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Full Length Research Paper

Evaluation of methionine-fortified blood meal as substitute for fish meal in poultry broiler diets

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This study was conducted to evaluate the growth performance, dressing percent and carcass composition, organ weights and cost-return analysis of broiler chickens fed methionine-fortified blood meal as replacement for fish meal. Two hundred and ten day-old hybro broiler chicks were allotted to 21 floor pens with 10 birds per pen. Seven experimental diets were formulated for starter and finisher phases respectively. Diets 1 (positive control) and 2 (negative control) contained 3% fish meal and 3% blood meal respectively. Diets 3 to 7 contained 3% blood meal each with 0.1, 0.2, 0.3, 0.4 and 0.5% methionine fortifications, respectively. Each diet was fed as mash to birds in 3 pens in completely randomized design. Results of growth performance showed no significant (p>0.05) differences in average daily feed intake, average daily weight gain and feed conversion ratio but mortality revealed significant (p<0.05) difference. Final body weight and dressing percentage were not affected by the treatment (p>0.05). Significant (p<0.05) differences were observed in the moisture, crude protein, ether extract, ash and nitrogen free extract contents for breast and thigh muscles. Cost-return analysis revealed significant (p<0.05) differences in total variable cost, total revenue, gross margin and returns on investment. In conclusion, 3% blood meal with up to 0.5% methionine fortification can favourably replace 3% fish meal as an animal protein source for broilers.

Key words: Methionine-fortified blood meal, fish meal, growth performance, carcass characteristics, broilers.

INTRODUCTION

The competition between man and poultry for feed is partly fuelled by the insufficient production of edible crops to meet the needs of man and his livestock (Babatunde et al., 1990; Esonu et al., 2001) and the threat of desert encroachment in numerous segments of the West Africa which has destroyed vegetation (Idufueko, 1984; Madubuike, 1992).

Poultry nutritionists are consequently faced with the responsibility of finding unconventional feedstuffs that will not compromise quality.

Animal protein sources have a good balance of essential amino acids but are expensive. Fish meal is an expensive animal protein concentrate and usually ranks highest in cost among animal protein concentrates in feed formulation. Consequently, an incessant effort exists in the replacement of fish meal with cheaper and protein sources in the diets of poultry (Dafwang et al., 1986; Udedibie et al., 1988; Fanimo et al., 1988; Dongmo et al., 2000).

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Bovine blood is a slaughter by-product which poses serious disposal problem in most slaughter houses (Onyimonyi and Ugwu, 2007). Blood meal from cattle contains about 80% crude protein (Ewane, 1996), and the protein has a very high biological value for poultry compared with vegetable protein (Memon et al., 2002). Blood meal protein is the richest source of natural lysine (Odukwe and Njoku, 1987). It is best considered as the feed ingredient for increasing lysine levels in diets (Donald et al., 1988). The low digestibility, low methionine content (Schingoethe, 1991) and distinctive smell of blood meal however, limit its use in poultry rations. Blood meal has been recommended at 5% in the diet (Seifdavati et al., 2008).

Methionine is an essential amino acid required by poultry (Itoe et al., 2010). Vegetable protein concentrates which are increasingly being used in poultry rations are mostly deficient in methionine thus the need for supplementing this amino acid. North and Bell (1990) revealed that it may be more cost-effective to supplement diet with methionine than to add more of soybean or other proteins to meet the requirement. Supplementation of low protein diets with amino acids for the various classes of poultry has been studied (Zeweil et al., 2011). Therefore, the objective of this research was to evaluate methionine-fortified blood meal as replacement for fish meal in poultry broiler diets.

MATERIALS AND METHODS

Location of the study

The study was carried out at the Poultry Unit of the Department of Animal Science, Faculty of Agriculture Teaching and Research Farm, University of Calabar, Nigeria.

Collection and preparation of blood meal and fish meal

Bovine blood was collected from the Abattoir in Akim Army Barracks in Calabar immediately after slaughter. The blood was boiled at 100°C for 40 min, cut into smaller pieces and sun-dried for 72 h. The sun-dried blood was milled using hammer mill to pass through 0.2 mm sieve and stored in bags in a cool dry place. Whole and shredded dry bonga fish (*Ethmalosa fimbriata*) were purchased from the Beach market in Calabar and ground into meal using the hammer mill to pass through 0.2mm sieve and stored in bags in a cool dry place. Blood meal and fish meal were analyzed for proximate composition and amino acid profile and used for the formulation.

