Haematological indices and economic benefit of utilizing blood meal at the expense of synthetic lysine and methionine in broiler chicken diets

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Abstract

Haematolgoical indices and economic benefit of utilizing blood meal at the expense of synthetic lysine and methionine in broiler chicken diets was studied. Three-hundred day- old broiler chicks were randomly allotted in a completely randomized design (CRD) into five treatment groups with three replicates of 30 birds each. Five experimental diets were formulated in such a way that blood meal was included at 0, 1, 2, 3 and 4 % and made to replace synthetic lysine and methionine representing: T1 (control), T2, T3, T4 and T5 respectively in both starter and finisher phases which lasted for 56 days. Birds were fed a*d libitum* with feed and water, The result showed that feed intake significantly (p<0.05) decreased only at 3 and 4 % inclusion levels of blood meal. The final live weight, average weight gain and feed gain ratio were not significantly (p>0.05) affected by dietary treatments. However, the cost (₦)/Kg, total feed cost (₦) and total production cost (₦) significantly (p<0.05) decreased as the level of blood meal increases in the diets. Relative cost difference (%) indicated that 2, 5, 19 and 26 % cost savings were made with 1, 2, 3 and 4 % blood meal respectively rather than with crystalline lysine and methionine. The haematological indices were not significantly (p>0.05) different between dietary treatments and were within the normal reference values for healthy chickens. In conclusion, up to 4 % blood meal could completely replace lysine and methionine in broiler diets with better economic returns without sacrificing the growth performance and haematopoietic status of the birds.

Keywords: blood, broiler, economic returns, lysine, methionine,

Introduction

The challenging animal protein inadequacy in Nigeria has led to series of livestock development drives by nutritionists. Low animal protein intake has remained a major human nutritional problem in Nigeria, especially for the low income and non-wage earners (Aduku, 2005; FAO, 2020). They also identified exorbitant cost of production of ruminants and identified exorbitant cost of production of monogastrics which cost less in terms of housing and other management practices. As human population continue to grow there will be need to ensure food safety for all. Two major identified areas of concentration are increasing the production of animals of fast growth and reduction in the production cost to make livestock and its products available and affordable (Nsa and Essien, 2019).

One of such animals is broiler chickens, which need diets with high bioavailability of nutrients if expected results should be achieved (Ndelekwute *et al.,* 2010). Unfortunately, these feedstuffs with high biological value are also consumed by man and used for industrial, purposes; imposing stiff competition between man and livestock with a resultant high cost of feeds and animal products.

In most cases synthetic lysine and methionine are still added to these already costly feedstuffs which are mostly depleted during storage or limiting in diets. Olomu (1995) reported that soybean meal contains 3.54 % lysine and maize 0.32 %; while blood meal has 7 % lysine and 6.8 % methionine, respectively. Fish meal is high in lysine and methionine (Ukoha, *et al.*, 2019), but recent astronomical increase in their prices has made it unreasonable to add any of these to feed ingredients as synthetic sources of amino acids.

It has become imperative to look for by-products that are rich in lysine and methionine as well as not useful by man or industry, available and inexpensive. One of such is blood meal. According to Olomu, (1995), blood meal is high in crude protein (80 %), lysine (7 %) and methionine (6.78%). Blood is obtained from slaughtered animals especially cattle and made to coagulate through boiling, drained of water, chopped into pieces before sun drying or oven drying to a constant weight between 8 and 12 % (Ukoha, *et al.,* 2019). The dried blood can then be milled and stored in an airtight container.

Blood meal is mostly not sold, and in some places poses a disposal hazard to the environment due to its rich protein content which encourages bacterial growth (Omatsuli *et al*., 2021). Therefore, the objective of this study was to determine the haematological indices and economics of using blood meal at different levels to replace synthetic lysine and methionine in broiler chicken diets.

Materials and Methods

Experimental site

The study was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar. Calabar is located within the Tropical Rain Forest Zone of Nigeria, with an average relative humidity of 88 %, mean annual rainfall of 3,076 mm (121.1 inches) with average yearly rainy days of 173, while its average (high) temperature is 33.01^{o}C (86.2^{o}F) and average (low temperature of 22.5^{o}C (72.5^{o}F) with elevation of 32 meters (105ft) above sea level (Nigeria Meteorological Agency, NiMet, 2023).

