HAEMATOLOGICAL AND ECONOMIC RESPONSES OF BROILER FINISHER CHICKENS TO DIETARY BLOOD MEAL AS REPLACEMENT FOR CRYSTALLINE LYSINE

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Abstract
This study evaluated the haematological and economic responses of broiler finisher chickens to dietary blood meal as replacement for crystalline lysine (CL). Four experimental diets were formulated in such a way that Diet 1 (control) contained 0% blood meal and 0.25%CL, while diets 2, 3 and 4 contained 1, 2 and 3% blood meal respectively without CL. One hundred and twenty Abor acre broiler finisher chickens of 4 weeks of age were used for the study and the birds were randomly distributed in a completely randomized design into four treatment groups and the treatment groups were then divided into three different replicates with each treatment and replicate having 10 and 30 birds respectively. At the beginning of the experiment, proximate composition of blood meal was assayed, while at the end of the experiment of 28 days, blood was collected for haematological parameters and analysed for haemoglobin, packed cell volume, red blood cell, white blood cell, mean corpuscular haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin concentration, lymphocytes and neutrophil count. Also analysed were the economic parameters namely; feed cost/kg feed, total feed cost, feed cost/weight gain ratio and profit margin. The results showed the blood meal to be high in crude protein (82.47%) and ash (7.22%) contents, but low in crude fibre (1.81%) and nitrogen free extract (6.39%). The final live weight (2550g) was significantly ($p<0.05$) highest for birds fed 2% dietary blood meal without CL(T3), while the least live weight value (2390g) was recorded for birds on T_4 (3% dietary blood meal). Feed intake, and protein efficiency showed no significant ($p>0.05$) differences across the treatment groups. There was no significant ($p>0.05$) effect on the packed cell volume, red blood cell counts, mean corpuscular haemoglobin concentration and mean corpuscular haemoglobin contents. But there were significant ($p<0.05$) increases in white blood cell counts (20.64 - 29.05 10^{12}mm/l), lymphocyte (41.22 - 51.66%) and neutrophil count (36.82 - 43.00%) with all increasing as the level of dietary blood meal increased in the diets. Feed cost per bird, feed cost/weight gain and profit margin improved significantly ($p<0.05$) as the level of dietary blood meal increased in the diets. The study concluded that dietary blood meal of 2% level in broiler finisher diets can totally replace crystalline lysine with improved live weight gain, low economic returns without compromising the blood characteristics of the birds.
Keywords: *Crystalline lysine, blood meal, broiler finisher bird, haematology*

Introduction

The major problem of poultry production in the developing countries, apart from the incidence of disease is that of high cost of feeds and feed ingredients, particularly the protein concentrates (Nsa and Archibong, 2018). For birds to perform optimally, adequate level of energy and protein must be provided through the feeds, the deficiency of which will affect the performance of the birds in terms of growth, production and reproductive performance (Alabi *et al*., 2020). Oluyemi and Robert (2000) recommended 23% crude protein and 2850-2900 Kcal/kg metabolizable energy for starter broilers, 19-20% crude protein and 3000-3100 Kcal/kg metabolizable energy

for finisher broilers in Nigeria. Their recommendations require inclusion of protein-rich feed ingredients like soyabean meal, groundnut cake and fish meal which are high in the essential amino acids for fast growth performance. Unfortunately, due to poor storage of these feedstuffs these amino acids are depleted, and not meeting the requirements of birds for optimal performance. In order to circumvent this gap, crystalline lysine and methionine are also added to the feeds which would adversely increase the cost of feeds. However, the potentials of blood meal in poultry diets are often over looked; but it can replace expensive crystalline lysine, leucine, pyridine and valine that support immune function, muscle metabolism, growth and repair of tissues (Chakraborty and Chakraborty, 2017).

Blood meal is a high-protein feed supplement made from dried animal blood, commonly used in poultry diets to support growth and production. It contains 80-95% crude protein and is rich in lysine that is limited in plant-based feeds (Ukoha *et al.*, 2019). It is cheap and readily available; it can be processed through ring drying or spray drying which are best methods to preserve the nutritional quality of the meal (Ukoha *et al*., 2019). However, blood meal utilization has the following setbacks such as poor palatability, bitter taste and unpleasant odour and risk of contamination with pathogens like salmonella, if not processed properly (insert Ref). It is also low in isoleucine and methionine (Insert Ref). Changes in the haematological parameters are often used to determine various status of the body and to determine stresses due to environmental, nutritional and/or pathological factors (Afolabi *et al*., 2010). Haematological values of poultry are influenced by age, sex, breed, climate, geographical location, season, day length, time of day, nutritional status, life habits of species, present status of animals and other factors (Jawad, 2007). This study was therefore designed to evaluate the haematological and economic responses of broiler finisher birds to dietary blood meal as replacement for crystalline lysine.

