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Effect of high threonine diets on growth performances of commercial broilers

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Abstract

A total of 720 Cobb 500 day old chicks with an average hatching weight 44.35 g each were divided into five dietary treatments groups (diet group 1, 2, 3, 4 and 5 with the doses of threonine like, 0 g/kg, 0.5g/kg, 1g/kg, 1.5g/kg and 2g/kg feed, respectively). Each of 144 birds under each treatment were replicated to eight subgroups of 18 birds each to investigate the productivity and cost effectiveness of commercial broilers fed increasing levels of threonine supplemented diets. The birds were reared in an open-sided shed up to the age of 35 days at Bangladesh Agricultural University Poultry Farm, Mymensingh, Bangladesh. Apart from differences in diets, care and management for all treatments groups were similar. Data were collected on body weight, feed intake, livability, average daily weight gain (ADG), feed conversion ratio (FCR), carcass traits and income over cost of production were calculated out. The highest live weight (1978.09±0.40 g/bird) at 35 days and the highest dressing yield (1314.63±1.48 g/bird) at 30 days were documented for the diet group five. The best amount of threonine for live body weight gain, FCR, ADG of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed. Very interestingly, the best amount of threonine for dressing yield per bird and breast weight of broiler bird was 2.0 g/kg feed and similarly the best economic dose of threonine for commercial broiler production was 2 g/kg feed.

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Introduction

Broiler farming is one of the promising sectors of poultry industry in Bangladesh. This industry is supplying complete protein at the cheapest rate compare to other animal protein sources to the people of Bangladesh. Akter and Uddin (2009) documented that, the poultry sector has grown with an annual rate of 20% during last two decades and this industry creating purchasing power and reducing poverty at a large scale in Bangladesh. In GDP, one third of the total agricultural contribution (18.60%) added from poultry industry (Khaled, 2014). The Breeders Associations of Bangladesh reported that, per capita availability of animal source protein was only 15.23 Kg here in Bangladesh but according to FAO and WHO, standard annual intake of animal protein per person per year was 43.8 kg. While the annual consumption of poultry meat was recorded 3.63 Kg and the poultry industry is trying to increase this rate to 12 Kg by 2021 (The Dhaka Tribune, 2014). Farkhoy *et al*. (2012) found that requirement of Lysine appear to be higher than suggested level by NRC-1994, to support obtaining the optimum of body weight and feed conversion ratio at early ages. Poultry nutritionists, specifically turkey nutritionists, further decreased dietary crude protein, when they got, L-threonine as a feed additive. Increased nitrogen utilization, tolerance of high ambient temperatures in poultry and decreased the level of ammonia in litter and nitrogen excretion, when dietary crude protein was reduced. However, in order to obtain optimum performance, the amino acid composition of the diet should match the bird's amino acid requirements for maintenance and tissue accretion, if dietary crude protein was decreased. Shortly after discovery of threonine in 1935,by W.C. Rose, it (threonine) was deemed an essential amino acid for chicks (Hegsted, 1944; Almquist and Grau, 1944).In corn and soybean meal diets for both broilers and turkeys, threonine is typically the third limiting amino acid. In linear programming with implementation of high dietary levels of threonine-limiting ingredients, particularly wheat, milo, barley, and meat and bone meals, threonine may become a pressure point, in practice. Nutritionists might be allowed to further reduce the inclusion of protein rich feedstuffs by dietary supplementation of L-threonine, along with synthetic methionine and L-lysine, while maintaining bird performance (Kidd and Kerr, 1996). One of the key issues for successful broiler production is therefore formulating broiler diets as closely as possible to the animal's needs related to the respective production goal while keeping the diet costs as low as possible. Crude protein is one of the major cost components of the poultry diets, so the main emphasis is placed on the crude protein (CP) during formulating a broiler diet, to reduce the feed cost. Under Bangladesh condition, data on its cost effectiveness are not so extensive. Therefore, it seems worthwhile to investigate the effects of feeding high threonine diets to commercial broilers on performance in one hand and cost-effectiveness of such efforts on the other. So, this research work was designed and conducted to investigate the productivity of commercial broilers fed different levels of threonine supplemented diets and to determine the cost effectiveness of feeding such diets in broiler production.

