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Effects of Dietary Tryptophan Supplementation and Feed Restriction on Growth Performance and Carcass Characteristics of Goslings

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Abstract: The effects of dietary levels of tryptophan and feeding regimen on growth performance and carcass characteristics were evaluated in Yangzhou goslings from 28-70 days of age. In a 2×3 factorial design, a total of two hundred and seventy birds were randomly assigned to 6 treatments according to a 2×3 factorial design. Treatments consisted of two feeding regimens (*ad libitum* vs. 90% restricted feeding) each contained three levels of tryptophan (0.15, 0.23 and 0.31%) to which 0.08% increments of tryptophan were supplemented. Each experimental treatment had 3 replicates of 15 birds per pen. Feed intake of goslings from each pen was recorded everyday during the 6th week while body weight and feed conversion ratio were measured at a 2 weeks interval. At the end of the feeding experiment, 9 goslings (three birds were randomly chosen from each replicate) were slaughtered to evaluate carcass characteristics. The results showed that average daily gain and carcass characteristics were significantly higher in goslings fed *ad libitum* when comparing with those restricted feeding. Positive responses in daily feed intake and weight gain were attained by the addition of tryptophan to level up to 0.23% in diet whereas no statistical difference was found when the dietary level reached 0.31%. Supplemental tryptophan had not significant effect on carcass characteristics with exception of breast meat yield. It was found that goslings maximized their breast meat yield at a dietary level of 0.23% tryptophan compared with 0.15% tryptophan in diet. This study indicated that the gosling diets fed in restriction have some unfavourable effects on growth performance and carcass characteristics. Dietary tryptophan addition up to level 0.23% can increase daily feed intake, weight gain and breast meat yield.

Key words: Yangzhou goslings, tryptophan, feed restriction, growth performance, carcass characteristic, China

INTRODUCTION

Tryptophan which concentration in organisms is among the lowest of all amino acids plays a rate-limiting in poultry growth. Several studies have shown that dietary tryptophan supplementation to the deficient diets of chickens may improve biological metabolism thus resulting in the increment of growth performance and carcass traits (Rosa *et al*., 2001; Corzo *et al*., 2005a, b; Fatufe *et al*., 2005; Emadi *et al*., 2010a, b; Yu *et al*., 2010). However, little information in the literature is known about the dietary supplementation of tryptophan in goslings.

Apart from being a nutrient that is essential to allow maximum growth in feeds for animals, tryptophan also has some other physiological functions such as the regulation of voluntary feed intake, immunity improvement and stress alleviation (Adeola and Ball, 1992; Terron *et al*., 2009; Emadi *et al*., 2010b). Among the multiple functions, feed intake affected by dietary tryptophan has been paid more and more attention. Increasing evidence shows that tryptophan has positive effects on voluntary feed intake in some species (Takman *et al*., 1990; Henry *et al*., 1992; Xi *et al*., 2009) which characteristic makes it become one of the most important nutrients in rations for animals especially with limited feed intake capacity. The increase in dietary tryptophan content can dramatically enhance feed intake thereby causing significant improvement in body weight change (Harms and Russell, 2000; Fatufe *et al*., 2005). Although, growth performance and carcass characteristics of chickens during tryptophan supplementation experiment have been well studied, few studies clearly clarify whether these changes are due to the supplemental tryptophan or increased feed consumption owing to high tryptophan intake. Therefore, the objectives of the present experiment were to evaluate the effects of dietary tryptophan supplementation and feed restriction on growth performance and carcass characteristics of goslings.

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MATERIALS AND METHODS

Two hundred and seventy, 21 days old Yangzhou male goslings were selected from one commercial hatchery and they were acclimated to the basal diet for 1 week. Then, birds were randomly divided into 6 treatments with 3 replications in each treatment each replication having 15 goslings. In a 2×3 factorial arrangement, 6 treatments included: two feeding regimens namely *ad libitum* (AD) and 90% feed restriction based on *ad libitum* intake of the previous 24 h (RF) and three levels of tryptophan supplementation (0.15, 0.23 and 0.31%) which meets the marginal, adequate and excess tryptophan for growth, respectively.