Experimental diets

Seven (7) diets were formulated for the broiler starter (Table 1) and finisher (Table 2) phases. Diets 1 (positive control) and 2 (negative control) contained 3% fish meal and 3% blood meal respectively without added methionine. Diets 3 to 7 contained 3% blood meal each with 0.1, 0.2, 0.3, 0.4 and 0.5% methionine fortifications respectively. The diets were analyzed for their proximate (AOAC, 1990) and amino acid compositions (Spackman et al., 1958).The results of the proximate and amino acid compositions of blood meal and fish meal (Table 3) guided the formulation of the experimental diets.

Experimental birds and management

Two hundred and ten day-old hybro broiler chicks, purchased from a reputable distributor in Calabar were used for this experiment. The chicks were weighed and randomly allotted 21 floor pens of similar body weights. Each diet was fed as mash to 3 replicate pens of 10 birds each in a completely randomized design. Vaccination schedule for broilers was strictly adhered to. The study lasted for 9 weeks.

Parameters measured

Weight gain was obtained weekly and divided by seven to obtain daily weight gain. Daily feed intake was obtained by deducting the weight of left over feed from that given. Feed conversion ratio was calculated by dividing the cumulative values of daily feed intake by daily weight gain. Mortality was properly monitored and recorded. To evaluate carcass, three (3) birds per replicate (9 birds per treatment) were selected randomly and fasted for 12 h in preparation for slaughter. The birds were slaughtered by severing the jugular vein. After slaughter, birds were bled, dipped in hot water at 100°C for 60 s and defeathered by hand-plucking. The shanks and viscera were removed for the determination of dressed weight and dressing percentages. The weights of cut up parts and internal organs were expressed as percentages of dressed weight. Intestinal length was measured in centimetres (cm). After slaughter and carcass evaluation, bones of breast and thigh were separated from muscle and connective tissues. Deboned samples were analyzed in the laboratory chemically for their proximate composition according to AOAC (1990). For cost-return analysis, the values for total variable cost and total revenue were computed and gross margin was calculated by deducting total variable cost from total revenue. Returns on investment were obtained by dividing the gross margin by total variable cost (Jhingan, 1997).

Chemical analyses of blood meal and fish meal

Samples of processed blood meal and fish meal were analyzed for their proximate (AOAC, 1990) and amino acid (Spackman et al., 1958) compositions. For amino acid analysis samples of blood meal and fish meal were dried to constant weights, defatted, hydrolyzed and evaporated in a rotary evaporator and then loaded into the Technicon Sequential Multisample amino acid analyzer (TSM).

Statistical analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) for CRD using Data Analysis Tool in Microsoft Excel 2010 and treatment means compared using Duncan multiple range test

Table 1. Ingredient composition of experimental diet for broiler starter phase.

	Methionine fortified blood meal diets						
Ingredient (kg)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**
Maize	54.02	54.02	54.02	54.02	54.02	54.02	54.02
Soybean meal	31.48	31.98	31.88	31.78	31.68	31.58	31.48
Fish meal	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Blood meal	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Palm kernel cake	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Methionine	0.00	0.00	0.10	0.20	0.30	0.40	0.50
Calculated composition							
ME (Kcal/kg)	2896.64	2919.14	2916.44	2913.74	2911.00	2908.34	2905.64
Lysine (%)	1.12	1.04	1.03	1.03	1.02	1.02	1.02
Methionine (%)	0.56	0.54	0.62	0.63	0.64	0.65	0.67
Analyzed composition							
Crude protein	22.78	23.11	23.04	23.10	23.12	23.08	23.01
Crude fibre	4.93	4.99	4.96	4.95	4.95	4.92	4.92
Ether extract	3.87	3.62	3.63	3.62	3.62	3.63	3.65
Calcium	1.94	1.93	1.92	1.92	1.92	1.92	1.90
Phosphorus	0.60	0.59	0.60	0.61	0.61	0.61	0.61
Ash	5.06	5.13	5.12	5.15	5.10	5.17	5.18
NFE	63.35	63.16	63.26	63.18	63.21	63.20	63.25

Each Kg feed contained (Optimix premix): Vitamin A 10,000000I.U.; Vitamin D3 2,00000 I.U.; Vitamin E 20,000I.U.; Vitamin 500 mg; K 2250 mg; Thiamine 1750 mg; Riboflavin B2 5000 mg; Pyridoxine B6 2,750; antioxidant 125 g; Niacin 27,500 mg; Vitamin B12 15 mg; Pantothenic acids 7,500 mg; Biotin 20 mh; Choline Chloride 400 g, Manganese 80 g; Zinc 50 g; Iron 20 g; Copper 5 g; Iodine 1.2 g; Selenium 200 mg; Cobalt 200 mg

Table 2. Ingredient composition of experimental diet for broiler finisher phase.

