

Carcass Evaluation and Blood Metabolites of Finishing Broiler Chickens Fed Bitterleaf (*Vernonia Amygdalina* Del.) Meal as Feed Additive in a Tropical Environment

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Abstract

The study was conducted using finishing broiler chickens to determine the commercial cuts and carcass characteristics, as well as the blood metabolites when fed diets containing bitterleaf (*Vernonia amygdalina* DEL.) meal at varying proportion as additive, with the aim of discovering a possibility of improving the commercial cuts of finishing broiler chickens to enable farmers and processors make better profit through better feed conversion to muscles, as well as to check the extent to which internal organs and blood metabolites can be affected from consumption of the leafmeal diets. Four diets were tested. Diet 1 contained no leafmeal and was the control, Diet 2 contained bitterleaf meal (BLM) at 2.5% inclusion level, Diet 3 contained BLM at 5.0% inclusion level and Diet 4 contained BLM at 7.5% inclusion level. Though there were significant ($P < 0.05$) differences in the average live weight of the birds, but the dress percentage had no significant ($P > 0.05$) difference. Some lacerations were observed in the liver of the chickens fed the leafmeal diet at higher inclusion levels of the additive (5% and 7.5%). It was concluded from the study that bitterleaf meal, BLM, can be added as an additive in finishing broiler diet up to 7.5% to improve commercial cuts, though at this inclusion level it might be injurious to some internal organs such as the liver.

INTRODUCTION

In Africa, chicken production is a major determinant on source of income, employment, and means of livelihood (Nemauluma et al., 2023) especially among the rural dwellers, also it takes part in food security within the people of Africa (Ngongolo et al., 2021). According to Nemauluma et al. (2022), to enhance feed utilization and growth performance of livestock, some producers resorted to the use of antibiotics in livestock diets. However, continuous unrestricted use of antibiotics could result to resistant bacterial strain in livestock and humans, thus necessitating the need for research in a continued search as well as promoting natural safe alternative growth promoters for livestock. *Vernonia amygdalina* VA is a plant native to tropical Africa and it is widely cultivated. It is commonly known as 'bitter leaf', and aside from being consumed in combination with staple foods, it is recognized as a proven herbal medicine used in polyherbal therapy (a combination of herbs or phytochemicals from several sources are used) to cure or manage many diseases (Atangwo et al., 2009). Not much study has been done on the effects of VA on the carcass characteristics as well as the blood metabolites of poultry chickens. This present study therefore explores the effects of feeding VA to finishing broiler chickens as an additive on their carcass characteristics and blood metabolites, so as to elucidate on its potential in broiler chicken nutrition.

MATERIALS AND METHODS

Experimental Site

The Research was carried out at the Teaching and Research Farm of the University of Benin, Nigeria. The Farm is located between latitude 6° and 6° 31' N of the equator and longitude 5° 40' and 6° E of the

Greenwich Meridian with a mean annual rainfall of about 2161mm and a mean relative humidity of 72.5% (Google Earth, 2022).

Diet Formulation

The leaves were harvested lush green, chopped and sundried (30–35°C) in an open concrete floor until the moisture content became constant, and then milled into leafmeal; the leaves retained their green colour. Proximate analysis of the leafmeal was carried out to determine its nutritional potential using the AOAC (2016) method. The experimental trial was done using the leafmeal at 2.5%, 5%, and 7.5% additive level (or 2.5kg/100kg, 5kg/100kg, and 7.5kg/100kg). The Diets are shown in Table 1.

