DETERMINATION OF OPTIMUM METHIONINE REQUIREMENTS OF BROILER CHICKENS REARED DURING THE HOT SEASON UNDER TROPICAL ENVIRONMENT

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ABSTRACT

Dietary amino acids in excess of the needs of broiler chickens may impair feed intake and growth rate. An experiment was conducted to determine the optimum dietary methionine requirement for broiler chickens reared during the hot season under tropical condition. A total of three hundred day old broiler chicks were used for the starter phase and two hundred and seventy chicks for the finisher phase. Each experiment had five treatment groups and three replicates per group. The experimental diets were five with graded levels of supplemental methionine at: 0.15, 0.20, 0.25, 0.30 and 0.35 % to give total dietary methionine levels of 0.45, 0.50, 0.55, 0.60 and 0.65 % for the starter phase feeding trial. For the finisher phase feeding trials, supplemental methionine levels of 0.14, 0.19, 0.20, 0.25 and 0.30 % to give total dietary methionine levels of 0.40, 0.45, 0.50, 0.55 and 0.60 % were fed to the chicks. Each experiment lasted from 0 – 4 weeks for the starter phase and 5 – 8 weeks for the finisher phase. Results for the starter phase indicated significant (p<0.05) linear increases for total weight gain and average daily gain as the dietary levels of methionine increased. The birds fed 0.60 % methionine diet had the highest (p<0.05) final body weight, better feed conversion ratio and feed cost per kg weight gain. The results for the finisher phase show that birds fed 0.60 % methionine diet performed significantly (p<0.05) better in terms of the body weight gain, feed conversion ratio and feed cost/kg weight gain than those fed lower methionine levels in diets. It was concluded that the methionine requirement was 0.60 % for the starter diet. For the finisher phase, a linear increase in the body weight gain was observed up to the highest dietary level of methionine tested (0.60 %). Hence, the optimum dietary level of methionine may be above 0.60 %. Further studies will be necessary to establish higher doses of dietary methionine in broiler finisher reared under tropical climatic conditions.

Keywords: Dietary amino acid, Methionine diets, Broiler, Growth rate, Tropical environment, Feed conversion ratio, Feed cost per kg weight gain

INTRODUCTION

In practice it is very difficult, if not impossible; to formulate diets with natural feed ingredients that will provide all the amino acids needed by broiler chickens in adequate quantities. It is known that addition of essential amino acids to diets allows a reduction in dietary crude protein content NRC (1994). An experiment conducted by *Acar et al.* (2001), showed that chicks fed diets marginal in protein but fortified with methionine or methionine and lysine performed

as well as those fed a diet higher in protein. Methionine is the first limiting amino acid in commercial broiler diets and is commonly supplemented as dry DL-methionine (DLM) containing about 99% of active substance or as liquid DL-methionine-hydroxyl-analogue-free-acid, commonly available as product with 88 % of active substance Lesson and Summer (2001). The requirement of methionine for growth and maintenance would be expected to vary with factors that influence maximum growth and feed intake. These factors include dietary nutrients, age, sex, physiological status, and environmental conditions (Denner and Bessi, 2003). Methionine is essential for various vital functions in body such as: protein synthesis, regulation of cell division, methyl donor, reduces reactive oxygen species Kalbande *et al*. (2009). Methionine may act as a lipotropic agent through its role as an amino acid in balancing protein or through its role as a methyl donor and involvement in choline, betaine, folic acid and vitamin B metabolism Kalbande *et al.* (2009). Methionine absorbed from the digestive tract is used for protein synthesis, production, health and protection against internal and external stresses. Furthermore methionine serves a precursor for cystine and an important source of dietary sulfur. Deficiency in methionine consumption has a significant negative impact on animal such as growth inhibition, the induction of metabolic disorder and the reduction of disease defensive potential. On the other hand, feeding excess dietary methionine has been reported to impair body weight gain Wang *et al*. (2004), although (Han and Baker, 1994) reported that 0.5 % excess of methionine are not harmful to broiler chicks fed corn-soybean meal diets. Most of the previous studies on the requirement of methionine for broiler chickens have been conducted under the temperate conditions and it is well documented that nutrient requirements of poultry is adversely affected by ambient temperature. Thus, the objective of this study was to determine the optimum dietary methionine requirement for broiler chickens reared during the hot season under tropical condition.