	Methionine fortified blood meal diets						
Ingredient (Kg)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**
Maize	56.50	56.50	56.50	56.50	56.50	56.50	56.50
Soybean meal	28.50	29.00	28.90	28.80	28.70	28.60	28.50
Fish meal	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Blood meal	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Palm kernel cake	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Methionine	0.00	0.00	0.10	0.20	0.30	0.40	0.50
Calculated composition							
ME (Kcal/kg)	2980.50	3003.00	3000.30	2997.60	2994.90	2992.20	2926.50
Lysine (%)	1.08	1.01	1.01	1.00	1.00	1.00	1.00
Methionine (%)	0.44	0.42	0.46	0.48	0.49	0.51	0.52
Analyzed composition							
Crude protein	19.58	20.82	20.72	20.52	20.36	20.19	20.02

Table 2. Contd.

Crude fibre	5.00	5.01	5.01	5.02	5.03	5.03	5.02
Ether extract	3.85	3.60	3.61	3.62	3.62	3.64	3.64
Calcium	1.85	1.83	1.83	1.82	1.82	1.82	1.81
Phosphorus	0.52	0.50	0.55	0.54	0.54	0.54	0.54
Ash	5.05	5.13	5.15	5.15	5.13	5.16	5.16
NFE	66.52	65.44	65.51	65.69	65.86	65.98	66.10

Each Kg feed contained (Optimix premix): Vitamin A 8,000000 I.U.; Vitamin D3 1,600000 I.U.; Vitamin E 5,000 I.U.; Vitamin K 2000 mg; Thiamine 1500 mg; Riboflavin B2 4,000 mg; Pyridoxine B6 1500 mg; antioxidant 125 g; Niacin 1,500 mg; Vitamin B12 10 mg; Panthotenic acids 5,000 mg; Folic acid 500 mg; Biotin 20 mg; Choline Chloride 200 g, Manganese 80 g; Zinc 50 g; Iron 20 g; Copper 5 g; Iodine 1.2 g; Selenium 200 mg;Cobalt 200 mg.

Table 3. Proximate composition and amino acid profile of blood meal and fish meal (dry matter basis).

Parameter (%)	Blood meal	Fish meal
Crude protein	83.12	65.43
Ether extract	1.00	12.95
Ash	5.00	13.38
NFE	10.88	8.24
Amino acids (g/100 g)		
Methionine	0.90	2.20
Cysteine	1.40	2.00
Lysine	9.00	5.20
Tryptophan	1.00	1.70
Isoleucine	0.75	2.50
Histidine	3.05	4.29
Valine	5.15	5.89
Leucine	10.30	6.86
Arginine	2.22	4.67
Glycine	4.60	5.00
Threonine	4.80	5.50
Phenylalanine	6.00	6.50
Tyrosine	3.30	3.50

(DMRT). Differences were considered significant at 5% probability.

RESULTS

Table 4 shows the results of the effect of blood meal with methionine fortification on growth performance of broilers. No significant ($p>0.05$) differences were observed in feed intake, weight gain and feed conversion ratio. There was significant ($p<0.05$) difference in mortality. The percentage mortality ranged between 3.33 and 10%. The result of carcass and internal organ characteristics (Tables 5 and 6) showed that there were no significant ($p>0.05$) differences in live weight, dressed weight, dressing percentage, and percent heart, liver, lungs, kidney, gizzard, proventriculus and gall bladder. However, there were significant differences in mean weights of breast (18.31 to 19.30%), thigh (20.33 to 22.71%), crop (0.50 to 0.68%), abdominal fat (0.95 to 1.57%) and intestinal length (187.40 to 244.41 cm). Table 7 shows the results of proximate composition for the breast and thigh muscles. Significant ($p<0.05$) differences were observed in moisture content (66.64 to 73.37%; 62.77 to 72.50%), crude protein (25.63 to 32.03%; 22.14 to 29.32%), ether extract (0.54 to 1.17; 2.83 to 5.77%), ash (0.14 to 0.63; 0.41 to 1.28%) and nitrogen free extract values (0.05 to 0.25; 0.25 to 1.02%) for the breast and the thigh muscles among treatments. The result of cost-return analysis (Table 8) showed significant ($p<0.05$) differences in total variable cost (₦952.81 to ₦1088.97), total revenue (₦1350.00 to ₦1600.00), gross margin (393.94 to 597.19) and return on investment (0.41 to 0.63).

