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EFFECT OF PROCESSED ABATTOIR WASTE (BOVINE BLOOD RUMEN DIGESTA MIXTURE) AS PARTIAL REPLACEMENT FOR SOYABEANS ON PERFORMANCE OF BROILER CHICKENS

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ABSTRACT

A total of 288-day-old chicks were used to investigate the effect of processed bovine blood rumen digesta mixture (BBRDM) as partial replacement for soyabeans on performance of broiler chickens. Considerable quantities of fresh bovine blood and rumen digesta were collected on weight/weight basis using the 1:2 ratio, processed via heat treatment for 2 hours 30 minutes and thereafter sun-dried for five days until it was dried. The BBRDM was used to formulate four dietary treatments consisting of 0 %, 20 %, 40 % and 60 % as partial replacement for soyabeans. The experimental birds were balanced for weight and divided into four (4) treatment groups of seventy-two (72) birds each. Each group was further divided into 4 subgroups comprising of 18 birds each serving as replicate. Data collected on the response variables (growth performance indices, haematological parameters and carcass traits) were subjected to One-way Analysis of Variance. Results revealed non-significant variations in all the growth, haematological indices (at starter and finishing phases) as well as carcass traits measured. In conclusion, partial substitution of soya beans meal with 60 % BBRDM in the diet is recommended for broiler chicken production for enhanced growth, better blood function, health status as well as carcass yield with probable reduction in the production cost.

Key words: animal nutrition; abattoir waste; recycling; unconventional protein

INTRODUCTION

Broiler production is a significant aspect of animal husbandry worldwide, owing to its impact on providing valuable protein for the ever-increasing population. Broiler chickens are known for rapid weight gain, efficient feed conversion to meat, a relatively short generational interval and excellent meat quality making them appealing to consumers. Despite the potential of broiler chicken production to address challenges associated with animal protein malnutrition in developing nations, its production is currently hindered by the high costs associated with feeding the birds to an acceptable market weight. The rising cost of conventional feed ingredients has driven many poultry producers out of business. Ingredients, such as maize and soybean meal, have become prohibitively expensive due to competitive demand from both human and animal consumption.

Given the increasing prices of protein-rich poultry feed ingredients like soybean meal, there is a need to explore non-conventional alternative protein feed resources that are affordable, readily available and possess good nutritive value (Laudadio *et al.*, 2012). One such alternative ingredient for broiler chicken production is the bovine blood-rumen digesta mixture (BBRDM). This mixture is a byproduct of processing bovine blood and rumen digesta collected from abattoirs. If not repurposed, these waste products can become environmental nuisances with negative implications for public health. However, these abattoir

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wastes possess nutritional value that can be highly beneficial for poultry feed production.

Previous studies have highlighted the potential of bovine blood-rumen mixture content to enhance livestock productivity. For example, Odunsi (2003) replaced fishmeal and groundnut cake in layer diets by mixing bovine blood and rumen digesta in a 1:1 ratio to produce bovine blood rumen meal. The resulting meal was found to contain 46.1 % of crude protein, 6.38 % of crude fibre, 2.13 % of ether extract, 23.4 % of ash, 16.0 % of nitrogen-free extract and 94.0 % of a dry matter. When used as a partial dietary replacement for groundnut cake and fishmeal, it was observed that feed intake decreased in birds fed diets containing bovine blood-rumen content. Onu *et al.* (2011) also demonstrated that up to 60 % of bovine blood-rumen content mixture can replace soybean meal in broiler chicken diets.

Thus, this approach not only reduces the cost of broiler chicken production but also offers a solution to mitigate the negative environmental and public health impacts of slaughterhouse waste. This study assessed the effect of bovine blood-rumen digesta mixture, as a replacement for soybean meal, on the performance of broiler chickens at both starter and finisher phases.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE) Broiler pen of the Directorate of the University Farm, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The area lies between Longitude 7°1328 N and Latitude 3°2526 E (Google Earth, 2023).

