of rest (usually nighttime). In chickens, the adaptive control of circadian rhythums by serotonin and melatonin is well known particularly that related to rhythms associated with blood pressure, body temperature, feed intake, growth and repair of tissues. In addition to all aforementioned, Trp has also been linked with niacin biosynthesis in chickens (Corzo *et al*., 2005a). There is little information in the literature about Trp requirements for broilers and some of the results are controversial. For example, dietary Trp has been found to be optimum for male chicken at total concentration of 1.4 g kg^{-1} (Shan *et al*., 2003), 1.6 g kg^{-1} (Rosa *et al*., 2001), 1.9 g kg^{-1} (Steinhart and Kirchgessner, 1984) and 2.2 g kg^{-1} (Corzo *et al*., 2005a, b). The quantification of Trp may allow for a reduction in dietary protein and thus, nitrogen excretion.

The experiments reported here were conducted to determine the Trp requirement and to evaluate the effects of dietary Trp levels on maximum growth performance and blood parameters.

MATERIALS AND METHODS

Three different dietary levels (A, B and C) of Trp for three age group periods (starter, grower and finisher) of broiler chickens were used. There were (Table 1) three levels of Trp for the Starter (S) 0-21 days of age (S-A, 0-control; S-B, 0.10 and S-C, 0.20), three levels for the Grower (G) 21-42 days of age (G-A, 0 - control; G-B, 0.07 and G-C, 0.15) and three for the Finisher (F)

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Table 1: Composition of experimental diets of broiler chickens during 0-49 days of age

	Starter (S)			Grower (G)			Finisher (F)		
Ingredients	S-A	S-B	S-C	G-A	G-B	G-C	F-A	F-B	F-C
Corn grain	54.4	54.4	54.4	67.9	67.9	67.9	71.1	71.1	71.1
Soybean meal	35.3	35.3	35.3	22.6	22.6	22.6	20.03	20.03	20.03
Fish meal	1.09	1.09	1.09	4.3	4.3	4.3	2.5	2.5	2.5
Dicalcium phosphate	1.35	1.35	1.35	0.54	0.54	0.54	0.55	0.55	0.55
Limestone	1.17	1.17	1.17	1.19	1.19	1.19	1.12	1.12	1.12
Vitamin-mineral mix[1]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vegetable oil	2.8	2.8	2.8	-	-	-	-	-	-
Salt	0.4	0.4	0.4	0.24	0.24	0.24	0.2	0.2	0.2
DL-Methionine	0.14	0.14	0.14	-	-	-	-	-	-
Tryptophan	0	0.10	0.20	0	0.07	0.15	0	0.05	0.13
Wheat bran	2.80	2.69	2.59	2.80	2.53	2.47	2.80	2.59	2.48
Calculated analysis									
ME[2] (kcal kg^{-1})	2900	2900	2900	2900	2900	2900	2900	2900	2900
Crude protein (%)	20.8	20.8	20.8	18.2	18.2	18.2	16.3	16.3	16.3
Crude fiber (%)	3.70	3.70	3.70	3.20	3.20	3.20	3.05	3.05	3.05
Linoleic (%)	2.2	2.2	2.2	1.6	1.6	1.6	1.7	1.7	1.7
Ca (%)	0.91	0.91	0.91	0.82	0.82	0.82	0.72	0.72	0.72
Available.P (%)	0.41	0.41	0.41	0.32	0.32	0.32	0.27	0.27	0.27
Na (%)	0.18	0.18	0.18	0.14	0.14	0.14	0.11	0.11	0.11
Arginin (%)	1.44	1.44	1.44	1.2	1.2	1.2	1.0	1.0	1.0
Lysine (%)	1.15	1.15	1.15	1.00	1.00	1.00	0.85	0.85	0.85
Methionine+cystine (%)	0.82	0.82	0.82	0.65	0.65	0.65	0.58	0.58	0.58
Tryptophan (%)	0.23	0.34	0.46	0.18	0.27	0.36	0.17	0.25	0.34