DISCUSSION

Growth performance

The values for feed intake, weight gain and feed

Table 4. Growth performance of broilers fed methionine-fortified blood meal.

	Treatment							
Parameter (g)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Initial body weight (g/bird)	47.00	44.00	43.00	43.00	44.00	45.00	45.00	0.53
Final body weight (g/bird)	1910.00	1700.00	1800.00	1910.00	1920.00	1925.00	1927.00	25.47
Av. Daily weight gain(g/bird/day)	29.57	26.28	27.89	29.63	29.78	29.84	29.89	6.96
Av. Daily feed intake (g/bird/day)	98.25	94.44	100.00	103.02	90.32	95.87	102.22	17.58
Feed conversion ratio	3.45	3.49	3.65	3.36	2.89	3.41	3.77	0.54
Mortality (%)	3.33^{c}	3.33^{c}	3.33^{c}	3.33^{c}	6.66^{b}	10.00^{a}	10.00^{a}	0.69

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

Table 5. Carcass characteristics and cut up parts of broilers fed methionine-fortified blood meal.

	Treatment							
Parameter	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Live weight (g)	1910.00	1700.00	1800.00	1910.00	1920.00	1925.00	1927.00	25.47
Dressed weight(g)	1846.67	1626.67	1727.33	1837.00	1847.00	1850.00	1855.00	33.25
Dressing %	96.68	95.69	95.96	96.18	96.20	96.10	96.26	4.91
Breast (%)	18.31^{d}	18.37^{d}	19.30^{a}	18.61^{c}	18.77^{c}	19.06^{b}	19.26^{a}	0.22
Thigh (%)	20.33^{f}	20.40^{e}	21.53^{c}	21.35^{d}	21.54^{c}	21.91^{b}	22.71^{a}	0.24

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

Table 6. Internal organ characteristics of broilers fed methionine-fortified blood meal.

	Treatment							
Parameter (%)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Heart	0.64	0.57	0.54	0.61	0.53	0.46	0.73	0.05
Liver	2.59	2.76	3.28	2.87	3.03	3.16	3.42	0.28
Lungs	0.65	0.74	0.72	0.64	0.61	0.53	2.59	0.10
Kidney	0.12	0.13	0.23	0.13	0.13	0.15	0.15	0.03
Gizzard	4.16	3.93	4.14	3.92	4.14	3.79	4.37	0.48
Proventriculus	0.62	0.63	0.63	0.58	0.55	0.56	0.66	0.08
Gall bladder	0.16	0.17	0.18	0.20	0.14	0.08	0.20	0.10
Crop	0.51^{e}	0.52^{e}	0.68^{a}	0.65^{b}	0.61^{c}	0.50^{d}	0.67^{a}	0.05
Abdominal fat	1.37^{b}	0.95^{f}	1.57^{a}	1.37^{c}	1.14^{d}	1.41^{b}	1.41^{b}	0.05
Intestinal length (cm)	244.41^{a}	189.10^{f}	239.00^{b}	199.40^{e}	200.60^{d}	187.40^{f}	225.80^{c}	5.18

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

conversion ratio on the methionine fortified diets were comparable with the positive control (based on fish meal).The values were statistically similar and showed that up to 0.5% methionine fortification in blood meal did not have any adverse effect on growth performance.

The broilers whose diets was fortified with 0.2% methionine tended to have consumed more feed (103.02 g) followed by 0.5% (102.22 g), 0.1% (100.00 g), positive control (98.25 g), 0.4% (95.87 g), negative control (94.44 g) and 0.3% (90.32 g).The absence of significant difference in feed intake may be caused by the similarity of the metabolizable energy concentration of the diets since birds eat to satisfy their energy requirements (Onu et al., 2010). Absence of significance agrees with the works of the following authors: Kalbande et al. (2009) who supplemented diets of broilers with different levels of methionine; Bouyeh (2012) who tested excess lysine and methionine on the immune system and performance of

Table 7. Proximate composition of the breast and thigh muscles of broilers fed methionine-fortified blood meal (dry matter basis).