Collection and preparation of test ingredients

Fresh blood was obtained from slaughtered cattle at Mami market abattoir located at Ikot Ansa, Calabar, Cross River State, Nigeria. The blood was boiled for 20 minutes before water was drained from it with a sac bag according to Ukoha *et al*. (2019) method. Thereafter, it was cut into small pieces and sun dried for 72 hours to constant weight. It was then milled using hammer mill (model 35) and sieved through a 5mm mesh to obtain blood meal.

Experimental animals, management, design, and diets

Three hundred (300), day-old Abor acre broiler chicks were purchased from FIDAN hatchery, Ibadan, Nigeria and used for the study. The chicks were randomly assigned to five dietary treatments of three replicates per treatment of 20 birds each in a completely randomized design (CRD). Five experimental diets at both starter and finisher phases were formulated in line with Aduku (2005) recommendations for the nutrient requirements of broiler chickens. Diet (T1) which served as the control contained 0 % blood meal, but had 0.25% synthetic lysine and methionine; while T2, T3, T4 and T5 had 1, 2, 3 and 4 % blood meal without synthetic lysine and methionine respectively. Feeds and water were provided *ad libitum*. The birds were weighed at the beginning of the experiment and weekly thereafter to determine weight gain. Daily feed intake was determined by weighing the feed offered and the leftover on a daily basis. Blood samples were collected from each bird per replicate at the end of the feeding trial through the prominent wing vein of which about 2.5ml of blood sample per bird were collected into sterilized bottles containing ethylene diamine tetra acetic acid (EDTA) as an anti-coagulant for the determination of haematological parameters. Hematological indices determined were packed cell volume (PCV), red blood counts (RBC), white blood cell counts (WBC) and haemoglobin (Hb) concentration. The improved Neubauer Haemocytometer was used to estimate the red and white blood cell counts (Jain, 1986). Haemoglobin, mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular concentration (MHC) were determined according to the methods of Jain (1986); while PCV was determined by Wintrobe Microhaematocrit method (Dacie and Lewis, 1991).

In the cost analysis, appropriate formulae were used to determine the economics of production based on the prevailing local market prices of feedstuffs during the study period.

Feed cos/Kg = sum of prices of ingredients/ Kilogram of feed

Total feed cost = Total feed intake × Feed cost/Kg/100

Total cost of feed consumed/Kg = Cost of feed/Kg(₦) × Total feed consumed (Kg/bird)

Cost of feed/Kg live weight gain (₦) = Total cost of feed consumed/Kg (₦)/Total weight gain(g/bird).

Cost-gain ratio = total cost of production/total revenue

Revenuer/bird = price/kg liveweight × Av. Final Live Weight

Profit margin = Revenue/bird-feed cost/bird

Cost differential/kg weight gain=feed cost/weight gain of the control group-feed cost/weight gain of each group.

Relative cost benefit =

Cost differential of each group
---------------------------- × 100
Feed cost/weight gain of control group

Statistical analysis

Data obtained in this study were subjected to one - way analysis of variance (ANOVA) using SAS (2020) and significant means were separated using Duncan Multiple Range Test (DMRT) method (Steel and Torrie, 1981).

Results and Discussion

Nutritional quality of experimental diets

Result of the proximate composition of the experimental diets is presented in Tables 1 and 2. The crude protein levels of both stater mash (23.48-23.56%) and finisher mash (20.40-20.90%) levels were within the rang (22-24 %) (starter mash) and (20-22%) (finisher mash) levels recommended by Nsa *et al*. (2019) and Olomu, (1995) for stater and finisher broiler birds respectively. The metabolizable energy (Kcal/Kg) calculated based on Pauzenga, (1985) methods showed that the stater diets (2980.09-3004.50) and finisher mash (3100-3120) levels were within the ranges of 2900-3000 (starter mash and 3100-3200Kcal/kg) recommended by Olomu (1995). Despite the exclusion of synthetic methionine and lysine in the diets the nutritional quality of the experimental diets was very high. This is because blood meal contains high level of these amino acids (Lysine and methionine) (Ndelekwute *et al*., 2010; Owen and Amakiri, 2011; Onunkwo *et al*. 2021). Blood meal is said to contain 7 % lysine and 6.7 % methionine, respectively (Olomu, 1995).