MATERIALS AND METHODS

Experimental Site: The experiment was conducted at the poultry unit of the Department of Animal Science, Ahmadu Bello University, Zaria Nigeria, which is within the northern guinea savannah zone and located on latitude 11^0 12′N, longitude 7^0 33′E and an altitude of 640 metres above sea level, having annual rainfall of 1100 mm which starts between late April and early May to mid October. The dry season begins around the middle of October, with cold weather that ends in February. This is followed by relatively hot-dry weather from March – April just before the rain begins. The mean minimum daily temperature is from 14^0 C – 24^0 C during the cold season while the mean maximum daily temperature is from 20^0 C – 40^0 C during the hot season. The mean relative humidity during dry and wet seasons is 21 % and 72 %, respectively (IAR, 2012).

Experimental Birds: The broiler chicks (Arbor Acre) used in this experiment was obtained from a commercial hatchery with good records of birds' performance.

Experimental Design and Management of Birds: A total of 300 day old chicks from a commercial hatchery were used for the starter phase and 270 birds were used for the finisher phase experiments. The mean weights of birds for all the pens were made to be approximately equal. The birds were randomly assigned to 5 dietary treatments. There were 20 birds per pen at the starter phase and 18 birds per pen at the finisher phase. It was a completely randomized design in a deep litter system. Heat and light were provided throughout the brooding period, using stoves, charcoal pots, lanterns and electricity. Routine vaccinations and all necessary medications were administered as recommended for Zaria area by the Faculty of Veterinary Medicine Teaching Hospital, Ahmadu Bello University. Feed and water were provided *ad libitum*. The experiment was conducted during the hot season between March and May. The maximum temperatures varied from 20^0 C – 39^0 C.

Experimental Diets: Five broiler starter and finisher diets were formulated. Such that the starter diets contained 0.45, 0.50, 0.55, 0.60 and 0.65 % and the finisher diets contained 0.40, 0.45, 0.50, 0.55 and 0.60 % total dietary methionine, respectively (Tables 1 and 2). Diet 2 was formulated to meet the NRC (1994) methionine requirement and this diet served also as the control for the experiment. The diets were formulated to be isocaloric and isonitrogenous. Diets were also formulated to meet the requirements for energy, protein, calcium, phosphorus and lysine for both starter and finisher phases.

Performance Characteristics: At the beginning of the experiment, the day old chicks were randomly allocated to the five dietary treatments on the basis of equal weights and thereafter weighed weekly. Weights obtained were subtracted from the previous ones to get weekly weight gain. The cumulative weight gain and feed consumption were computed and used to calculate the feed efficiency and feed cost per kilogram weight gain. Mortality was monitored daily and recorded.

Statistical Analysis: Data obtained from all the experiments were subjected to the analysis of variance (ANOVA) using the general Linear Model Procedure of SAS (2001) thus: $Y_{ij} = \mu + K_{i +} e_{ij,}$ where Y_{ij}= Observation of the i^{th} level of methionine as shown by broilers performance, μ= Overall mean, K_i =i^{th} effect of methionine and e_{ij} = Random error. Significant differences among treatment means were separated using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The performance of broiler starter chicks reared in the hot season and fed diets containing 0.45%, 0.50 %, 0.55 %, 0.60 % and 0.65 % supplemental methionine levels are shown in Table 3. Broiler starter chicks fed methionine level of 0.60 % during this study had the best result in terms of final weight and weight gain as shown in Table 3. Final weights, weight gains, feed intake, feed conversion ratio feed cost per kg gain and leg deformity were significantly affected ($p<0.05$) by dietary treatments. Birds fed methionine level of 0.60 % had the best result in terms of final weight and weight gain. This level probably marked the optimum requirement of broiler chicks, since there was a drop in final weight and weight gain for treatment 5 with 0.65 % methionine. This result agreed with the finding of Lemme *et al*. (2002) who reported that the methionine requirements of broiler birds reared in the tropics under ambient temperatures of 30 to 45^0 C showed an increase in the requirements of DL-methionine. The diet with 0.65 % methionine had the highest feed intake. This result agreed with the study of Elwinger and Tausen (2009) who reported significantly high ($p<0.05$) feed intake with increasing methionine levels in the diet of broiler birds. The better feed conversion ratio of treatment 4 birds which contained 0.60 % methionine level compared with other treatments was in agreement with the findings of Chattopadhyay *et al*. (2006). This was indicative that broiler starter diets containing 0.60 % methionine had enhanced rate of feed conversion to flesh. Feed cost per kg weight gain was better for the birds fed methionine levels of 0.60 % and 0.65 %. There was no significant difference ($p>0.05$) between treatments 4 and 5 containing methionine levels of 0.60 % and 0.65 %. The inclusion of methionine in the diets for all the treatments had no significant ($p>0.05$) effect on mortality rate. These results agreed with the earlier findings of Sundrum (2005) and Halder and Roy (2007), who reported no adverse effect of methionine inclusions on animal health. The performance of broiler finisher chickens fed diets containing 0.40 %, 0.45 %, 0.50 %, 0.55 % and 0.60 % supplemental methionine is shown in Table 4. Final weight, weight gain, feed conversion ratio and feed cost per kg gain were significantly ($p<0.05$) affected by dietary treatments, while dietary treatments had no significant ($p>0.05$) effect on feed intake and on the mortality rate. Methionine supplementation significantly ($p<0.05$) improved the final weight, weight gain, feed conversion ratio and feed cost per kg gain. Body weight gain of broiler finisher birds generally improved with increasing methionine levels as