	Treatment							
Parameter (%)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Breast								
Crude protein	27.35[b]	30.26[a]	32.03[a]	31.53[a]	25.63[c]	25.74[c]	26.76[b]	0.59
Ether extract	0.57[d]	0.79[b]	0.67[c]	1.17[a]	0.67[c]	0.54[d]	0.55[d]	0.03
Ash	0.28[d]	0.63[a]	0.33[c]	0.50[b]	0.26[d]	0.27[d]	0.14[e]	0.03
NFE	0.22[a]	0.05[c]	0.25[a]	0.16[b]	0.07[c]	0.23[a]	0.14[b]	0.03
Moisture	71.58[ab]	68.27[b]	66.72[b]	66.64[b]	73.37[a]	73.27[a]	72.41[ab]	0.66
Thigh								
Crude protein	22.14[c]	27.68[ab]	25.32[b]	26.85[ab]	25.14[b]	29.32[a]	26.03[ab]	0.49
Ether extract	4.26[c]	2.83[e]	4.77[b]	4.57[b]	4.63[b]	5.77[a]	3.29[d]	0.50
Ash	0.69[c]	0.63[c]	1.00[b]	0.98[b]	1.28[a]	1.12[a]	0.41[d]	0.05
NFE	0.41[c]	0.31[c]	0.71[b]	0.25[d]	0.88[a]	1.02[a]	0.27[d]	0.05
Moisture	72.50[a]	68.55[ab]	68.20[ab]	67.35[ab]	68.07[ab]	62.77[c]	70.00[a]	0.72

Means with different superscripts within the same row are significantly ($p<0.05$) different.

Table 8. Cost-return analysis of broilers fed methionine-fortified blood meal.

	Treatment							
Cost (₦)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Day-old cost	170.00	170.00	170.00	170.00	170.00	170.00	170.00	
Feed cost	742.49	609.58	654.19	679.57	606.33	651.90	703.89	
Vaccine	7.62	7.62	7.62	7.62	7.62	7.62	7.62	
Medication	16.43	16.43	16.43	16.43	16.43	16.43	16.43	
Litter material	10.71	10.71	10.71	10.71	10.71	10.71	10.71	
Miscellaneous	141.72	141.72	141.72	141.72	141.72	141.72	141.72	
Total variable cost	1088.97[a]	956.06[f]	1000.67[d]	1026.05[c]	952.81[f]	998.38[e]	1050.37[b]	10.72
Av. Income/bird	1400.00	1200.00	1300.00	1350.00	1400.00	1400.00	1450.00	
Sale of manure/bag	150.00	150.00	150.00	150.00	150.00	150.00	150.00	
Total revenue	1550.00[b]	1350.00[e]	1450.00[d]	1500.00[c]	1550.00[b]	1550.00[b]	1600.00[a]	18.26
Gross margin	461.03[c]	393.94[e]	449.33[d]	473.95[c]	597.19[a]	551.62[b]	549.63[b]	15.54
ROI	0.42[e]	0.41[e]	0.45[d]	0.46[d]	0.63[a]	0.55[b]	0.52[c]	0.02

Means with different superscripts within the same row are significantly ($p<0.05$) different; ROI, returns on investment.

broilers; Kaur et al. (2013) where performance of commercial broilers were compared after replacing Herbomethione® with DLmethionine in their diets; Egenuka et al. (2015) where increasing level of dietary level of blood meal and reduced supplementary lysine were tested on performance of broilers and Ahmed and Abass (2015) who evaluated the broiler performance and carcass characteristics when herbal methionine versus dl-methionine were supplemented in broiler diets.

Broilers fed diets containing 0.5% methionine fortifications seemed to have higher daily weight gain values (29.89 g), followed by 0.4% (29.84 g), 0.3% (29.78 g), 0.2% (29.63 g), positive control (29.57 g), 0.1% (27.89 g) and negative control (26.28 g). The values tended to increase non-significantly as methionine fortifications increased across treatments. This confirms that methionine aids broilers to meet up with body tissue deposition that is a pre-requisite for rapid growth. Absence of significant difference in daily weight gain is in line with the works of Kaur et al. (2013), Egenuka et al. (2015) and Ahmed and Abass (2015).

In order of improvement, feed conversion ratio was best in 0.3% methionine fortification (2.89), followed by 0.2% (3.36), 0.4% (3.41), positive control (3.45), negative control (3.49), 0.1% (3.65) and 0.5% (3.77). The feed conversion for non-ruminants is influenced by the concentrations of methionine and lysine in the diet (Onu et al., 2010). Statistically similar values observed across treatments may be attributable to a more balanced combination of methionine and lysine in broiler diets.

Absence of significant difference in feed conversion ratio is in line with the works of Kaur et al. (2013), Egenuka et al. (2015) and Ahmed and Abass (2015).