Materials and Methods

Location of study

The study was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State, Nigeria. , from March to May, 2025.

Sources and Preparation of Blood Meal

Blood meal was sourced from the Abattoir located at Ikot Ansa Mami Market, (with little or no cost) And boiled at 100^{o}C for 45 minutes, after which it was oven-dried to constant weight before being milled to obtain blood meal and stored in an airtight container before incorporating into the diets.

Experimental Diets

Four (4) dry mash diets were formulated according to requirements of broiler finisher chickens in the tropics (Olomu, 1995). Blood meal was included in the diets at 0, 1, 2 and 3 without crystalline lysine. Experimental diets are presented in Table 1.

Table 1: Gross composition of experimental finisher diets

Ingredient	T_1	T_2	T_3	T_4
Maize	58.00	58.00	58.00	58.00
Soybean meal	28.00	28.00	28.00	28.00
Wheat offal	6.00	5.25	5.25	4.75
Palm kernel cake	5.25	5.25	4.50	3.75
Fish meal	2.00	2.00	2.00	2.00
Blood meal	0.00	1.00	2.00	3.00
Lysine	0.25	0.00	0.00	0.00
Methionine	0.25	0.25	0.25	0.25
Vitamin/mineral premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated analysis:				
% Crude protein (CP)	19.55	19.58	19.61	19.64
% Crude fibre (%)	4.48	4.46	4.45	4.43
ME (Kcal/kg)	3100.41	3100.56	3100.58	3102.50
Lysine	1.23	1.19	1.20	1.22
Methionine	0.83	0.85	0.87	0.89

* Premix supplied (per/kg diet) Vit. A (10,00 iu), Vit. D3 (2,000 iu), Vit. E (20 iu), Vit. K (2.0mg), Thiamine (2.0mg), Riboflavin (3.0mg), Pyridine acid (4.0mg), Niacin (20mg), Cobalamine (0.05mg), Pantothenic acid (5.0mg), Folic acid (0.5mg), Biotine (0.8mg), Chlorine chloride (0.2g), Manganese (0.06g), Zinc (0.03g), Iron (0.005g), Copper (0.006g), Iodine (0.014g), Selenium (0.24mg), Cobalt (0.025mg), antioxidants (0.125g). State how ME was obtained as stated in Table 1. State the crude fibre levels

Experimental birds and management

A total of one hundred and twenty (120) unsexed 4 weeks old Abor acre broiler birds were randomly distributed into four (4) treatment groups of 30 birds each with three replicates of 10 birds per pen in a Completely Randomized Design (CRD). Each group was assigned to the four experimental diets and they were all subjected to the same management practices all through the 28 days period of the experiment from March to April, 2025). Before the distribution, the birds were given Newcastle disease intra ocular vaccine on arrival and anti-stress vitalytes was added to their drinking water to reduce stress. Their first dose of gumboro vaccine was given at 7 days old, while first dose of lasota vaccine was administered at 14 days of age. Second dose of gumboro and second dose of lasota were given at 21 and 28 days, respectively. Coccidiosis treatment (amprolium) was at 3 weeks of age. The birds were all raised on a deep litter system.

Data Collection

Determination of proximate composition of blood meal

The proximate composition of blood meal was carried out according to the methods of AOAC (2000).

Determination of Growth Performance Indices

During the feeding trial, daily feed consumption and weekly weight changes were recorded. Weight gain, feed/gain ratio and protein efficiency ratio were determined to measure the growth performance of birds.

Blood Collection

Two milliliters (2.0 ml) of blood were collected from the wing vein of each bird per replicate at the end of the feeding trial. Blood samples were collected into labeled bottles with Ethylene Diamine Tetra acetic Acid (EDTA) and taken to Biochemistry Laboratory, University of Calabar for haematological assay. The parameters determined included: packed cell volume (PCV), haemoglobin (Hb), white blood cell (WBC), red blood Cell (RBC) and differential blood counts (heterophils, lymphocytes, monocytes, eosinophils, basophils).