[1]Supplied per kg of diet: vitamin A, 10,000 IU, vitamin D_3, 9790 IU, vitamin E, 121 IU, B_{12}, 20 μg; riboflavin, 4.4 mg, calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 μg; thiamine, 4 mg; zinc sulphate, 60 mg; manganese oxide, 60 m; [2]Metabolizable energy

42-49 days of age (F-A, 0 - control; F-B, 0.05 and F-C, 0.13). All diets met the National Research Council (1994) recommendations for broilers. One-day-old Cobb500 male broiler chickens (150) were utilized in the experiment consisting of 3 treatments with 5 replicates and 10 chickens per replicate each. Birds were housed randomly in pen, so that initially each bird occupied approximately 0.11 m^2 of floor space. The pens were floor pens with wood litter. Birds were maintained under continuous light and the environmental temperature in the barn was initially set at 31°C and was gradually reduced to 20°C by week 7. Feed and water were provided *ad libitum* throughout the experiment. Chickens were vaccinated for Marek`s, infectious bursal and infectious bronchitis diseases at the hatchery and then at 7 and 14 days of age for Newcastle disease. Body weight gain and FI were recorded weekly and adjusted for the three periods (starter, grower and finisher). At 27 and 49 days of age, two chickens were randomly selected from each replicate in each treatment and blood samples were collected from the wing vein by Terumo Syringe with needle (0.7×32 mm). Blood samples (six samples for each treatment) were allowed to cloth and then centrifuged and serum was separated and stored at -20°C until analyzed for serum parameters (albumin, total protein, glucose, cholesterol, triglyceride, urea, uric acid, Aspartate Amino-Transferase (AST), Alanine Amino-Transferase (ALT), Alkalin Phosphatase (ALP), Lactic Dehydrogenase (LDH) and Creatine Kinase (CK)) using automatic analyzer according to the instructions of the manufacturer (Aravind *et al*., 2003). A completely randomized experimental design was used.

All data were statistically analyzed using the General Linear Models (GLM) procedure of SAS software (SAS Institute, 1996) for the analysis of variance. Duncan (1955)s multiple range test was used to determine differences among treatment means. Means were considered different at $p<0.05$.

RESULTS

As shown in Table 2, compared with control in all periods the values of FI and BWG have gradually elevated ($p<0.0001$) and Feed Gain Ratio (FGR) have gradually decreased ($p<0.0001$) due to increased level of dietary Trp (Table 2). FI and BWG were enhanced linearly with increased dietary Trp. This linear enhancement was continuous up to group C. The highest FI and BWG were observed in treatment C. However, compared with control dietary Trp decreased ($p<0.05$) FCR in each treatment with the highest in treatment A.

The effects of different levels of Trp on blood serum parameters in broiler chickens have been summarized in Table 3-5. Tryptophan supplementation of control diets significantly increased the serum concentration of total protein, albumin, urea and uric acid at 27 and 49 days of age. Dietary Trp had no effect ($p>0.05$) on CK, ALT and AST at 27 and 49 days of age. The use of Trp at 27 and

Table 2: Effects of dietary tryptohan on Feed Intake (FI), Body Weight Gain (BWG) and Feed Conversion Ratio (FCR) of broiler chickens from 0-49 days of age