Significantly higher mortalities observed in 0.4 and 0.5% methionine fortifications were consistent with the findings of Khawaja et al. (2007) when 3% blood meal was included in broiler diets than when 0, 4, 5 and 6% blood meal were included in their diets. The authors suggested that this was due to ascites occurring because of fast growth, high feed conversion and bulky pectoral muscle mass which all require high level of oxygen.

Carcass characteristics

Live weight and dressing weight were highest for 0.5% methionine fortification (1927.00 and 1855.00 g, respectively) and lowest for the negative control (1700.00 and 1626.67 g, respectively). The values increased non-significantly as methionine fortifications increased across treatments; confirming the role of methionine in aiding broilers meet up with body tissue deposition which is a pre-requisite for rapid growth. Absence of significant difference was supported by the findings of El-shinnawy (2015) who supplemented betaine in methionine adequate diet of broilers. It also aligns with the work of Poosuwan et al. (2015) who evaluated the effects of varying levels of liquid DL-methionine hydroxyl analog free acid in drinking water on production performance and gastrointestinal tract of broiler chickens at 42 days of age. Dressing percentages were comparable with the highest percentage recorded for the positive control (96.68%) and lowest for negative control (95.69%).

Breast meat yield was highest for 0.1% methionine fortification (19.30%) and lowest for the positive control (18.31%). Breast meat yield constitutes a major portion of protein synthesis and is sensitive to amino acid status in diets (Jialin et al., 2004). This sensitivity may have contributed to the variations in the breast yield. The observed significant increase in breast muscles was supported by the reports of Bouyeh (2012) and Ebrahimzadeh et al. (2013) who checked the effects of chromium methionine supplementation on performance, carcass traits, and the Ca and P metabolism of broiler chickens under heat-stress conditions and El-shinnawy (2015).

Thigh yield was highest in 0.5% methionine fortification (22.71%) and lowest for the positive control (20.33%). The values tended to increase as methionine fortifications increased from 0.2 to 0.5%. Significant increase in weight of thigh muscles may also be associated with the function of methionine in creatine synthesis (Hesabi et al., 2006). Significant differences for thigh muscles align with the findings of Ebrahimzadeh et al. (2013) and Poosuwan et al. (2015).

Significant difference in the crop weight may have been affected by the quantity of feed retained in the crop and was highest in 0.1% methionine fortification. Values of intestinal length for 0.1 and 0.5% were comparable with the positive control which was the highest. This indicated that their capacity to extract and maximize nutrients from the diets (Sibley, 1981) was high compared to others. Absence of significant differences in the weight of liver agreed with the findings of the following authors: Memon et al. (2002) when effect of blood meal on the growth and carcass yield of broilers were studied; Khawaja et al. (2007) and Nasr and Kheiri (2012) who investigated the effects of lysine levels of diets formulated based on total or digestible amino acids on broiler carcass composition; Ebrahimzadeh et al. (2013), El-shinnawy (2015) and Ndelekwute et al. (2016) who combined fish meal and blood meal at different proportions and checked for broilers' response in terms of carcass yield and internal organs. Absence of significant differences in the weight of heart and gizzard agreed with the findings of Memon et al. (2002) and Khawaja et al. (2007). Broilers in negative control had significantly lower abdominal fat than other treatments suggesting that the absence of methionine fortification in a diet might cause a decrease in abdominal fat deposition. Significant differences in abdominal fat is in line with the reports of Andi (2012) who undertook a study to investigate the effect of additional DL-methionine in starter diet of broilers abdominal fat and Bouyeh, 2012; Ebrahimzadeh et al., 2013; El-shinnawy, 2015.

Proximate composition

Crude protein content of breast muscles was higher than those of the thigh muscles among treatments except in 0.4% methionine fortification. This may suggest that methionine fortification of 0.1 to 0.3 and 0.5% significantly influenced a higher retention of crude protein in the white meat (breast muscle) than in dark meat (thigh muscle). This agrees with report of Jialin et al. (2004) that breast meat represents a major portion of protein synthesis and is sensitive to amino acid status in diets. Significant difference observed in crude protein of thigh muscles agreed with the result of El-shinnawy (2015) who supplemented betaine in methionine adequate diet of broilers and observed significant differences in crude protein value of thigh muscles. On the other hand, ether extract, ash and nitrogen free extract for thigh muscles were higher in thigh muscles than breast muscles among treatments. This may also suggest that methionine supplementation significantly influenced a higher retention of fats, minerals and carbohydrates in the thigh muscle than breast muscle. Moisture content seemed to be similar in range. Significant differences observed in parameters measured among treatments for both breast and thigh muscles may have been caused by differences in proximate composition of feeds. Snežana et al. (2010) noted that nutrition has a significant influence on the proximate composition of broiler meat. Nutritional factors that affect chemical composition and quality of broiler meat are: Choice of feed ingredients for feed formulation, chemical composition of feed ingredients and energy and protein values of formulated rations (Snežana et al., 2010).