Economic Parameters

Economic parameter such as price/kg weight of birds (₦4000) was used to calculate the revenue per bird. The prevailing prices of feedstuffs (March, 2025) were used to calculate the cost of production. Cost/kg feed = summation of the preparation of each feed ingredient, multiplied by cost per kg of the ingredient, divided by 100 (Haruna *et al*., 2020).

$$\text{i.e. Cost/kg feed} = \frac{Pf_1 \times Cf_1}{100} + \frac{Pf_1 \times Cf_2}{100} + \frac{Pf_3 \times Cf_3}{100} \ldots\ldots \frac{Pfn \times Cfn}{100}$$

Where Pf = Proportion of each feed ingredient in the diet

Cf = Cost/kg of each feed ingredient in the diet

Feed cost/bird = Cost/kg x average total feed intake

Feed cost/weight gain = Cost/kg x Feed conversion ratio

$$\text{Feed cost/live weight} = \frac{\text{Feed cost/bird}}{\text{Average live weight}}$$

Revenue/bird = Price/kg live weight x average 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.

$$\text{Relative cost benefit} = \frac{\text{Cost differential of each group}}{\text{Feed cost/weight gain of control group}}$$

Data Analysis

All data obtained were subjected to one – way analysis of variance (ANOVA) as outlined by Snedecor and Cochan (1978). Significant means were separated using Duncan's New Multiple Range Test (DNMRT) as outlined by Little and Hills (1978).

Results and Discussion

Proximate composition of blood meal

The proximate composition of blood meal used for the feeding trial was 80.94% crude protein, 1.81% crude fibre, 3.64% ether extract, 7.22% ash, 6.39% nitrogen free extract and 79.47 dry matter (Table 2). The result confirms that blood meal is rich in crude protein and ash (Oyenuga, 1997), which makes it ideal in monogastric diets (Ukoha *et al*., 2019). The 79.47% dry matter is an indication of poor storage shelf life of blood meal (Ukoha *et al*., 2019).

Table 2: Proximate composition of blood meal (dry matter basis)

Proximate fraction	%
Dry matter	79.47
Crude protein	80.94
Crude fibre	1.81
Ether extract	3.64
Ash	7.22
Nitrogen free extract	6.39

Growth Performance Indices

Data on growth response (Table 3) revealed that only the average live weight and daily weight gain of broiler finisher chickens increased significantly ($p<0.05$) as dietary blood meal increased in the diets, however; only up to 2% of inclusion level and thereafter declined at 3% of inclusion level. The feed intake was not affected by inclusion level of dietary blood meal, though numerically decreased as the level of blood meal increased in the diets. This could be due to the low palatability associated with blood meal (Ukoha *et al*., 2019). The protein efficiency showed no significant differences ($p>0.05$). Feed conversion ratio showed significant difference ($p<0.05$) and tended to increase as the level of dietary blood meal increased in the diets, but decreased ($p>0.05$) at 3% level of inclusion of blood meal.

Table 3: Performance indices of broiler finisher birds fed diets containing blood meal as replacement for crystalline lysine

Parameter	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Initial weight (g/bird)	950.00	949.50	950.00	950.00	2.03
Average live weight (g/bird)	2500.00[a]	2550[a]	2536[a]	2390.80[b]	6.91
Average daily weight gain (g/bird/day)	1550.00[a]	1600.50[a]	1585.95[a]	1440.8[b]	9.82
Average daily feed intake (g/bird/day)	3200.50[a]	3231.80[a]	3208.9[a]	3197.22[b]	41.08
Feed gain ratio	1.97	2.02	2.02	2.22	0.63
Protein efficiency ratio (%)	1.78	1.76	1.73	1.69	0.82
Mortality (%)	0.00	0.00	0.00	0.00	-

[ab] Means on the same row with different superscripts differ significantly ($p<0.05$).

Economic Indices

The economic indices of birds fed blood meal as replacement for crystalline lysine is represented in Table 4. Feed cost per birds, feed cost/weight gain and profit margin improved significantly ($p<0.05$) as the level of blood meal increased in the diets. This could be attributed to the low or no cost situation associated with the use of blood meal when compared to the high cost of crystalline lysine.

Cost differential per kilogram gain was possibly the highest with birds fed 2% blood meal followed by 3% blood meal. Relative cost benefit indicates that 4.21 and 2.28% cost savings were made when 2% and 3% blood meal respectively were used rather than crystalline lysine, representing. The above observation could be attributed to the low cost of blood meal when compared to lysine and the fact that it supports growth performance since it contains other essential amino acids; apart from lysine, it has histidine, isoleucine, leucine, phenylalanine and minerals like iron, zinc and copper (Ukoha *et al*., 2019). This is in consonance with the findings of (Jaydip, 2014) who produce cheaper broilers' feed using blood meal supplementary diets. Revenue and gross margin obtained per naira invested in feed were better in 2% and 3% than the control and 1%.