Collection and processing of bovine blood rumen digesta mixture

Fresh bovine blood and rumen digesta were collected from a commercial abattoir (Gbonogun abattoir, Odo-eran Abeokuta, Ogun State) close to experimental location. The blood was collected during slaughtering process directly into a container and, thereafter, transferred immediately into kegs for easy handling. The rumen digesta was collected into container after the visceral of slaughtered cattle(s) were split.

After collecting considerable quantities of the abattoir wastes, the fresh blood and rumen content were weighed into a cooking vat on weight/weight basis using the 1:2 ratio. The mixture was placed on the fire and allowed to boil for 2 hours 30 minutes while continuously stirred until the mixture was semi-dried. The heat-treated blood-digesta mixture was then spread in the sun for five days until all its moisture was eliminated.

Assessment of proximate composition of test ingredient

A sample of fifty grams (50 g) was collected from the prepared bovine blood rumen digesta mixture for proximate composition according to AOAC (2005) for the determination of protein, lipid, carbohydrate, moisture and ash contents.

Experimental diets preparation

Four experimental diets were formulated at starter and finishing phases during the period of the study. The processed mixture of BBRDM was ground with the aid of hammer mill and incorporated into the birds' diets as partial replacement for soybean meal at 0 %, 20 %, 40 % and 60 %. Diets were formulated to meet the nutrient requirement of the birds as shown in Tables 1 and 2.

Experimental birds and management

A total of two hundred and eighty-eight (288) day-old Ross 308 broiler chick were used for the study. The birds were managed intensively in a Deep litter housing (birds were raised indoor with litter covered floor and each replicate unit has 0.07 m^2 floor space per bird) with a supply of feed and water *ad libitum* throughout the experimental period (6 weeks).

Experimental design

The experiment was performed in a completely randomized design. The birds were balanced for weight and divided into four (4) treatment groups of seventy-two (72) birds each. Each treatment was further divided into 4 replicates comprising of 18 birds each (with a total of 16 experimental units).

Data collection

Growth performance indices

The day-old chicks were weighed on the day of arrival from the hatchery, before they were assigned to different replicates; the birds were also weighed on weekly basis. The feed intake was deduced by finding

Table 1. Composition of starter diets

Ingredient (kg)	BBRDM level of replacement			
	0 %	20 %	40 %	60 %
Maize	46.00	46.00	46.00	46.00
Wheat offal	3.00	3.00	3.00	3.00
Groundnut cake	17.00	17.00	17.00	17.00
Soybean meal	24.00	19.20	14.40	9.60
BBRDM	-	4.80	9.60	14.40
Fish meal (72 %)	2.50	2.50	2.50	2.50
Bone meal	2.50	2.50	2.50	2.50
Oyster shell	1.50	1.50	1.50	1.50
*Vit./min. premix	0.25	0.25	0.25	0.25
Vegetable oil	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Determined analysis				
Metabolizable energy (Kcal/kg)	2955	2913	2902	2892
Crude protein (%)	22.21	22.36	22.41	22.47
Crude fibre (%)	4.42	4.48	4.53	4.64
Ether extract (%)	5.38	4.46	4.31	4.23

BBRDM: Bovine blood rumen digesta mixture
*Premix composition per kg diet: Vit A: 400000 IU, Vit D: 80000 IU, Vit E: 40000 ng, Vit K 3: 800 mg, Vit B1: 1000 MG, Vit B2: 6000 mg, Vit B6: 500 mg, VitB12: 25 mg, Niacin: 6000 mg, Pantothenic acid: 2000 mg, Folic acid: 200 mg, Biotin: 8 mg, Manganese: 300000 g, Iron: 8000 mg, Zinc: 20000 g, Cobalt: 80 mg, Iodine: 400 mg, Selenium: 40 mg, Choline: 800000 g