Table 1: Composition of broiler starter diets containing graded levels of supplemental methionine fed to broiler starter (0 – 4 weeks) in the hot season

Ingredients	Percentage Composition				
	Group 1 Met 0.45 %	Group 2 Met 0.50 %	Group 3 Met 0.55 %	Group 4 Met 0.60 %	Group 5 Met 0.65 %
Maize	41.75	41.90	41.40	41.90	41.60
Full fat soyabean	10.00	10.00	10.00	10.00	10.00
Brewers Dried Grain	5.00	5.00	5.00	5.00	5.00
Palm Kernel Cake	5.00	5.00	5.00	5.00	5.00
Groundnut Cake	30.00	29.80	29.80	29.70	29.50
Palm oil	3.00	3.00	3.00	3.00	3.00
Bone meal	3.10	3.10	3.10	3.10	3.10
Common Salt	0.30	0.30	0.30	0.30	0.30
Lime stone	1.00	1.00	1.00	1.00	1.00
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.40	0.40	0.40	0.40	0.40
Methionine	0.15	0.20	0.25	0.30	0.35
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME Kcal/kg	2951	2948	2949	2947	2949
Crude protein	23.10	23.10	23.20	23.20	23.10
Ether extract	8.52	8.51	8.51	8.50	8.50
Crude fibre	4.47	4.46	4.46	4.45	4.45
Calcium	1.29	1.29	1.29	1.29	1.29
Lysine	1.24	1.24	1.24	1.24	1.24
Methionine	0.45	0.50	0.55	0.60	0.65
Available P%	0.54	0.54	0.54	0.54	0.54
Met+ Cys%	0.80	0.85	0.90	0.95	1.00
Feed cost/kg (~~₦~~)	59.28	61.43	62.13	62.78	63.54

*Met = Methionine; P = Phosphorus; ME = Metabolizable Energy; Cys = Cysteine ** Biomix premix supplied per kg of diet: Vit. A, 10,000 iu; Vit. D_3, 2000 iu; Vit E, 23 mg, Vit. K, 2 mg; Vit. B_1, 1.8 mg; Vit B_2, 5.5 mg; Niacin, 27.5 mg; Pantothenic acid, 7.5 mg; Vit. B_{12}, 0.015 mg: Folic acid, 0.75 mg; Biotin, 0.06 mg; Choline Chloride, 300 mg; Cobalt, 0.2 mg; Copper, 3 mg; Iodine 1 mg; Iron, 20 mg; Manganese, 40 mg; Selenium, 0.2 mg; Zinc, 30 mg; Antioxidant, 1.25 mg.*

Table 2: Composition of broiler finisher diets containing graded levels of supplemental methionine fed to broiler finisher (5 – 8 weeks) in the hot season