A tryptophan-deficient diet based on maize-corn gluten meal was formulated to provide an optimal concentration of all the essential nutrients for requirement of goslings (NRC, 1994). Table 1 shows ration composition and nutrient levels of the basal diets. Except the duration of the feed restriction, all birds had free access to feed and clean drinking water. They were maintained under natural light and environmental temperature. All birds handling procedures were approved by Yangzhou University Animal Care and Use Committee.

The Feed Intake (FI) of goslings was noted everyday and Average Daily Feed Intake (ADFI) was calculated by dividing FI by the number of days. Body weight gain was recorded at a 2 weeks interval and Average Daily Gain (ADG) for each weighing period was calculated as the difference obtained by dividing the total weight of goslings with a pen by the value which is the product of the goslings number and day number. Feed Conversion Ratio (FCR) was calculated by dividing ADFI by the ADG.

Table 1: Composition (%) and nutrient levels of the tryptophan-deficient basal diets

Ingredient (%)	Values
Corn	63.00
Corn gluten meal	9.50
Wheat bran	8.10
Alfalfa meal	14.50
Choline chloride	0.20
$CaHPO_4$	1.74
Limestone	1.00
NaCl	0.30
L-Lys-HCl	0.45
Met	0.05
Thr	0.16
Premix[1]	1.00
Nutrient levels[2]	
ME (MJ kg^{-1})	11.16
CP (%)	15.17
CF (%)	5.35
Ca (%)	1.03
Available P (%)	0.44
Lysine (%)	0.84
Met+Cys (%)	0.60
Thr (%)	0.68
Trp (%)	0.15

[1]Provided per kg of premix: vitamin A 960 KU; vitamin D_3 340 KU; vitamin E 2400 IU; vitamin K_3 210 mg; vitamin B_1 10 mg; vitamin B_2 600 mg; vitamin B_6 280 mg; vitamin B_{12} 1 mg; niacin 3.4 g; pantothenic acid 1.35 mg; folic acid 90 mg; biotin 95 mg; Cu 2 g; I 200 mg; Fe 12 g; Zn 10 g; Mn 12 g; Se 40 mg; [2]values were determined except ME

At 70 days of age after being deprived of feed for 12 h, 9 birds from each treatment were randomly selected, slaughtered, defeathered and then dissected to determine the carcass characteristics. The indicators of carcass yield, the eviscerated yield, breast meat (including pectoralis major and pectoralis minor), leg meat (including thigh and drum stick) and abdominal fat were respectively measured.

All data were performed by the General Line Model (GLM) procedures of SAS software (SAS Institute, 1996) as a completely randomized design. Contrasts among different treatments means were evaluated using Duncan's multiple-range test when probability values of <0.05 were significant.

RESULTS

Effects of tryptophan supplementation and feed restriction on growth performance of goslings are shown in Table 2. Average daily weight gain of goslings fed in *ad libitum* were significantly higher ($p<0.05$) than those in feed restriction treatment during the overall periods (28-70 days) except grower-stage (42-56 days). Feed conversion in the starter and grower period (28-56 days) was dramatically different ($p<0.05$) by feeding regimen treatment but no significant differences ($p>0.05$) were observed in FCR for the finisher (56-70 days) and overall periods.

Dietary tryptophan levels influenced ADG and ADFI in the starter and overall period ($p<0.05$) whereas no significant difference was showed in FCR all over the period ($p>0.05$). Goslings fed 0.23% tryptophan had the highest ADG and ADFI when comparing with those fed 0.15 and 0.31% tryptophan diets. Furthermore, tryptophan levels x feeding regimen interactions for ADG, ADFI and FCR were observed in different growing periods, respectively ($p<0.05$).