Table 2. Composition of finisher diets

Ingredient (kg)	BBRDM level of replacement			
	0 %	20 %	40 %	60 %
Maize	44.00	44.00	44.00	44.00
Wheat offal	12.00	12.00	12.00	12.00
Groundnut cake	20.00	20.00	20.00	20.00
Soybean meal	15.00	12.00	9.00	6.00
BBRDM	-	3.00	6.00	9.00
Fish meal (72 %)	0.40	0.40	0.40	0.40
Bone meal	2.50	2.50	2.50	2.50
Oyster shell	1.00	1.00	1.00	1.00
*Vit./min. premix	0.25	0.25	0.25	0.25
Vegetable oil	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Determined analysis				
Metabolizable energy (Kcal/kg)	2998	2966	2956	2892
Crude protein (%)	20.64	21.36	21.61	21.80
Crude fibre (%)	5.21	5.38	5.51	5.63
Ether extract (%)	6.10	6.37	6.46	6.55

BBRDM: Bovine blood rumen digesta mixture
*Premix composition per kg diet: Vit A: 400000 IU, Vit D: 80000 IU, Vit E: 40000 ng, Vit K3: 800 mg, Vit B1:1000 mg, Vit B2: 6000 mg, Vit B6: 500 mg, Vit B12: 25 mg, Niacin: 6000 mg, Pantothenic acid: 2000 mg, Folic acid: 200 mg, Biotin: 8 mg, Manganese: 300000 g, Iron: 8000 mg, Zinc: 20000 g, Cobalt: 80 mg, Iodine: 400 mg, Selenium: 40 mg, Choline: 800000 g

difference between quantities of offered feed and left over. Feed conversion ratio was determined as the ratio of feed consumed to the weight gain. Body weight gain of birds was recorded by weighing them on replicate basis. This was done on a weekly basis and the values were subtracted from the initial weight of the preceding week.

Collection of blood samples and determination of haematological parameters

At 4 and 8 weeks of age, two birds of average weight were selected from each replicate and blood samples were collected from the birds via the wing (bronchial vein). Two millilitres (2 ml) of blood were collected from a bird into the tube containing ethylene--diamine tetraacetate (EDTA) for evaluating haematological parameters (red blood cell, white blood cell, packed cell volume and haemoglobin). Packed cell volume (PCV) was determined by the micro-haematocrit method, as described by Dacie and Lewis (1991). Haemoglobin (Hb) concentration was determined by a spectrophotometer using the cyano-methaemoglobin method, as described by Kelly (1979). Red blood cell (RBC), white blood cell (WBC) counts and its "differentials" were determined using Neubauer hemacytometer method, as described by Jain (1993) and Feldman *et al.* (2000). Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to Jain (1993) and Bain *et al.* (2006).

Measurements of carcass traits

At eight weeks of age, four birds of average weight from each replicate were selected and slaughtered, bled, plucked and eviscerated. The live weight, dressed weight and weights of cut-parts or prima cut (head, neck, wings, breast, thighs, drumstick, back and shank) were taken with the aid of sensitive scale, the weights of the prima cuts were expressed as percentage of the live weight.

Data analysis

Data collected were subjected to One-way Analysis of Variance (ANOVA) in a completely randomized design using Statistical Package for Social Sciences (SPSS) version 21 (SPSS 2012). Significant means were separated using Duncan Multiple Range Test of the same software at 5 % level of significance.

RESULTS

Chemical composition of bovine blood rumen digesta mixture

The bovine blood rumen digesta mixture (BBRDM) contained 94.38 % of dry matter, 36.82 % of crude protein, 5.41 % of ether extract, 24.61 % of crude fibre, 13.25 % of ash and 2708.83 Kcal/kg of metabolizable energy (Table 3).