Table 1
Composition of the Diets

% Per 100 Kg				
Ingredients	Diet 1 (0%)	Diet 2 (2.5%)	Diet 3 (5.0%)	Diet 4 (7.5%)
Yellow Maize	55.00	55.00	55.00	55.00
Soybean meal	27.75	27.75	27.75	27.75
Wheat offal	13.00	13.00	13.00	13.00
Bone meal	2.65	2.65	2.65	2.65
Limestone	1.00	1.00	1.00	1.00
Salt (NaCl)	0.25	0.25	0.25	0.25
*Vitamin-Mineral Premix	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
BLM	0.00	2.50	5.00	7.50
TOTAL (Kg) + BLM	100.00	100.00 + 2.50	100.00 + 5.00	100.00 + 7.50
Determined Composition:				
Dry Matter (%)	91.20	89.70	87.67	89.17
Crude Protein (%)	20.35	21.81	22.52	23.07
Crude fat (%)	15.67	14.00	15.67	15.67
Crude Fibre (%)	3.71	3.73	3.73	3.77
Ash (%)	12.91	12.12	14.29	16.80
NFE (%)	38.57	38.04	31.46	29.86
* Composition of vitamin – mineral premix per kg of diet: vit A., 5,000 IU; Vit. D, 800IU; Vit E. 12mg; vit. B, 1.5mg; Niacin, 12mg; Pantothenic acid, 5mg; Biotin, 0.02mg; Vit. B12, 0.01mg; Folic acid, 0.3mg; Chlorine chloride, 150mg; Manganese, 60mg; Iron, 10mg; Zinc, 15mg; Copper, 0.8mg; Iodine, 0.4mg; Cobalt, 0.08mg; Selenium, 0.04mg; Antioxidants, 40mg. BLM – Bitterleaf meal; NFE – Nitrogen free extract				

Experimental Design and Management

The experiment was carried out using a completely randomized design. A total of one hundred (100) finishing broiler chickens were housed in a standard tropical open-sided poultry house using a deep litter system. There were four experimental treatments; twenty-five (25) broiler chickens were used per treatment, and each treatment had five (5) replicates of five (5) birds each. Experimental birds were grouped such that the mean body weight of the birds will not differ among dietary treatments. The birds were fed with the experimental diets for 4 weeks, after allowing a one-week adaptation period.

Data Collection

Parameters measured were live weight and weight gain (by difference), feed intake and Feed Conversion Ratio (FCR), blood metabolites (albumin, globulin and blood glucose), and the carcass characteristics (organs and commercial cut).

Blood Metabolites

Blood sample (2mL) was taken from the wing vein of a randomly selected bird from each replicate. The blood samples were collected in lithium-heparin and fluoride-oxalate bottles (bottles not containing Ethylene Diamine Tetra Acetate, EDTA). The blood samples were analyzed in a standard chemical pathology lab for parameters such as Total Protein, serum albumin, serum globulin and blood glucose following standard methods as described by Baker and Silverton (1985).

Carcass Characteristics

One bird per replicate was selected on the basis of closeness to the replicate mean weight. The selected birds were deprived of feed overnight and weighed prior to slaughtering to determine the liveweight. The slaughtered birds were defeathered and eviscerated to get the carcass weight. The absolute weight is expressed as a percentage of the liveweight. Commercial cut, weight and other physical characteristics of the organs (liver, kidneys, heart, spleen, gizzard, and koilin layer) were determined and expressed as a percentage of the liveweight.

Statistical Analysis

Data collected were analysed for analysis of variance (ANOVA) using Genstat Statistical Package, and separation of means was done using Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate and Mineral Composition of Bitterleaf Meal

The leaves harvested lush green retained their green colour after processing could imply that the chlorophyll compounds responsible for the green colouration of leaves were not adversely affected. The proximate nutrient and some mineral composition of Bitterleaf Meal (BLM) are presented in Table 2.