Materials and methods

Experimental birds and diets

A total of 720 Cobb 500 day old chicks (DOCs) with an average hatching weight 44.35 g were reared in an open-sided shed from 17 July to 21 August 2016 up to the age of 35 days at Bangladesh Agricultural University Poultry Farm, Mymensingh, Bangladesh. The experimental birds were divided into five dietary treatments groups each of 144 birds and each group were replicated into eight subgroups of 18 birds each. The five groups were randomly assigned to the experimental diets in a completely randomized design (CRD) experiment. The diets were used in the research like below (Table 1 & 2).

Statistical analysis

Data were collected on body weight, weight gain, feed intake, feed conversion ratio, bird mortality and income over cost of production up to fifth week of age. Collected data were stored onto the excel spread sheet for further analysis. Stored data were edited and for having meansproc means menu,

for calculating the differences among means, Duncan's New Multiple Range Test and to measure the level of significance proc reg menu were applied using SAS (2009) software.

Results and discussion

Growth performance

The highest amount of feed (523.94 kg) consumed by the birds fed diet number one, where the limitingamino acid threonine was not used but the highest amount of live weight (267.03 kg) gain documented for diet number five, where the amino acid threonine used in a dose of 2g per kg feed (Table 3).The lowest feed consumed in the diet group three (457.88 kg) while the lowest amount of live weight was reported under diet group one (261.97 kg).For both maintenance and skeletal muscle accretion to effectively allow for increased synthesis of white meat, dietary amino acids concentrations needs to match (Kidd *et al.,* 2004).

Table 1. Broiler rations(starter feed for mixed sex birds) was used like below:

Ingredients in kg	Diets under different treatments used from day old to 14 days of age of birds				
	1	2	3	4	5
Soybean meal (44% CP)	30.26	30.26	30.26	30.26	30.26
Maize	60.80	60.75	60.7	60.65	60.6
Meat and Bone meal (44% CP)	5.00	5.00	5.00	5.00	5.00
Soybean oil	1.33	1.33	1.33	1.33	1.33
Limestone (CaCO3)	0.19	0.19	0.19	0.19	0.19
Di-calcium phosphate	1.03	1.03	1.03	1.03	1.03
Common salt (NaCl)	0.15	0.15	0.15	0.15	0.15
Sodium bicarbonate	0.28	0.28	0.28	0.28	0.28
Vitamins premix	0.05	0.05	0.05	0.05	0.05
Minerals premix	0.05	0.05	0.05	0.05	0.05
Methionine	0.34	0.34	0.34	0.34	0.34
Lysine	0.32	0.32	0.32	0.32	0.32
Threonine	0	0.05	0.1	0.15	0.20
Choline Chloride (60%)	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100

Diet group three and five were the best in case of conversion of feed into meat (1.74), while diet group one was the poorest (2.00) performer.

Feed consumption

The highest amount of feed consumed by the birds fed diet number one, at one (180.40±0.40 g/bird), two (593.19±0.40 g/bird), three (1339.06±0.40 g/bird), four (2417.09±0.40 g/bird) and five (3910.86±0.40 g/bird) weeks of age of birds.

Table 2. Broiler rations (grower feed for mixed sex birds).

Ingredients in kg	Diets under different treatments used from 15 days to 35 days of age of birds				
	1	2	3	4	5
Soybean meal (44% CP)	25.86	25.86	25.86	25.86	25.86
Maize	66.57	66.52	66.47	66.42	66.37
Meat and Bone meal (44% CP)	2.00	2.00	2.00	2.00	2.00
Soybean oil	2.24	2.24	2.24	2.24	2.24
Limestone (CaCO3)	0.77	0.77	0.77	0.77	0.77
Di-calcium phosphate	1.24	1.24	1.24	1.24	1.24
Common salt (NaCl)	0.2	0.2	0.2	0.2	0.2
Sodium bicarbonate	0.28	0.28	0.28	0.28	0.28
Vitamins premix	0.05	0.05	0.05	0.05	0.05
Minerals premix	0.05	0.05	0.05	0.05	0.05
Methionine	0.27	0.27	0.27	0.27	0.27
Lysine	0.27	0.27	0.27	0.27	0.27
Threonine	0	0.05	0.1	0.15	0.20
Choline Chloride (60%)	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100

On the other hand, the lowest amount of feed consumed by the birds fed diet number one, at one (169.36±0.40 g/bird), two (561.22±0.40 g/bird), three (1247.40±0.40 g/bird), four (2123.86±0.40 g/bird) and five (3422.09±0.40 g/bird) weeks of age of birds.