Ingredients	Percentage Composition				
	Group 1 Met 0.40 %	Group 2 Met 0.45 %	Group 3 Met 0.50 %	Group 4 Met 0.55 %	Group 5 Met 0.60 %
Maize	47.08	47.20	47.65	47.40	47.45
Full fat soyabean	7.50	7.50	7.50	7.50	7.50
Brewers Dried Grain	5.00	5.00	5.00	5.00	5.00
Palm Kernel Cake	5.00	5.00	5.00	5.00	5.00
Groundnut Cake	27.20	27.00	26.80	26.70	26.60
Palm oil	3.00	3.00	3.00	3.00	3.00
Bone meal	3.10	3.10	3.10	3.10	3.10
Common Salt	0.30	0.30	0.30	0.30	0.30
Lime stone	1.00	1.00	1.00	1.00	1.00
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.46	0.46	0.46	0.46	0.46
Methionine	0.09	0.14	0.19	0.24	0.29
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME Kcal/kg	2983	2982	2981	2982	2980

Crude protein	21.50	21.50	21.50	21.50	21.50
Ether extract	7.28	7.28	7.28	7.27	7.27
Crude fibre	4.28	4.28	4.26	4.26	4.25
Calcium	1.00	1.00	1.00	1.00	1.00
Lysine	1.28	1.28	1.28	1.28	1.28
Methionine	0.40	0.45	0.50	0.55	0.60
Available P	0.54	0.54	0.54	0.54	0.54
Met + Cys.	0.70	0.75	0.80	0.85	0.90
Feed cost/kg (₦)	86.26	87.97	89.90	90.05	90.89

*Met = Methionine; P = Phosphorus; ME = Metabolizable Energy; Cys = Cysteine ** Biomix premix supplied per kg of diet: Vit. A, 10,000 iu; Vit. D_3, 2000 iu; Vit E, 23 mg, Vit. K, 2 mg; Vit. B_1, 1.8 mg; Vit B_2, 5.5 mg; Niacin, 27.5 mg; Pantothenic acid, 7.5 mg; Vit. B_{12}, 0.015 mg: Folic acid, 0.75 mg; Biotin, 0.06 mg; Choline Chloride, 300 mg; Cobalt, 0.2 mg; Copper, 3 mg; Iodine 1 mg; Iron, 20 mg; Manganese, 40 mg; Selenium, 0.2 mg; Zinc, 30 mg; Antioxidant, 1.25 mg.*

shown in Table 4. There were significant improvements in final weight, weight gain, feed conversion ratio and feed cost per kg gain with increasing methionine levels from 0.40% to 0.60% of the diets. This result agreed with the findings of Wang *et al.* (2004). Chattopadhyay *et al*. (2006) also reported that methionine inclusion in the diet led to increase in body weight and weight gains of birds with lower feed cost per kg gain. The best performance in terms of body weight gain was observed in treatment 5. Body weight gain increased and feed conversion ratio improved with increasing methionine levels. There was no significant ($p>0.05$) difference in feed intake across treatments. This result is similar to the findings of Yalcin *et al*. (1999) who reported no significant differences in feed intake across the treatments but contrary to the findings of Halder and Roy (2007) who reported increased difference ($p<0.05$) in feed intake for control diet that had no supplemental DL- methionine. The best feed conversion ratio was observed in treatment 5. This is similar to the report of Hickling *et al*. (1990) who reported increase in body weight gain and feed conversion ratio with increasing levels of methionine. Increase in weight gain observed as the levels of methionine supplementation increased significantly ($p<0.05$) contributed to leg deformity because of generally low level of calcium in the rations. Methionine supplementation in broiler diets also had no significant ($p>0.05$) effects on mortality rate at this phase. This was also in agreement with the findings of Sundrum (2005) who reported that there was no adverse effect of methionine on animal health at inclusion rate higher than 0.45% recommended level by NRC (1994).

Conclusion: The results of this study showed that the methionine requirement was 0.60 % for the broiler starter diet. For the finisher phase, a linear increase in the body weight gain was also observed up to the highest dietary level of methionine (0.60 %) tested. There is therefore probability that the optimum dietary level of methionine lies beyond 0.60 % level. Further studies are needful to establish higher doses of dietary methionine in diets of broiler finisher reared under tropical climatic conditions.