Table 2
Proximate and Some Mineral Composition
of BLM (% Dry Matter)

Nutritional Component	% Composition
Moisture content	7.56
Crude Protein	27.40
Crude Fat	17.00
Crude Fibre	11.36
Ash	9.73
Nitrogen Free Extract	26.96
Sodium (mg/g)	0.04
Potassium (mg/g)	2.14
Calcium (mg/g)	1.01
Magnesium (mg/g)	0.52
Phosphorus (mg/g)	0.55

The results indicated that bitter leaf meal had a dry matter of 92.44%. The crude protein content was 27.40%, which is higher than the value reported by Tsado et al. (2015), but lower than the crude protein content reported by Asaolu et al. (2012) and Sodamade (2013). The ash content of 9.73% was lower than that reported by Udochukwu et al. (2015) but higher than the value reported by Tsado et al. (2015), and Asaolu et al. (2012). Higher carbohydrate content was reported in this study than what was obtained by Udochukwu et al. (2015) and Ejoh et al. (2007). The mineral profile of Bitterleaf meal was shown in the Table to contain 0.04 mg/g Sodium, 2.14 mg/g Potassium, and 1.01 mg/g Calcium. The analysis result shows that BLM can support growth because protein and carbohydrates are the nutrients required for growth, while minerals are required for strong and healthy bones development. Several factors are most likely responsible for the variations in the chemical and mineral composition reported; the environment of the plant, the season of planting the stem as well as harvesting the leaves, accuracy of the analytical methods used, cultural practices carried out during the cultivation of the plant, the preparatory method of the leafmeal before analysis, and the type of fertilizers which were previously used in the soil because a soil treated with nitrogen fertilizer will grow protein-rich plants.

Feeding Trial and Growth

The weights of the birds assigned to the diets were not significantly different to ensure minimal variation due to size differential. Table 3 shows the performance of the broiler chickens on the test diets was significantly ($P < 0.05$) different from that of the Control. A trend was observed in the average weight gain per bird across the diets, as the average weight gain per bird in the test diets (D2, D3 and D4) improved

with an increase in the inclusion of BLM; this improvement in the weight gain may have been due to the leafmeal causing an improved secretion of digestive enzymes causing a better utilization of the available nutrients in the feed.

Table 3
Performance of finishing Broiler Chickens fed diets containing BLM as additive for 28 days

Parameter	Diets (% inclusion of BLM in broiler chicken finisher diet)				
	D1 (0%)	D2 (2.5%)	D3 (5.0%)	D4 (7.5%)	SEM
Average Initial Weight (g/bird) at 7 weeks	1114.75 ± 2.82	1116.56 ± 1.78	1115.00 ± 2.32	1114.70 ± 2.52	0.44
Average Final Weight (g/bird)	2085.13 ± 27.53 ^a	2170.31 ± 31.92 ^a	2210.06 ± 56.30 ^a	2409.33 ± 62.21 ^b	64.38
Average Weight Gain (g/bird)	970.38 ± 34.39 ^a	1053.75 ± 25.94 ^{ab}	1095.06 ± 8.92 ^b	1294.63 ± 24.71 ^c	33.64
Average Weight Gain (g/bird/day)	34.66 ± 0.53 ^a	37.63 ± 0.38 ^{ab}	39.11 ± 0.13 ^b	46.24 ± 0.37 ^c	2.41
Average Feed Intake (g/bird)	3564.63 ± 63.80 ^a	2956.91 ± 54.17 ^b	3475.22 ± 74.12 ^a	3849.54 ± 50.28 ^c	59.61
Average Feed Intake (g/bird/day)	127.31 ± 0.31 ^a	105.60 ± 0.79 ^b	124.12 ± 1.10 ^a	137.48 ± 0.73 ^c	6.65
Feed Conversion Ratio	3.67 ± 0.11 ^a	2.81 ± 0.07 ^b	3.17 ± 0.06 ^c	2.97 ± 0.15 ^{bc}	0.09

^{abc} means on the same row with same or no superscript are not significantly ($P > 0.05$) different.

The bioactivities of BLM could have enhanced the gastrointestinal activities of the chickens and hence may be responsible for this improved weight gain; this supports the report by Ijeh et al. (1996) on the bioactivities of VA in the gastrointestinal tract of animals. Other factors that could have influenced the weight gain per bird include the genetic makeup of the individual bird, light duration, the housing temperature amongst others. The average feed intake per bird seem to not have been influenced by the inclusion of BLM despite its bitter taste, while Diet 2 had the lowest average value (2960.71 g/bird), Diet 4 recorded the highest average value for feed intake (3850.97 g/bird) and this may be because their bitter taste receptor is very small and found behind their tongue as reported by Roura et al. (2013). The birds fed the diets containing BLM had lesser feed conversion ratio (FCR) than the birds fed the Control diet (D1); implying that less quantity of the BLM diets will be required to get a desired standard size.