The performance of broiler chickens fed graded levels of blood meal as a source of lysine and methionine is represented in Table 3. Result did not show significant (P>0.05) differences in the feed consumption of the experimental diets, except on birds fed diet 4 (3 % blood meal) and diet 5 (4% blood meal). This observation was in consonant with the report of Ewa *et al*. (2017); Opoula *et al*. (2018); Onunkwo *et al*. (2021) which indicated that high of blood meal in broilers. diets from 3% and above encourage growth and economic improvement, There were no significant differences in final live weight and daily weight gain. The feed gain ratio also showed similar trend with liveweight gain as there were no significant ($p>0.05$) differences. An indication of proper utilization of the diets. This agrees with findings by Ewa *et al*. (2017), that blood is properly utilized by broiler birds up to 5% level of inclusion.

The economic analysis showed that the cost price per kg of feed was ₦285.05, ₦280.12, ₦275.62, ₦269.25 and ₦250.22 for treatment diets 1, 2, 3, 4 and 5 respectively. The observation of decrease in feed cost per Kg could be attributed to the low cost of blood meal when compared to the cost price of lysine and methionine. A kg of synthetic lysine and methionine was ₦5,000 and ₦7, 000 respectively, as at 2023 while 25 litres of blood was ₦1000 same year. This sharp difference in prices means a lot in terms of cost of feed produced. The feed cost/bird followed similar trend, which decreases as the level of blood meal increases in the diets. The feed cost/kg weight gain also tended to decrease as the blood meal increases in the diets. This is so because there were no significant ($p>0.05$) differences in the final liveweight and weight gain. However, revenue/bird showed no numerical differences ($p>0.05$) across the treatment groups. In terms of revenue, feed cost ratio and gross margin were positively increased as the level of blood meal was increasing in the diets. Relative cost difference (%) indicated that 2.00, 5.00, 19.00 and 26.00% cost savings were made when 1.0, 2.0, 3.0 and 4.0% blood meal respectively were used rather than crystalline lysine and methionine.

Haematological parameters

Table 4 shows the haematological indices of broiler birds fed diets with blood meal as replacement for lysine and methionine. Variations in haematocrit or PCV values (35.98-38.09 %) observed in this study were not significant and fell within the range of 24.9 to 45.2 % reported by Mitruka and Rawnsley (1977) for healthy chickens. The haemoglobin values of 9.87-11.09 g/dl were within the reference values of 7.4-13.1 g/dl for normal chickens as reported by Mitruka and Rawnsley (1977). The RBC, leucocytes, heterophils, eosinophils, lymphocytes and monocytes were all within the normal ranges of 1.58-4.1 ($\times 10^6$mm), 3 9.20-31.0 ($\times 10^6$/mm), 25-33.6 %, 0.00-15.0 %, 47.2 – 81.26 % and 0.06-3.8% respectively for healthy birds (Mitruka and Rawsley, 1977; Banks, 1974; Mmereole, 1996; Ikhimioya *et al*., 2000). The PCV, Haemoglobin and RBC values obtained in this study showed that the birds were healthy and not anaemic and can withstand respiratory stress.

Conclusion

The study demonstrated that the expensive synthetic lysine and methionine could be replaced with blood meal. Blood meal inclusion up to 4% without synthetic lysine and methionine will not affect blood indices of broiler chickens. The 4 % blood meal in broiler diets recorded better economic returns to farmers.

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Table 1: Gross composition of experimental starter diets

Dietary replacement of lysine and methionine with blood meal					
Ingredient (%)	T1(0%)	T2(25%)	T3(50%)	T4(75%)	T5(100%)
Maize	54.00	54.00	54.00	54.00	54.00
Soybean meal	33.00	33.00	33.00	33.00	33.00
Wheat offal	6.00	5.00	4.00	3.00	2.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Blood meal	0.00	1.00	2.00	3.00	4.00
Lysine	0.25	-	-	-	-
Methionine	0.25	-	-	-	-
*Vit/min. premixes	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude Protein (%)	23.48	23.50	23.52	23.54	23.56
Crude fibre (%)	3.89	3.97	3.99	4.34	4.89
ME (Kcal/Kg)	2980.09	2986.94	2989.67	2995.05	3004.50