Table 3. Proximate composition of bovine blood rumen digesta mixture

Parameters	Composition
Dry matter	94.38 %
Crude protein	36.82 %
Ether extract	5.41 %
Crude fibre	24.61 %
Ash	13.25 %
Metabolizable energy	2708.83 Kcal/kg

Table 4. Effect of bovine blood-rumen digesta meal on growth performance of broiler chickens

Parameters	BBRDM level of replacement					
	0 %	20 %	40 %	60 %	SEM	P-value
Initial body weight (g/bird)	40.00	39.44	40.28	40.28	0.34	0.330
Final body weight (g/bird)	2333.40	2368.90	2369.70	2330.60	27.50	0.626
Total weight gain (g/bird)	2293.40	2329.40	2329.40	2290.30	27.50	0.620
Daily weight gain (g/bird)	54.61	55.46	55.46	54.53	0.66	0.620
Total feed intake (g/bird)	3081.90	3242.80	3222.70	3098.60	86.70	0.475
Daily feed intake (g/bird)	73.38	77.21	76.73	73.78	2.06	0.475
Feed conversion ratio	1.34	1.39	1.38	1.35	0.05	0.841

BBRDM: Bovine blood rumen digesta mixture

Effect of bovine blood rumen digesta meal on growth performance of broiler chickens

Table 4 presents the effect of bovine blood rumen digesta meal as a partial replacement for soybean meal on the growth performance of broiler chickens. No significant differences were observed among all growth performance indices with mean values comparable to those of the control group. Although not statistically significant, the feed conversion ratio ranged from 1.34 to 1.39.

Effect of bovine blood rumen digesta meal on haematological indices of broiler chickens

Table 5 illustrates the impact of bovine blood--rumen digesta meal (BBRDM) on the haematological parameters of broiler chickens during the starter phase. All measured parameters showed no significant variation ($p > 0.05$) among the treatment groups. Similarly, Table 6 presents the effect of BBRDM on the haematological parameters of broiler chickens during the finisher phase. None of the indices differed significantly ($p > 0.05$) among the treatments.

Table 5. Effect of bovine blood-rumen meal on haematological indices of broiler chickens at starter phase

Parameters	BBRDM level of replacement					
	0 %	20 %	40 %	60 %	SEM	P-value
Packed cell volume (%)	30.50	30.00	31.00	28.00	3.47	0.929
Red blood cell (x 10^{12}/L)	3.10	3.10	3.39	2.98	0.34	0.850
Haemoglobin (g/dl)	10.45	10.35	10.55	9.60	1.35	0.954
White blood cell (x 10^{9}/L)	12.30	11.90	12.80	9.60	1.16	0.346
Heterophils (%)	29.00	25.50	26.00	35.00	5.57	0.634
Lymphocyte (%)	67.00	70.50	71.50	61.00	5.95	0.630
Monocytes (%)	1.50	2.00	1.00	2.00	0.75	0.757
Eosinophils (%)	1.50	0.50	0.50	0.50	0.43	0.242
Basophils (%)	1.00	1.50	1.00	2.00	0.56	0.584
MCV (fl)	93.95	91.35	94.15	94.40	2.31	0.774
MCH (%)	35.30	34.80	32.00	18.08	7.56	0.431
MCHC (%)	34.15	34.30	33.95	34.20	0.57	0.974

BBRDM: Bovine blood rumen digesta mixture

Table 6. Effect of bovine blood-rumen meal on haematological indices of broiler chickens at finisher phase

Parameters	BBRDM level of replacement					
	0 %	20 %	40 %	60 %	SEM	P-value
Packed cell volume (%)	42.33	36.33	41.67	44.00	5.02	0.730
Red blood cell (x 10^{12}/L)	4.12	3.56	3.90	4.33	0.50	0.740
Haemoglobin (g/dl)	14.17	2.60	14.27	14.83	1.75	0.830
White blood cell (x 10^{9}/L)	11.63	11.10	12.07	11.60	1.25	0.960
Heterophils (%)	31.00	31.00	34.33	33.33	3.93	0.910
Lymphocyte (%)	64.33	64.67	61.67	62.67	4.15	0.950
Monocytes (%)	1.00	1.67	2.00	1.33	0.69	0.760
Eosinophils (%)	1.67	0.67	0.67	1.00	0.50	0.490
Basophils (%)	2.00	2.00	1.33	1.67	0.24	0.220
MCV (fl)	93.42	93.08	95.04	89.21	1.92	0.420
MCH (%)	33.41	34.69	34.32	33.65	0.30	0.060
MCHC (%)	34.34	35.14	36.80	34.18	1.03	0.320