Table 3 shows the results of carcass characteristics for goslings affected by tryptophan supplementation and feed restriction. The carcass yield, eviscerated yield, breast meat, leg meat and abdominal fat were significantly decreased ($p<0.05$) in goslings under feed restriction. However, no significant differences ($p>0.05$) were observed by increasing tryptophan addition with the

Table 2: Effect of dietary tryptophan supplementation and feed restriction on growth performance of goslings from 28-70 days

Items	Feeding regimen		Dietary tryptophan (%)			SEM	p-values		
	Limit fed	*Ad libitum* fed	0.15	0.23	0.31		Regimen	Tryptophan	Regimen x Tryptophan
ADFI (g/bird/day)									
28-42 days	125.36	159.99	137.39^{b}	148.43^{a}	142.20^{b}	2.3900	<0.0001	0.0029	0.0029
42-56 days	172.14	183.71	173.10^{b}	183.35^{a}	177.33^{b}	2.6800	0.0002	0.0083	0.0083
56-70 days	185.00	200.93	192.37	197.08	189.45	3.2700	<0.0001	0.1018	0.1018
28-70 days	160.83	181.54	167.62^{b}	176.29^{a}	169.66^{b}	1.8600	<0.0001	0.0014	0.0014
ADG (g/bird/day)									
28-42 days	37.49	54.45	44.19^{b}	48.70^{a}	45.03^{b}	1.3100	<0.0001	0.0113	0.0017
42-56 days	38.66	35.30	35.23^{b}	39.16^{a}	36.56^{ab}	1.6900	0.0317	0.1004	0.5717
56-70 days	31.73	34.75	31.48	35.25	32.98	1.6000	0.0388	0.0988	0.0424
28-70 days	36.47	41.08	37.70^{b}	40.84^{a}	37.69^{b}	0.8490	<0.0001	0.0043	0.0056
FCR (g:g)									
28-42 days	3.36	2.94	3.16	3.13	3.17	0.0751	<0.0001	0.8995	0.0055
42-56 days	4.47	5.25	4.99	4.69	4.88	0.2500	0.0025	0.4904	0.8690
56-70 days	5.83	5.83	6.15	5.48	5.74	0.2600	0.9964	0.1266	0.0231
28-70 days	4.42	4.43	4.44	4.32	4.51	0.0967	0.8937	0.2038	0.3228

$^{a, b}$Means within the same row that do not share a common superscript are significantly different (p<0.05)

Table 3: Effects of tryptophan supplementation and feed restriction on carcass characteristics of 70 days old goslings

Items	Feeding regimen		Dietary tryptophan (%)			SEM	p-values		
	Limit fed	*Ad libitum* fed	0.15	0.23	0.31		Regimen	Tryptophan	Regimen x Tryptophan
Carcass yield (g)	2252.04	2469.07	2296.94	2423.61	2361.11	96.81	0.0085	0.4313	0.5602
Eviscerated yield (g)	1562.41	1732.59	1605.56	1688.89	1648.06	67.78	0.0035	0.4755	0.6313
Semi-eviscerated yield	1763.52	1928.70	1798.06	1886.67	1853.61	74.96	0.0096	0.4949	0.6607
Breast yield (g)	104.69	130.32	105.58^{b}	126.61^{a}	120.32^{ab}	8.28	0.0004	0.0416	0.4962
Thigh yield (g)	197.87	218.58	199.07	217.82	207.79	11.96	0.0391	0.3009	0.5205
Abdominal fat yield (g)	50.21	69.86	62.45	59.01	58.64	4.25	<0.0001	0.6174	0.0418

$^{a, b}$Means within the same row that do not share a common superscript are significantly different (p<0.05)

exception of breast meat yield. Compared with 0.15% tryptophan, goslings fed 0.23 and 0.31% tryptophan supplemented levels gained significantly increases by 19.94 and 13.96%, respectively. Additionally, interaction effects between tryptophan levels and feeding regimen were noted for abdominal fat response.