Feed consumption amount varied significantly among diet groups, where diet group five was the best performer and this was followed by diet group three.

Table 3. Growth performance and dressing weight of commercial broiler birds.

Diet	Doses of threonine in g/kg	Total Feed Intake in kg	Total Live Weight in kg of Birds	FCR	Livability
1	0	523.94	261.97	2.00^{d}±0.40	134 (93.06%)
2	0.5	488.02	262.37	1.87^{c}±0.40	134 (93.06%)
3	1	457.88	263.04	1.74^{a}±0.40	134 (93.06%)
4	1.5	463.46	264.87	1.76^{b}±0.40	135 (93.75%)
5	2.0	461.97	267.03	1.74^{a}±0.40	135 (93.75%)

Table 4. Effect of feed type on feed consumption in grams of commercial broiler birds.

Diet	fd1	fd2	fd3	fd4	fd5
1	180.40^{e}±0.40	593.19^{e}±0.40	1339.06^{e}±0.40	2417.09^{e}±0.40	3910.86^{e}±0.40
2	176.45^{d}±0.40	587.52^{d}±0.40	1301.99^{d}±0.40	2212.03^{d}±0.40	3642.09^{d}±0.40
3	169.58^{b}±0.40	568.14^{b}±0.40	1267.69^{b}±0.40	2168.92^{b}±0.40	3417.30^{a}±0.40
4	170.95^{c}±0.40	580.65^{c}±0.40	1282.55^{c}±0.40	2198.42^{c}±0.40	3433.57^{c}±0.40
5	169.36^{a}±0.40	561.22^{a}±0.40	1247.40^{a}±0.40	2123.86^{a}±0.40	3422.09^{b}±0.40
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Note: fd1-feed consumption at one week of age, fd2-feed consumption at two week of age, fd3-feed consumption at three week of age, fd4-feed consumption at four week of age and fd5-feed consumption at five week of age.
^{abcde} Means with the different superscripts differed significantly within the column (P<0.05).

Effect of diet group on live body weight in different ages

Body weight at different weeks of old birds varied Significantly (Table 5). Live weight at the age of fifth week (35 days) differed significantly and higher live weight was documented for the diet group five (1978.09±0.40 g/bird) than diet group three, four, two and one. Live broiler's body weight at 30 days old commercial broiler birds was documented 1730 g/bird with a diet having no threonine (Islam *et al.,* 2016).

Table 5. Effect of feed type on growth performances in grams of commercial broiler birds.

Diet	docw	bwt1	bwt2	bwt3	bwt4	bwt5
1	46.72^{a}±0.22	202.70^{c}±0.40	502.70^{c}±0.40	1038.04^{c}±0.40	1569.54^{d}±0.40	1955.43±0.40
2	44.35^{c}±0.30	202.82^{c}±0.40	503.48^{c}±0.40	1041.61^{b}±0.40	1580.45^{d}±0.40	1958.08±0.40
3	44.35^{c}±0.30	204.32^{a}±0.40	511.84^{b}±0.40	1047.74^{a}±0.40	1606.60^{b}±0.40	1963.96±0.40
4	43.83^{d}±0.28	203.51^{b}±0.40	509.36^{b}±0.40	1042.72^{b}±0.40	1593.05^{c}±0.40	1962.04±0.40
5	45.09^{b}±0.29	204.47^{a}±0.40	519.65^{a}±0.40	1048.24^{a}±0.40	1621.27^{a}±0.40	1978.09±0.40
P-value	<0.0001	0.1860	0.0036	0.1445	<0.0001	0.2676

Note: docw-day old chick weight, bwt1-body weight at one week of age, bwt2-body weight at two week of age, bwt3-body weight at three week of age, bwt4-body weight at four week of age and bwt5-body weight at five week of age. ^{abcd}Means with the different superscripts differed significantly within the column (P<0.05).

Similarly, at four weeks of age the highest live weight was reported at diet five (1621.27±0.40 g/bird) and it was followed by diet three, four, two and one. A higher amino acids-to-energy ratio is required in faster growing strains of broilersas amino acid requirements increase proportionately faster than do energy requirements (Gous, 2010).

This findings might be pointed out that the best amount of threonine for live body weight gain of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed.