BBRDM: Bovine blood rumen digesta mixture

Table 7. Effect of bovine blood-rumen meal on carcass traits of broiler chickens

Parameters	BBRDM level of replacement					
	0 %	20 %	40 %	60 %	SEM	P-value
Live weight (g/bird)	2342.76	2358.04	2351.30	2342.12	41.50	0.999
Dressing per cent	69.05	71.94	73.57	70.11	50.30	0.430
Cut-part (%)						
Breast	24.83	27.02	26.92	26.25	31.30	0.604
Drumstick	9.77	9.98	10.20	10.03	11.30	0.921
Thigh	10.49	11.30	11.89	10.65	7.94	0.056
Back	16.23	16.08	16.70	15.48	12.30	0.441
Head	2.24	2.03	2.20	2.26	2.65	0.545
Neck	1.69	2.76	2.78	2.61	10.40	0.311
Organs (%)						
Spleen	3.48	3.17	3.55	3.28	0.46	0.068
Bursa	4.60	4.19	3.48	4.18	0.60	0.072
Thymus	4.89	3.99	3.46	4.79	1.51	0.062
Proventriculus	8.66	8.42	9.05	9.37	0.76	0.823
Gizzard	48.71	48.87	59.62	51.93	4.88	0.404
Heart	10.18	10.40	10.74	9.97	1.21	0.972
Liver	38.06	45.70	41.22	35.60	2.60	0.107

BBRDM: Bovine blood rumen digesta mixture
[a,b] Means in the same column with different superscripts differ significantly ($P < 0.05$) - ?

Effect of bovine blood rumen digesta meal on carcass traits of broiler chickens

Table 7 shows the influence of bovine blood rumen digesta meal on the carcass traits of broiler chickens. The results revealed no significant variation ($p > 0.05$) in any of the cut parts or organs measured.

DISCUSSION

The crude protein content of the BBRDM, obtained in this study (36.82 %), was higher than those reported by Dairo *et al.* (2005; 33.81 %) but lower than documented by Onu *et al.* (2011; 45.35 %) and Odunsi (2003; 46.10 %). Additionally, notable differences were observed in crude fibre (8.81 %), ether extract (4.10 %) and ash (15.42 %) contents reported by Onu *et al.* (2011) when compared to our study. These variations in the nutritional composition of BBRDM may be attributed to factors such as the quality of forage consumed by the animals and the stage of digesta degradation, which can influence the contribution of microbial protein. Furthermore, it was observed that increasing the inclusion rate of BBRDM, as a partial replacement for soybean meal in the experimental diets, resulted in higher crude protein levels. This proves the suitability of BBRDM as a protein supplement for broiler chickens.

The growth performance parameters measured did not significantly vary with treatments performing similarly throughout the experimental period. These results are consistent with findings of Obadire *et al.* (2020), who partially substituted graded levels (0 %, 20 %, 25 %, 30 % and 35 %) of combined bovine and camel rumen content for maize in broiler chicken production, observing no significant differences in growth indices during the finishing phase. Similarly, Adenui and Balogun (2003) reported no differences in growth rates of pullets fed varying levels of bovine blood rumen content mixture, even when the incorporation rate increased. According to AFRIS (2010) the weight gain of broiler chickens was not negatively affected by fed diets containing 10 – 15 % of dried rumen. In addition, Dairo *et al.* (2005) and Esonu *et al.* (2011) reported non-significant variations in feed conversion ratios of rabbits and broiler chickens fed diets containing varying levels of BBRDM. In contrast, Onu *et al.* (2011) observed significantly higher final body weight, weight gain and feed intake in broiler chickens

fed a diet containing 60 % of BBRDM compared to other treatment groups.