Cost-return analysis

Total variable costs of production for negative control up to 0.5% methionine fortifications were lower than positive control. This implies that cost of production using fish meal as an animal protein source was higher than using blood meal with or without methionine fortification. The highest gross margin observed in 0.3% implies maximum profitability when broilers were raised on diets containing 3% dietary blood meal inclusion with 0.3% methionine fortification. The highest return on investment (ROI) observed in 0.3% indicates better returns on naira invested and confirms maximum profitability. The result is consistent with the findings of Memon et al. (2002) who supplemented four different levels of blood meal in broiler diet and concluded that broilers could be reared economically by using 3% of blood meal as an animal protein source and Khawaja et al. (2007) who supplemented four different levels of blood meal in broiler diet and discovered that it is more feasible and economical to obtain maximum profitability from broiler production when 3% level of blood meal was included in their diets..

Conclusion

From the results it can be concluded that fortification of blood meal with methionine will reduce cost of production without adverse effects on broiler performance compared to a fish meal-based control. Maximum profitability was achieved when 0.3% methionine fortified 3% blood meal.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

AOAC (1990). Association of Analytical Chemists, Official methods of analyses 15th Edition, Washington, D.C.

Andi MA (2012). Effects of additional DL-methionine in broiler starter diet on blood lipids and abdominal fat. Afr. J. Biotechnol. 11(29):7579-7581.DOI: 10.5897/AJB11.1500

Ahmed ME, Abbas TE (2015).The effect of feeding herbal methionine versus dl-methionine supplemented diets on broiler performance and carcass characteristics. International Conference on Agricultural, Ecological and Medical Sciences (AEMS-2015) Feb. 10-11, 2015 Penang (Malaysia). http://dx.doi.org/10.15242/IICBE.C0215133

Babatunde GM, Pond WG, PedJr ER (1990). Nutritive value of rubber seed (*Hevea brasiliensis*) meal: utilization by growing pigs fed semi-purified diets in which rubber seed meal partially replaced soya bean meal. J. Anim. Sci. 68:392-397.

Bouyeh M (2012) Effect of excess lysine and methionine on immune system and performanceofbroilers. Ann. Biol. Res. 3(7):3218-3224.

Dafwang II, Olomu J M, Offiong SA, Bello SA (1986).The effect of replacing fish meal with blood meal in the diets of laying chickens. J. Anim. Prod. Res. 6:81-92.

Donald R, Edward A, Greenhalgh DFD (1988). Poultry nutrition. John Wiley and Sons Inc. New York P 425.

Dongmo T, Ngoupayou JDN, Duplaise MP (2000).Use of some local animal protein Sources in the feeding of broilers. Tropiculture 18:122-125.

Ebrahimzadeh S, Farhoomand P, Noori K (2013). Effects of chromium methionine supplementationon performance, carcass traits, and the Ca and P metabolism of broiler chickens under heat-stress conditions. J. Appl. Poult. Res. 22:382-387.

Egenuka FC, Omaliko PC, Aladiand NO, Okeudo NJ (2015). Effect of increasing dietary level of blood meal and reducing supplementary lysine on performance of broilers. Int. J. Agric. Rural Dev. 18(1):2037-2042.

El-Shinnawy AM (2015). Effect of betaine supplementation to methionine adequate diet on growth performance, carcass characteristics, some blood parameters and economic efficiency of broilers. J. Anim. Poult. Prod. 6(1):27-41.

Esonu BO, Emenalom OO, Udeddibie ABI, Herbert U, Ekpor CF, Okoli IC, Iheukwumere FC (2001). Performance and blood chemistry of weaner pigs fed raw Mucuna (velvet bean) meal. Trop. Anim. Prod. Investig. 4:49-55.

Ewane D (1996). A study of the mix of cassava ingredient for monogastric animals. M.Sc. Thesis, University of Nigeria, Nsukka (Unpublished).

Fanimo AO, Oduguwa OO, Jimoh YO, Faronbi AO (1988). Performance and carcass evaluation of broiler chicks fed shrimp waste meal supplemented with synthesis amino acids. Nig. J. Anim. Prod. 25:17-21.

Hesabi A, Nasiri H, Birjandi M (2006). Effect of supplemental methionine and lysine on performance and carcass yield characteristics in broiler chicks. Proceedings of 12th European Poultry Conference, Verona, Italy, 10 - 14 September, paper 112.