Feed conversion into meat

The FCR values differed significantly among the diet groups (Table 6).

FCRs were better for diet group three and five (1.74±0.40) than the diet group four, two and control diet (2.00±0.04) at the age of 35 days. However, feed conversion ratio was documented 1.93±0.04 for the feed formulated and used without having threonine at the age of 30 days in commercial broiler birds (Islam *et al.,* 2014).

Table 6. Effect of feed type on feed conversion ratio (FCR).

Diet	fcr1	fcr2	fcr3	fcr4	fcr5
1	0.89^{d}±0.40	1.18^{d}±0.40	1.29^{e}±0.40	1.54^{e}±0.40	2.00^{d}±0.40
2	0.87^{c}±0.40	1.17^{c}±0.40	1.25^{d}±0.40	1.40^{d}±0.40	1.87^{c}±0.40
3	0.83^{a}±0.40	1.11^{a}±0.40	1.21^{b}±0.40	1.35^{b}±0.40	1.74^{a}±0.40
4	0.84^{b}±0.40	1.14^{b}±0.40	1.23^{c}±0.40	1.38^{c}±0.40	1.76^{b}±0.40
5	0.83^{a}±0.40	1.08^{a}±0.40	1.19^{a}±0.40	1.31^{a}±0.40	1.74^{a}±0.40
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Note: fcr1-feed conversion ratio at one week of age, fcr2-feed conversion ratio at two week of age, fcr3-feed conversion ratio at three week of age, fcr4-feed conversion ratio at four week of age and fcr5-feed conversion ratio at five week of age. ^{abcde} Means with the different superscripts differed significantly within the column (P<0.05).

Similarly, FCR value was the best for diet group five (1.31±0.40) and this was followed by the diet group three, four, two and control diet (1.54±0.40) at the age of 28 days. In Bangladesh context FCR for 28 days is more important than at 35 days, because farmers here in Bangladesh used to rear commercial broiler birds up to the age of 28 days. Variability in nutrient composition of the commercial feeds is an important factor to be considered by farmers in the choice of feeds for broiler production as the varied performance of the birds on the different commercial feeds observed (Uchegbu *et al.*, 2009).

Table 7. Effect of feed type on daily average body weight gain (ADG) in gram.

Diet	adg1	adg2	adg3	adg4	adg5
1	28.96^{c}±0.40	35.91^{d}±0.40	49.43^{c}±0.40	56.06^{e}±0.40	55.87±0.40
2	28.97^{c}±0.40	35.96^{d}±0.40	49.60^{b}±0.40	56.44^{d}±0.40	55.95±0.40
3	29.19^{a}±0.40	36.56^{b}±0.40	49.89^{a}±0.40	57.38^{b}±0.40	56.11±0.40
4	29.07^{b}±0.40	36.38^{c}±0.40	49.65^{b}±0.40	56.89^{c}±0.40	56.06±0.40
5	29.21^{a}±0.40	37.11^{a}±0.40	49.92^{a}±0.40	57.90^{a}±0.40	56.52±0.40
P-value	0.1864	0.0036	0.1444	<0.0001	0.2677

Note: adg1-daily average body weight gain at one week of age, adg2-daily average body weight gain at two week of age, adg3-daily average body weight gain at three week of age, adg4-daily average body weight gain at four week of age and adg5-daily average body weight gain at five week of age. ^{abcde}Means with the different superscripts differed significantly within the column (P<0.05).

The discussion might be suggestive that the best amount of threonine for FCR of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed.

Daily body weight gain

Average daily live body weight gain differed significantly among the diet groups (Table 7) at the ages of two and four weeks. Daily live weight gain up to the age of 35 days was the highest in diet group five (56.52±0.40 g/bird) and it was followed by diet group three, four, two and one (55.87±0.40 g/bird).

Similarly, ADG up to the age of 28 days was the highest in diet group five (57.90±0.40 g/bird) and it was followed by diet group three, four, two and one (56.06±0.40 g/bird).

However, lower amount of ADG than the present observation at 28 and 35 days were documented (50.39 g/bird) at the age of 30 days old broiler birds (Islam *et al.,* 2016).

Above discussion might be indicative that the best amount of threonine for ADG of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed.

Table 8. Carcass measurements at the age of 30 days old.