Blood is routinely used as a physiological marker or diagnostic tool to assess the condition of animals exposed to diseases and various other factors like nutritional status and overall health in birds (Olafedehan *et al.*, 2010). Isaac *et al.* (2013) noted that animals with favourable blood composition tend to exhibit better performance. The fact, that the haematological indices in this study were within reference ranges and that BBRDM had no significant impact on the haematological parameters of broiler chickens at both the starter and finisher phases, suggests that BBRDM is a safe, non-toxic unconventional protein feed ingredient for broiler chicken production. The healthy blood profile of the broiler chickens with values within the established normal range for healthy birds as documented by Anonymous (1980), Campbell *et al.* (2003) and Abubakar and Yusuf (1991), supports its non-toxicity. The normal haemoglobin values observed indicates an improved capacity to carry oxygen suggesting that the diet was enriched with BBRDM-derived nutrients.

The success of poultry production is closely linked to improvements in growth and carcass yield, particularly by increasing breast proportion and reducing abdominal fat (Musa *et al.*, 2006). Similar trends observed in growth performance indices were also seen in carcass traits with no significant variations in any of the parameters evaluated. This suggests that BBRDM has the potential to serve as an alternative to conventional protein sources like soybean meal in broiler chicken production. The protein content of BBRDM was sufficient to promote growth and muscle development comparable to that of birds in the control group. This outcome aligns with findings of Esonu *et al.* (2011), who reported no significant differences in live weight and dressing percentage of birds fed different levels of fermented bovine blood rumen digesta. Onu *et al.* (2011) observed significantly higher dressing weight in broiler chickens fed a diet containing 60 % of BBRDM compared to other treatments, though other carcass traits showed no significant differences. Conversely, Olukayode *et al.* (2008) reported significant differences in carcass yields of birds fed sun-dried rumen blood meal diets compared to those on a control diet. The variations in responses among experimental animals can be attributed primarily to the nutritional quality of the rumen digesta mixtures and the physiological stage of the birds, which influences efficient feed utilization.

CONCLUSION

The results indicate that replacing up to 60 % of soybean meal with BBRDM in broiler chicken diets, particularly during the starter and finisher phases, is feasible without negatively impacting growth rate, carcass yield or haematological indices.

AUTHOR'S CONTRIBUTIONS

Conceptualization: IYANDA, A.

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Project administration: IYANDA, A.

All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on request from the corresponding author.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Abubakar, M. M. & Yusuph, A. O. (1991). Effectiveness of rumen content in poultry rations. *16th Annual Conference of Nigerian Society for Animal Production*, Sokoto, 75–79.

Adenui, A. A. & Balogun, O. O. (2003). Influence of bovine blood rumen content meal in the diets of growing pullets on their subsequent laying performance. *Ghana Journal of Agricultural Science*, 6, 47–51. DOI: 10.4314/gjas.v36i1.2063

AFRIS (Animal feed resources information system). (2010). File://C: Documents and Setting/ ADMIN/My Document Retrieved 26/4/2010.

Anonymous. (1980). Guide to the care and use of experimental animals. Canadian Council of Animal Care, Ottawa, Ontario, Canada, 1(1), 85–90.

AOAC (2005). *Official Method of the Association of Official Analytical Chemists*. 17th Edition, AOAC, Washington, DC., USA, pp. 21–47.

Bain, B. J., Lewis, S. M. & Bates, I. (2006). Basic Hematological Techniques. In: Lewis, S. M., Bain, B. J. & Bates, I., (Ed), Livingstone Elsevier, Philadelphia, 26–54.

Campbell, J. R., Kenealy, M. D. & Campbelln, K. L. (2003). *Animal Science. The biology, care and production of domestic animals*. Mc Graw Hill, USA, pp. 510.