Table 2: Gross composition of experimental finisher diets

Dietary replacement levels if lysine and Methionine with blood meal					
Ingredient (%)	T1(0%)	T2(25%)	T3(50%)	T4(75%)	T5(100%)
Maize	58.00	58.00	58.00	58.00	58.00
Soyabean seed meal	28.00	28.00	28.00	28.00	28.00
Wheat offal	8.00	7.00	6.00	5.00	4.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Blood meal	0.00	1.00	2.00	3.00	4.00
Lysine	0.25	-	-	-	-
Methionine	0.25	-	-	-	-
*Vit/min. premixes	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude Protein (%)	20.40	20.49	20.60	20.79	20.90
Crude fibre (%)	4.98	5.11	5.34	5.57	5.89
ME (Kcal/Kg)	3100.08	3109.80	3110.42	3160.76	3191.77

Table 3: Economic indices of broiler chicken fed blood meal as replacement for lysine and methionine

	Blood meal levels (%)					
Parameters	T1(0.00)	T2 (1.00)	T3(2.00)	T4(3.00)	T5(4.00)	SEM
Av. Initial wt. (g/bird)	40.00	41.00	40.50	40.00	41.00	1.63
AV. Final weight(g/bird)	2016.15	2023.10	2029.30	2036.11	2072.90	18.43
AV. Final Weight gain(g/bird/bird)	1976.15	1982.10	1988.80	1996.11	2031.90	9.54
Av. Daily wt. gain(g/bird)	35.28	35.39	35.51	35.64	36.28	3.55
AV. Total feed intake(g/bird)	5003.10[a]	4996.00[a]	4908.50[a]	4306.60[b]	4290.08[b]	12.90
Av. Daily feed intake(g)	89.34[a]	89.21[a]	87.65[a]	76.90[b]	76.60[b]	2.90
Feed: gain ratio	2.53	2.52	2.46	2.15	2.11	0.13
Cost/Kg feed(₦)	285.05[a]	280.12[b]	275.62[c]	269.25[d]	250.22[e]	11.97
Feed cost/bird(₦)	1426.11[a]	1399.48[b]	1352.88[c]	1159.55[d]	1073.44[e]	21.53
Feed cost/kg weight gain(₦)	721.66[a]	706.05[b]	680.24[c]	580.90[d]	528.29[e]	19.00
Sales/Kg weight(₦)	2500.00	2500.00	2500.00	2500.00	2500.00	0.00
Revenue/bird(₦)	5040.37	5057.75	5073.25	5090.27	5182.25	23.53
Gross margin(₦)	3614.26	3658.27	3720.37	3930.72	4108.81	21.90
Revenue: feed cost ratio	3.53	3.61	3.74	4.38	4.82	0.91
Gross margin: feed cost ratio	2.53	2.61	2.74	3.38	3.82	0.11
Cost differential	-	15.61[d]	41.42[c]	140.76[b]	193.37[a]	1.86
Relative cost difference (%)	-	2.00[d]	5.00[c]	19.00[b]	26.00[a]	1.55

[a, b, c,d, e]Means on the same row with different superscripts are significantly different ($p<0.05$)

Table 4: Haematological indices of broiler chickens fed diets containing blood meal as replacement for lysine and methionine

Parameter	T1	T2	T3	T4	T5	SEM
Haemoglobin (g/dl)	11.09	10.67	10.60	9.87	9.95	2.54
Packed cell volume (%)	35.98	37.05	36.74	36.00	38.09	4.09
Red blood cell ($\times 10^{12}$/L)	1.66	1.98	2.31	2.32	3.00	0.47
White blood cell ($\times 10^{9}$/L)	5.99	4.70	4.00	3.65	4.90	2.88
MCV (fl)	18.00	16.98	19.00	18.95	17.76	3.70
MCH (pg)	57.00	59.98	59.00	59.67	60.00	7.78
MCHC (g/dl)	57.56	55.04	55.70	55.55	60.54	6.80
Heterophils (%)	65.09	62.59	66.97	63.75	61.66	5.38
Lymphocytes (%)	49.00	50.86	51.76	49.76	50.71	5.98
Eosinophils (%)	1.99	1.90	2.98	3.00	3.54	0.81
Monocytes (%)	2.78	2.56	2.09	1.11	0.97	0.59