Idufueko A (1984). Self-sufficiency in animal protein supply under changing economic fortunes. Nig. J. Anim. Prod. 11:14-21.

Itoe S, Dafwang II, Bawa GS (2010). Evaluation of methiorep as a substitute for methionine in broiler diets. Int. J. Poult. Sci. 9(8):809-812.

Jialin SI, Kersey JH, Fritts CA, Waldroup PW (2004). An evaluation of the interaction of lysine and methionine in diets for growing broilers. Int. J. Poult. Sci. 3(1):51-60.

Jhingan ML (1997). Microeconomic theory. India, Vrinda publications.

Khawaja T, Khan SH, Ansari NN (2007). Effect of different levels of blood meal on broiler performance during two phases of growth. Int. J. Poultry Sci. 6(12):860-865.

Kalbande VH, Ravikanth K, Maini S, Rekhe DS (2009). Methionine supplementation option in poultry. Int. J. Poult. Sci. 8(6):588-591.

Kaur D, Nagra SS, Sodhi S, Dwivedi P (2013). Comparative performance of commercial broilers fed Herbomethione® as a replacement for DL methionine in diet. J. Appl. Anim. Res. 41(4):410-416.

Madubuike FN (1992). Bridging the animal protein gap for development in Nigeria: The potential of pigs. J. Agric. Rural Dev. 5:5-12.

Memon A, Ansar NN, Solangi AA, Memon G (2002). Effect of blood meal on the growth and carcass yield of broilers. Pak. Vet. J. 22(3):97-100.

Nasr J, Kheiri F (2012). Effects of lysine levels of diets formulated based on total or digestible amino acids on broiler carcass composition. Rev. Bras. Cienc. Avic. 14:233-304.delekwute EK, Afolabi KD, Assam ED, Okonkwo AC (2016). Effect of fish meal and blood meal on growth, carcass yield, internal organs size and economics of broiler chickens. J. Anim. Prod. Res. 28(1):151-159.

North MO, Bell DD (1990). Commercial chicken production manual.4th Edition. AVI Publishing Inc, New York, USA.

Odukwe CA, Njoku PC (1987). Evaluation of blood meal and its potential as a supplementary source of lysine in laying chicken diets. J. Anim. Prod. Res. 7:9-18.

Onyimonyi AE, Ugwu SOC (2007). Bioeconomic indices of broiler chicks fed varying ratios of cassava peel/bovine blood. Int. J. Poult. Sci. 6(5):318-321.

Onu PN, Ayo-Enwerm MC, Ahaotu EO (2010). Evaluation of carcass characteristics and cost effectiveness of broiler chicks fed synthetic lysine and methoinine supplemented soyabean-based diets. Int. J. Sci. Nat. 1(1):22-26.

Poosuwan K, Bunchasak C, Thiengtham J, Markvichitr K, Chansawarng S, Chutesa A (2015). Effects of varying levels of liquid dl-methionine hydroxy analog free acid in drinking water on production performance and gastrointestinal tract of broiler chickens at 42 days of age. Thai. J. Vet. Med. 45(4):581-591.

Schingoethe D (1991). Amino acid profiles of some common feeds. Feedstuffs 18th March. pp. 11-12.

Seifdavati J, Navishad B, Seyedsharifi R, Sobhani A (2008). Effects of locally produced and nitrogen retention of broiler chicken. Pak. J. Biol. Sci. 11(12):1625-1629.

Sibley RM (1981). Strategies of digestion and defecation. In: Townsend CR, Callow P, editors. Physiological ecology: an evolutionary approach to resource use. Oxford, UK:Blackwell Scientific Publications. pp. 109-139.

Snežana BB, Zlatica P, Milun DP, Vladimir D, Simeon R (2010). Broiler meat quality: Proteins and lipids of muscle tissue. Afr. J. Biotechnol. 9(54):9177-9182.

Spackman DH, Stein WH, Moore S (1958). Automatic recording apparatus for use in chromatography of amino acids. Anal. Chem. 30(7):1190-1206.

Udedibie ABI, Anyanwu G, Ukpai UI, Ojet AJ (1988). Poultry offal as a protein supplement in the diets of broilers starters and finishers. Niger. J. Anim. Prod. 20(1):103-109.

Zeweil HS, Abdala AA, Ahmed MH, Marwa RS (2011). Effect of different levels of protein and methionine on the performance of baheij laying hens and environmental pollution. Egypt. Poult. Sci. 31(11):621-639.