	FI (g)				BWG (g)				FCR			
Treatments	0-21	21-42	42-49	0-49	0-21	21-42	42-49	0-49	0-21	21-42	42-49	0-49
A	1504^{a}	2576^{a}	2578^{a}	6254^{a}	806.2^{a}	1035^{a}	925.5^{a}	2767^{a}	1.7^{a}	2.49^{a}	2.7^{a}	2.26^{a}
B	1306^{b}	1673^{b}	2373^{b}	5537^{b}	819.1^{b}	1044^{b}	956.4^{b}	2849^{b}	1.6^{b}	1.56^{b}	2.56^{b}	1.94^{b}
C	1287^{c}	1594^{c}	2237^{c}	5335^{c}	844^{c}	1073^{c}	989.8^{c}	2878^{c}	1.5^{c}	1.53^{c}	2.26^{c}	1.85^{c}
SE	11	24	15	44	11	13	17	29	0.04	0.05	0.06	0.06
P	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R^2	0.74	0.79	0.79	0.83	0.48	0.44	0.22	0.41	0.20	0.30	0.04	0.04^{a-c}

$^{a-c}$Means within columns with different superscripts are significantly different ($p<0.05$)

Table 3: Effects of dietary tryptophan on the serum concentration of Glucose (GLU), Total Protein (TP), Albumin (ALB) and Creatine Kinase (CK) in broiler chickens at different days of age

	GLU (mg dL^{-1})		TP (g dL^{-1})		ALB (g dL^{-1})		CK (U L^{-1})	
Treatments	27 days	49 days	27 days	49 days	27 days	49 days	27 days	49 days
A	184.52	235.36^{a}	2.75^{ab}	2.35^{b}	0.95^{b}	1.07^{b}	1523.5	2210.8
B	191.35	293.57^{b}	2.17^{b}	2.90^{ab}	0.98^{b}	1.30^{b}	1884.8	2184.8
C	191.81	295.16^{b}	3.25^{a}	3.55^{a}	1.15^{a}	1.72^{a}	1901.8	1823.5
SE	6.37	13.50	0.20	0.23	0.02	0.10	208.85	209.96
P	0.67	0.01	0.015	0.016	0.002	0.004	0.38	0.38
R^2	0.08	0.62	0.60	0.59	6.74	0.69	0.19	0.19

^{a,b}Means within column with different superscript are significantly different ($p<0.05$)

Table 4: Effects of dietary tryptophan on the serum concentration (mg dL^{-1}) of Triglyceride (TRIG), Cholesterol (CHOL), Urea (URE) and Uric Acid (UA) in broiler chickens at different days of age

	TRIG		CHOL		URE		UA	
Treatments	27 days	49 days	27 days	49 days	27 days	49 days	27 days	49 days
A	165.50^{a}	195.25^{a}	171.67	250.50^{a}	2.52^{b}	2.7^{b}	3.25^{c}	4.6^{c}
B	100.25^{b}	143.25^{b}	161.53	198.75^{b}	2.80^{b}	3.0^{b}	4.45^{b}	5.25^{b}
C	100.50^{b}	140.25^{b}	160.06	181.45^{b}	3.52^{a}	3.7^{a}	5.70^{a}	5.95^{a}
SE	8.20	12.01	5.85	12.75	0.16	0.16	0.16	0.194
P	0.0004	0.017	0.09	0.01	0.006	0.004	0.0001	0.002
R^2	0.82	0.59	0.41	0.63	0.67	0.70	0.92	0.72

$^{a-c}$Means in each columns with different superscripts are significantly different ($p<0.05$)

Table 5: Effects of dietary tryptophan on the activity (U L^{-1}) of serum Alanine Amino-Transferase (ALT), Alkalin Phosphatase (ALP), Aspartate Amino-Transferase (AST) and Lactic Dehydrogenase (LDH) in broiler chickens at different days of age

	ALT (days)		ALP (days)		AST (days)		LDH (days)	
Treatment	27	49	27	49	27	49	27	49
A	35.80	44.52	410.0	403.25^{a}	337.0	363.20	1598.4^{a}	1423.40
B	35.10	43.67	364.0	381.75^{b}	321.0	334.85	1327.1^{ab}	12720.0
C	34.77	41.70	358.0	374.50^{b}	316.0	323.18	1073.1^{b}	1165.50
SE	1.390	0.800	22.67	6.4900	10.19	20.860	106.47	101.400
P	0.860	0.080	0.260	0.0300	0.350	0.4100	0.0200	0.24000
R^2	0.030	0.410	0.250	0.5400	0.200	0.1700	0.5700	0.26000