Blood Metabolites

The total protein concentration of the blood showed no particular trend across the diets, with D3 showing the lowest concentration and D2 having the highest concentration. However, there was a trend in the albumin concentration of the blood; the Control diet (D1) had the least albumin concentration, followed by D2 (2.5% BLM) and the trend progressed with D4 (7.5% BLM) having the highest albumin concentration. The blood metabolites are presented in Table 4.

Table 4
Some blood metabolites of Broiler Chickens fed diets containing BLM as additive

Parameter	DIETS (% inclusion of BLM in broiler diet)				S.E.M.
	D1 (0%)	D2 (2.5%)	D3 (5.0%)	D4 (7.5%)	
T.P (g/dL)	4.33 ± 0.09	4.47 ± 0.20	4.07 ± 0.09	4.37 ± 0.17	0.15
ALB (g/dL)	1.33 ± 0.09	1.40 ± 0.15	1.50 ± 0.06	1.57 ± 0.09	0.10
GLO (g/dL)	3.00 ± 0.06ab	3.07 ± 0.22a	2.57 ± 0.07b	2.80 ± 0.12ab	0.13
GLU (mg/dL)	117.00 ± 5.69	117.00 ± 3.06	110.00 ± 4.58	105.00 ± 6.11	5.00
^{ab} means on the same row with same or no superscript are not significantly (P > 0.05) different					
T.P = Total Protein; ALB = Albumin; GLO = Globulin; GLU = Glucose					

This increase in albumin concentration as the inclusion level of BLM increased may have been due to the effect of the leafmeal on the liver. It is a possibility that the liver may have been injured or overworked leading to more secretion and escape of the albumin into the blood stream. This supports the report of Ologhobo et al. (1998) that bitterleaf meal in broiler diet at a particularly high level even as an additive could cause injuries to internal organs. The blood glucose level experienced a decrease with an increase in the inclusion level of BLM; while the control treatment and the treatment with the lowest BLM inclusion level in the diet (D1 and D2) had the highest blood glucose level, the other levels of dietary inclusion of BLM experienced a decrease in their blood glucose as the inclusion level increased. This implies that bitterleaf meal can be used in cases of hyperglycemia (high blood glucose), to bring about a reduction and control of blood glucose level, hence supporting the reports of Atangwho et al. (2009), Okolie et al. (2008), Akah et al. (2004) and Akah et al. (2002) that bitterleaf has an anti-diabetic effect and can be used in the treatment of diabetic conditions.

Carcass Evaluation

Table 5 showed the average liveweight of the broiler chickens fed on diets containing BLM was greater than that of the broiler chickens fed the control diet. Also, the dress percentage of the broiler chickens fed the leafmeal-based diets at higher inclusion levels (Diet 3 and 4) was also greater than the control-diet fed broiler chickens; Diet 4 gave the highest value for dress percentage (78.20 ± 1.60), back weight (19.57 ± 1.38%) and breast weight (23.34 ± 0.71%).

Table 5
Carcass evaluation of Broiler Chickens fed diets containing BLM as additive (Organs)