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Table 3: Performance of broiler starter chicks fed (0 – 4 weeks) with graded levels of methionine in broiler starter diets during the hot season

Parameters	Treatments				
	Group 1 Met 0.45 %	Group 2 Met 0.50 %	Group 3 Met 0.55 %	Group 4 Met 0.60 %	Group 5 Met 0.65 %
Initial weight (g)	38.33 ± 0.17	38.00 ± 0.16	38.00 ± 0.16	38.33 ± 0.17	38.25 ± 0.17
Final weight (g)	560.00 ± 47.25^{d}	643.30 ± 69.41^{c}	721.67 ± 108.95^{b}	811.70 ± 20.48^{a}	730.50 ± 46.51^{b}
Total weight gain (g)	521.70 ± 47.13^{d}	605.30 ± 69.84^{c}	683.70 ± 108.95^{b}	773.30 ± 20.45^{a}	690.50 ± 46.65^{b}
Av. daily gain(g)	18.63 ± 1.68^{d}	21.62 ± 2.49^{c}	24.42 ± 3.89^{b}	27.67 ± 0.73^{a}	24.66 ± 1.67^{b}
Total feed intake (g)	950.70 ± 2.23^{b}	910.35 ± 15.46^{b}	930.39 ± 49.93^{b}	1023.77 ± 23.39^{ab}	1105.00 ± 54.87^{a}
Daily feed intake (g/d)	26.81 ± 0.08^{b}	31.32 ± 0.55^{a}	29.66 ± 1.78^{ab}	31.80 ± 0.79^{a}	30.50 ± 1.96^{ab}
FCR	1.85 ± 0.12^{b}	1.53 ± 0.19^{a}	1.44 ± 0.23^{a}	1.33 ± 0.02^{a}	1.61 ± 0.09^{a}
Feed cost/kg gain (₦)	88.30 ± 9.55^{bc}	91.54 ± 11.15^{c}	80.40 ± 14.22^{b}	62.75 ± 0.03^{a}	63.54 ± 0.03^{a}
Mortality (%)	6.67 ± 1.05	8.33 ± 1.67	8.33 ± 1.67	6.67 ± 4.41	5.00 ± 1.67

a, b, c, d=means with different superscripts on the same row differ significantly, SEM = Standard Error of Means, Met= Methionine, FCR = Feed conversion ratio

Table 4: Performance of broiler finisher chicks fed (5 – 8 weeks) with graded levels of methionine in broiler finisher diets during the hot season

Parameters	Treatments				
	Group 1 Met 0.40 %	Group 2 Met 0.45 %	Group 3 Met 0.50 %	Group 4 Met 0.55 %	Group 5 Met 0.60 %
Initial weight (g)	799.85 ± 0.18	800.23 ± 0.03	798.00 ± 0.4.72	798.33 ± 1.67	803.33 ± 1.67
Final weight (g)	1912.33 ± 44.28^{e}	2046.67 ± 31.79^{d}	2346.67 ± 57.83^{c}	2471.67 ± 17.63^{b}	2534.67 ± 73.17^{a}
Total weight gain (g)	1112.48 ± 44.15^{e}	1246.63 ± 31.83^{d}	1548.60 ± 53.29^{c}	1673.33 ± 17.64^{b}	1731.33 ± 73.17^{a}
Av. daily gain (g)	39.73 ± 1.58^{e}	44.52 ± 1.14^{d}	55.31 ± 1.90^{c}	59.76 ± 0.62^{b}	61.83 ± 2.66^{a}
Total feed intake (g)	2759.70 ± 198.24	2848.20 ± 90.32	2812.00 ± 28.76	2967.00 ± 293.85	2947.60 ± 130.50
Daily feed intake (g/d)	98.56 ± 7.08	101.72 ± 3.22	100.43 ± 1.03	105.96 ± 10.49	105.27 ± 4.66
FCR	2.48 ± 0.17^{b}	2.29 ± 0.13^{b}	1.82 ± 0.05^{a}	1.77 ± 0.16^{a}	1.71 ± 0.13^{a}
Feed cost/kg gain (₦)	213.96 ± 13.37^{b}	199.03 ± 11.18^{a}	161.98 ± 3.93^{a}	158.94 ± 14.05^{a}	154.89 ± 11.66^{a}
Leg deformity (%)	1.85 ± 1.85^{b}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	9.19 ± 1.81^{c}	3.71 ± 1.85^{b}
Mortality (%)	7.41 ± 1.85	3.71 ± 1.85	1.85 ± 1.85	1.85 ± 1.85	9.22 ± 1.83

a, b, c, d=means with different superscripts on the same row differ significantly, SEM = Standard Error of Means, Met= Methionine, FCR = Feed conversion ratio

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