Table 4: Economic indices of broiler finisher chickens fed diets containing blood meal as replacement for crystalline lysine

Parameter	T_1 (0)	T_2 (1%)	T_3 (2%)	T_4 (3%)	SEM
Average total live weight (g/bird)	2500	2550	2536	2390	3.96
Average total weight gain (g/bird)	1550[b]	1600.5[b]	1585.95[a]	1440.8[c]	3.94
Average total feed intake (g/bird)	3200.50	3231.80	3208.9	3197.22	41.00
Feed gain ratio	1.97	2.02	2.12	2.22	0.63
Cost of feed/kg (₦)	508.15	495.60	480.50	465.30	2.33
Feed cost/bird (₦)	1651.49[a]	1.601.28[b]	1540.27[c]	1488.20[d]	10.63
Feed cost/kg weight gain (₦)	838.32[a]	792.71[b]	762.51[b]	670.36[c]	10.34
Sales/kg live weight (₦)	4000	4000	4000	4000	15.06
Revenue/bird (₦)	10,400[a]	10,200[a]	10,144[a]	9,560[b]	50.55
Gross margin (₦)	8,748.51[a]	8598.71[a]	8603.73[a]	8071.80[b]	102.11
Revenue: Feed cost ratio	6.30	6.37	6.59	6.42	0.76
Gross margin: Feed cost ratio	5.30	5.37	5.59	5.42	0.66
Cost differential	-	45.61	75.81	167.96	0.07
Relative cost difference (%)	-	0.05	0.09	0.20	0.01

[abcd] Means on the same row with different superscripts are significantly different ($p<0.05$)

Haematological parameters of broiler chickens fed diets containing blood meal as replacement for crystalline lysine

The effect of dietary blood meal as replacement for crystalline lysine on the haematological parameters of broiler finisher chickens are presented in Table 5. There were no significant ($p>0.05$) differences in the packed cell volume (PCV), red blood cell (RBC), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH). The values were within normal haematological ranges as reported by Mitruka and Rawnsley (1977). These results were in agreement with the reports of Dimcho *et al*. (2005); Pikhalf *et al*. (2010) and

Mokhtar (2022) who reported that blood meal supplementation in broiler diets did not affect their blood constituents. In contrast, the findings in this study disagreed with that of Cretin *et al*. (2005) who observed that blood meal supplementation caused significant ($p<0.05$) increase in most haematological indices. The difference in their report may be attributed to the level of blood meal in the diets. There were significant ($p<0.05$) differences in some blood parameters which tended to increase as the level of blood meal increased in the diets. This observation could be due to the need to combat the microbes in the blood meal by the white blood cells. The WBCs are involved in antibody formation and cell mediated immunity (Iheukuereme and Odinaniwo, 2009) and also plays a major role in defending the body against disease producing microbes. This is an indication that blood meal contains some harmful microbes which the body is reacting to, therefore producing more WBC in order to fight the microbes). The leukocytes and lymphocyte increased significantly ($p<0.05$) with increase in blood meal in the diets. This observation was in consonance with the report of Khaksetidi and Ghoorchi (2006) who attributed the increase in leukocytes and lymphocytes to the stimulation of immune system of birds fed blood meal, which according to Anthouri *et al*. (2001), also helps the birds to increase their resistance to infection.

Table 5: Effect of different dietary levels of blood meal as replacement for crystalline lysine on the haematological parameters of broiler finisher birds

Parameter	T_1	T_2	T_3	T_4	SEM
PCV (%)	25.65	23.88	26.91	24.61	0.92
Hb (g/dl)	7.82	8.91	8.43	7.89	0.46
WBC ($\times10^{12}$mm/L)	20.64^{d}	22.82^{c}	26.11^{b}	29.05^{a}	0.39
RBC ($\times10^{9}$mm/L)	4.00	3.96	3.66	4.03	0.18
MCV (fl)	115.86	116.41	118.00	128.82	4.41
MCH (g/dl)	35.98	40.11	42.62	36.35	3.97
MCHC (g/dl)	50.05	49.34	45.50	45.00	6.81
Lymphocytes (%)	41.22^{d}	45.28^{c}	48.91^{b}	51.66^{a}	1.89
Neutrophils (%)	36.82^{c}	37.95^{c}	39.64^{b}	43.00^{a}	1.26

^{abcd} Means on the same row with different superscripts are significantly different ($p<0.05$)

Conclusion

The study concludes that blood meal can totally replace crystalline lysine at 2% level, with improved body live weight, better reduction in cost of production without compromising the health status of the birds.

Recommendation

Farmers should be advised to use 2% of blood meal in finisher broilers' diets in place of crystalline lysine.

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