^{a,b}Means within columns with different superscripts are significantly different ($p<0.05$)

49 days of age decreased ($p<0.05$) triglyceride. At 27 days of age dietary Trp did not affect ($p>0.05$) glucose but increased ($p<0.05$) glucose in chickens at 49 days of age. At 27 days of age dietary Trp decreased ($p<0.05$) LDH, but had no effect ($p>0.05$) at 49 days. At 27 days of age dietary Trp did not change ($p<0.05$) the cholesterol and ALP levels cholesterol and ALP but decreased ($p<0.05$) cholesterol and ALP in chickens at 49 days of age. For glucose, albumin, total protein, triglyceride, cholesterol, ALP and LDH, the best results were observed on 27 and 49 days of age in groups C. Urea and uric acid were increased linearly with the increase of dietary Trp. Dietary Trp had no effect ($p>0.05$) on serum ALT, AST and CK, however, it could improve these parameters.

DISCUSSION

In the study, effect of Trp on various growth performance and blood parameters were studied. As shown, dietary Trp increased FI and BWG. This is in agreement with Koid and Ishibashi (1995) and Harms and Russell (2000). Peganova and Eder (2003) reported that feed consumption was 6% higher in broiler chickens which received high concentration of dietary Trp compared with those which received low concentration of it. This effect could be due to the function of tryptophan as a precursor of the neurotransmitter serotonin. It is well known that serotonin, which is formed in the brain and influences feed consumption of animals (Takman *et al*., 1990; Mullen and Martin, 1992: Denbow *et al*., 1993; Shea-Moore *et al*., 1996; Peganova and Eder, 2003). These alternations could also lead to decrease behavioral aberrations in birds with the addition of supplement Trp (Corzo *et al*., 2005a, b). It has been visually observed that birds consuming low Trp exhibited abnormal behavior characterized by an increase in feed spillage (Corzo *et al*., 2005b). This observation may be partially explained by the fact that birds were searching for the missing nutrient (Trp). The same research group also reported depressed body weight, feed intake and feed conversion in diets containing the lowest Trp concentration. Similar findings were shown by other groups (Steinhart and Kirchgessner, 1984; Rogers and Pesti, 1990; Han *et al*., 1991; Rosa *et al*., 2001). Whereas, Smith and Waldroup (1988) reported increased feed conversions with Trp-deficient diets. Corzo *et al*. (2005a) showed body weight, feed intake and feed conversion optimization points were estimated to be 2.1, 2, 2.2 g of Trp kg^{-1} of diet, respectively.

Increased dietary Trp in the present study resulted in improvement of blood plasma parameters such as glucose which has been shown to have a linear relationship with dietary Trp. The increase of blood glucose may be an indication of metabolic adaptation for gluconeogenesis in broilers experiencing threatening conditions in maintaining amino acid homeostasis (Corzo *et al*., 2005b). We showed that uric acid as the remaining products of Trp catabolism had a numerical increase. Broilers with higher body weight were observed to have a higher concentration of blood plasma total protein when compared with the lighter broilers, possibly associated with higher demand for lean tissue maintenance and turn over (Corzo *et al*., 2005a). Feeding low protein and amino acid diets have been shown to be associatiated with decreased total serum protein and serum albumin in chickens (Corzo *et al*., 2005b).

The Trp requirement to minimize lipid levels is almost double that to the maximize body growth of broilers (Rogers and Pesti, 1990; Rosa *et al*., 2001). Corzo *et al*. (2005a, b) showed that blood plasma cholesterol showed a linear decrease with increasing dietary Trp.

CONCLUSION

In this study, we can say that Trp supplementation improves the growth performance and health status of broiler chickens without imposing any toxicity as all blood parameters were in normal range.

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