DISCUSSION

Tryptophan is the precursor for synthesis of neurotransmitter serotonin in the hypothalamus which plays an important role in the regulation of appetite and feed intake (Denbow *et al*., 1993; Xi *et al*., 2009). Birds fed tryptophan deficient diets exhibited a declined level of serotonin in the body which is directly associated with the reduced availability of tryptophan for serotonin biosynthesis thus resulting in appetite depression and decreased feed intake. However, dietary tryptophan supplementation can be useful to improve that circumstance. Shan *et al*. (2003) showed that an increase of feed intake due to dietary tryptophan supplementation was observed in young broiler chicks raised at moderate (25°C) and warm (35°C) temperatures. Harms and Russell (2000) reported that feed consumption of the commercial layer was significantly enhanced as the dietary level of Trp increased which is in agreement with the present research in Yangzhou goslings. However, Denbow *et al*. (1993) showed that supplementation with tryptophan in diets of turkeys had no significant effect on feed intake.

It was previously reported that tryptophan has been shown to improve body weight gain in poultry (Koide and Ishibashi, 1995; Rosa *et al*., 2001; Corzo *et al*., 2005a, b; Fatufe *et al*., 2005; Emadi *et al*., 2010b; Yu *et al*., 2010). This increase in body weight gain may be partly due to the elevated feed intake as the tryptophan content of the diet increased. However, none of these researchers had used diets fed in *ad libitum* or feed restriction manner to validate the positive response in body weight gain due to dietary tryptophan supplementation. Consequently, no previous studies have documented the potential limitations involving the feeding regimen and tryptophan level in improving growth performance and carcass characteristics. In the present study, differences in average daily gain between goslings fed the excess and the deficient level of tryptophan did not reach statistical significance. However, birds fed optimal tryptophan diet dramatically gained more daily BW than those in tryptophan-deficient diet. The influence of tryptophan on daily BW gain in goslings can be explained by a phenomenon of amino acid balance. An adequate tryptophan content broughts about optimal amino acid balance while excess tryptophan supplementation dramatically disrupt the balance of amino acid especially when tryptophan is limited or marginal thus resulting in low utilization rate of nitrogen and poor growth performance.

No statistical differences on the response of slaughter yield, viscerated yield and leg meat were observed due to tryptophan levels and feeding regimen treatments. The results of this experiment were in close consistent with Xi *et al*. (2009) who reported that chickens fed five dietary tryptophan levels did not show dramatically influence on the percentage of dressing, eviscerated yield and thigh muscle. Whereas, Corzo *et al*. (2005a) showed that chilled carcass weight of broiler males significantly increased in parallel with live performance due to the addition of tryptophan. An increase in dietary tryptophan resulted in improved breast muscle percentage which was in agreement with Corzo *et al*. (2005a) and Xi *et al*. (2009).

The response of abdominal fat was extremely higher in goslings fed in *ad libitum* relative to birds fed in restriction. However, no significant difference was observed due to tryptophan treatments. These findings are in contrast to those previously reported in chickens. Rosa *et al*. (2001) indicated that responses of fat pad weights observed in broiler chickens were significant increased with the elevated tryptophan level that paralleled changes in BWG. Corzo *et al*. (2005a) reported that dietary tryptophan supplementation dramatically increased the weight and percentage of depot fat when comparing with male broilers fed tryptophan at 0.12% of the diet. Such differences in abdominal fat observed between different studies may be partially explained by higher feed consumption with tryptophan addition.

CONCLUSION

The present experiment shows that adequate supplementation of tryptophan to the gosling diet can increase daily feed intake and weight gain, dietary tryptophan deficiency or excess supply will bring about poor growth. This increment in weight gain may be most likely due to the optimal amino acid balance and elevated utilization of nitrogen rather than the increase of feed consumption. Therefore, further study should focus on regulatory mechanism for improving growth performance because of tryptophan addition.

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