Dacie, J. V. & Lewis, S. M. (1991). *Practical Haematology,* 7th edition, ELSB with Church Hill Living Stone, England, pp. 37–85.

Dairo, F. A. S., Aina, O. O. & Asafa, A. R. (2005). Performance evaluation of growing rabbits feed varying levels of rumen content and blood rumen content mixture. *Nigerian Journal of Animal Production*, 32(1), 67–73. DOI: 51791/njap.v36i1.1036

Esonu, B. O., Azubuike, J. C., Udedibie, A. B. I., Emenalom, O. O., Iwuji, T. C. & Odoemenam, V. (2011). Evaluation of the nutritive value of mixture of fermented bovine blood and rumen digesta for broiler finisher. *Journal of Natural Sciences Research*, 1(4), 65–71.

Feldman, B. F., Zinkl, J. G. & Jain, N. C. (2000). *Schalm's Veterinary Hematology*, 5th edition, Lippincot Williams and Wilkins, Baltimore.

Google Maps. (2023). Federal University of Agriculture. Retrieved from https://earth.google.com/web/@7.22330744,3.44033719,137.84884575a,1046.69760578d,35y,100.57030218h,44.99999706t,-0r/data=Cm4abBJmCiUweDEw

Isaac, L. J., Abah, G., Akpan, B. & Ekaette, I. U. (2013). Haematological properties of different breeds and sexes of rabbits. *Proceeding of the 18th Annual Conference of Animal Science Association Nigeria*, 24–27.

Jain, C. N. (1993). *Essentials of Veterinary Haematology*. Lea and Febiger, Philadelphia, USA, 133–168.

Kelly, W. R. (1979). *Veterinary Clinical Diagnosis*, 2nd edition, Bailliere Tindall, London, 266.

Laudadio, V., Passantino, L., Perillo, A., Lopresti, G., Passantino, A., Khan, R. U. & Tufarelli, V. (2012). Productive performance and histological features of intestinal mucosa of broiler chickens fed different dietary protein levels. *Poultry Science*, 91, 265–270.

Musa, H. H., Chen, G. H., Cheng, J. H., Li, B. C. & Mekki, D. M. (2006). Study on carcass characteristics of chicken breeds raised under the intensive condition. *International Journal of Poultry Science*, 5(6), 530–533. DOI: 10.3923/ijps.2006.533

Obadire, F. O., Oso, A. O., Yunusa, S., Ibiwoye, K. O., Mustapha, Y., Osofowora A. O., Ejiofor, I. & Oluwatosin, O. O. (2020). Growth Performance and Carcass Characteristics of Broiler Chickens Fed Combined Bovine and Camel Rumen Contents. *Nigerian Journal of Animal Science and Technology*, 3(1), 42–52.

Odunsi, A. A. (2003). Blend of Bovine and Rumen digesta as a replacement for fishmeal and groundnut cake in layer diets. *International Journal of Poultry Science*, 2(1), 58–61.

Olafedehan, C. O., Obun, A. M., Yusuf, M. K., Adewumi, O. O., Olafedehan, A. O., Awofolaji, A. O. & Adeniji, A. A. (2010). Effects of residual cyanide in processed cassava peal meals on haematological and biochemical indices of growing rabbits. *35th Annual Conference Nigerian Society for Animal Production*, 212.

Olukayode M., Baafunso, S. & Segun, A. (2008). Conversion of abattoir wastes into livestock feed: Chemical composition of sun-dried rumen content blood meal and its effect on performance of broiler chickens. *Conference on International Research on Food Security, Natural Resources Management and Rural Development*, University of Hohenheim, Germany.

Onu, P. N., Otuma, M. O., Odukwe, C. A. & Aniebo, A. O. (2011). Effects of different levels of bovine blood/rumen content mixture on productive performance, carcass characteristics and economics of production of finisher broilers. *International Journal of Food Agriculture Veterinary Science*, 1(1), 10–16.