Variables (g)	Different dietary groups					P-value
	T1	T2	T3	T4	T5	
Dressing weight	1201.25±1.48	1155.88±1.48	1181.75±1.48	1275.63±1.48	1314.63±1.48	0.0002
Thigh	121.88±1.48	114.13±1.48	105.38±1.48	114.25±1.48	120.25±1.48	0.5511
Drumstick	73.63±1.48	68.75±1.48	72.25±1.48	73.88±1.48	77.88±1.48	0.0114
Breast	401.00±1.48	385.00±1.48	413.63±1.48	429.13±1.48	459.38±1.48	<0.0001
Wing	72.38±1.48	64.13±1.48	67.25±1.48	75.63±1.48	72.63±1.48	0.0437
Heart	7.50±1.48	6.75±1.48	7.38±1.48	7.38±1.48	7.75±1.48	0.2978
Liver	41.75±1.48	43.63±1.48	40.75±1.48	44.75±1.48	44.63±1.48	0.4133
Gizzard	20.38±1.48	24.13±1.48	20.75±1.48	20.50±1.48	26.00±1.48	0.1494
Fat in abdomen	26.75±1.48	20.13±1.48	35.88±1.48	36.38±1.48	34.25±1.48	0.0333

Carcass measurements

Dressing yield per bird and breast weight significantly varied among the diet groups at the age of 30 days (Table 8) in case of both sexes. The highest dressing yields (1314.63±1.48 g/bird) were documented for the diet group five and the lowest were in diet two. Breast muscles maintained a positive allometric growth after 34 days of age in the Ross 708 broiler bird (Schmidt *et al.,* 2009).

Table 9. Effect of threonine on economics of broiler production.

Diet	Total Feed Intake in kg	Total amount of threonine used in kg	Total Cost of threonine (@1.7 us$ /kg)	Total sale amount in kg	Total sale amount in (@1.69 us$ /kg live broiler) us dollar
1	523.94	0	0	261.97	442.73
2	488.02	0.244	0.414	262.37	443.40
3	457.88	0.458	0.778	263.04	444.54
4	463.46	0.695	1.181	264.87	447.63
5	461.97	0.923	1.569	267.03	451.28

Above discussion might be indicative that the best amount of threonine for dressing yield per bird and breast weight of broiler bird was 2.0 g/kg feed.

Threonine and cost minimization in broiler production

Total cost of threonine for 267.03 kg of broiler meat production was 1.569 us dollar and total sale amount was 451.28 us dollar, where excess gain 37.95 us dollar (Table 9).

This means 24.18 us dollar extra (Table 10) income could be done by investing 1 us dollar for threonine purpose. Feed accounts for about 70% of the cost of production in livestock enterprises (Oyediji, 2001).

Table 10. Effect of threonine on economics of broiler production.

Diet	Dose of threonine per kg feed in g	Feed purpose excess cost in us dollar	Total Cost of threonine (@1.7 us$ /kg)	Threonine cost variation in us dollar	1 us dollar investment variation for threonine, profit variation in us dollar	Excess gain in us dollar
1	0	61.97*37/78=29.40	0	1.569	24.18 less than Diet 5	-(29.40+8.55)= -37.95
2	0.5	26.05*37/78=12.36	0.414	1.155	17.33 less than Diet 5	-12.36-7.88=-20.02
3	1	-4.09*37/78=-1.94	0.778	0.791	6.07 less than Diet 5	1.94-6.74=-4.8
4	1.5	1.49*37/78=0.71	1.181	0.388	11.24 less than Diet 5	-0.71-3.65=-4.36
5	2.0	0	1.569			

To enhance live broiler performance and meat yields as well as the sales market price, the economics of amino acids density needs to consider (Vieira and Angel, 2012). Above simple calculation might be pointed out that the best economic dose of threonine for commercial broiler production was 2 g/kg feed.

Conclusion

Feed consumption amount varied significantly among diet groups, where diet group five was the best performer and this was followed by diet group three. The best amount of threonine for live body weight gain of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed. Similarly, the best amount of threonine for FCR of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed. However, the best amount of threonine for ADG of broiler bird was 2.0 g/kg feed and it was followed by 1.0 g/kg feed, 1.5 g/kg feed and 0.5 g/kg feed. Very interestingly, the best amount of threonine for dressing yield per bird and breast weight of broiler bird was 2.0 g/kg feed and the best economic dose of threonine for commercial broiler production was 2 g/kg feed.

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