DIETS (% inclusion of BLM in broiler diet)					
Parameter	D1 (0%)	D2 (2.5%)	D3 (5.0%)	D4 (7.5%)	S.E.M.
Liveweight (Kg/bird)	2090.80 ± 7.48 ^a	2177.00 ± 13.27 ^b	2197.00 ± 25.38 ^b	2403.00 ± 17.86 ^c	16.70
Liver (% LW)	1.68 ± 0.11 ^a	2.45 ± 0.40 ^b	1.76 ± 0.03 ^a	1.66 ± 0.05 ^a	0.21
Kidney (% LW)	0.48 ± 0.06 ^a	0.31 ± 0.06 ^b	0.42 ± 0.05 ^{ab}	0.43 ± 0.02 ^{ab}	0.05
Heart (% LW)	0.33 ± 0.06	0.33 ± 0.03	0.29 ± 0.01	0.34 ± 0.02	0.04
Right Lungs (% LW)	0.27 ± 0.03	0.26 ± 0.02	0.25 ± 0.05	0.22 ± 0.03	0.03
Left Lungs (% LW)	0.27 ± 0.02	0.26 ± 0.03	0.26 ± 0.06	0.23 ± 0.03	0.04
Spleen (% LW)	0.08 ± 0.02	0.06 ± 0.00	0.08 ± 0.00	0.06 ± 0.02	0.02
Koilin layer (% LW)	0.28 ± 0.06	0.27 ± 0.03	0.21 ± 0.01	0.38 ± 0.17	0.09
Gizzard (% LW)	2.25 ± 0.35	2.16 ± 0.39	1.87 ± 0.18	1.98 ± 0.14	0.29
^{abc} means on the same row with same or no superscript are not significantly (P > 0.05) different					

The presence of BLM in the diets may have caused a reduced head weight percentage as its inclusion level increased i.e. the average head weight for the control-diet fed chickens was higher than the diets with BLM and as the inclusion level of BLM increased across the treatments, the head weight decreased. The liveweight percentage of the back and breast improved as the inclusion of BLM increased; the leafmeal based Diets, D2, D3 and D4, had higher values than the control Diet, D1, with D4 giving the highest value for back weight (19.57 ± 1.38%) and breast weight (23.34 ± 0.71%). The bird on the control diet, D1, had higher liveweight percentage of wing weight (right wing 4.10 ± 0.23 and left wing 4.15 ± 0.20), and the wing weight percentage decreased as the inclusion level of BLM increased. Diet 3 had the highest percentage values for the right and left drumstick (5.65 ± 0.30 and 6.09 ± 0.61 respectively), and neck weight (4.18 ± 0.25).

Table 6
Carcass evaluation of Broiler Chickens fed diets containing BLM as additive (Commercial cuts)

Parameter	DIETS (% inclusion of BLM in broiler chicken diet)				S.E.M
	D1 (0%)	D2 (2.5%)	D3 (5.0%)	D4 (7.5%)	
Liveweight (Kg/bird)	2090.80 ± 7.48 ^a	2177.00 ± 13.27 ^b	2197.00 ± 25.38 ^b	2403.00 ± 17.86 ^c	16.70
Dress percentage (%)	74.45 ± 2.94	72.37 ± 3.22	75.69 ± 0.94	78.20 ± 1.60	2.37
Head (%LW)	2.56 ± 0.11	2.54 ± 0.26	2.28 ± 0.16	2.18 ± 0.14	0.18
Right Drumstick (%LW)	5.34 ± 0.18	5.60 ± 0.34	5.65 ± 0.30	5.46 ± 0.20	0.26
Left Drumstick (%LW)	5.67 ± 0.24	5.59 ± 0.25	6.09 ± 0.61	5.60 ± 0.34	0.39
Neck wt. (%LW)	4.04 ± 0.05	3.95 ± 0.47	4.18 ± 0.25	3.58 ± 0.21	0.29
Neck Length (cm)	13.39 ± 1.51	13.61 ± 0.84	14.11 ± 1.60	15.48 ± 0.80	1.24
Back wt. (%LW)	14.91 ± 2.08	15.07 ± 2.60	16.97 ± 1.29	19.57 ± 1.38	1.92
Breast wt. (%LW)	17.32 ± 2.34	17.58 ± 2.56	20.59 ± 1.16	23.34 ± 0.71	1.86
Right Wing (%LW)	4.10 ± 0.23 ^a	4.00 ± 0.06 ^{ab}	3.96 ± 0.25 ^{ab}	3.45 ± 0.10 ^b	0.18
Left Wing (%LW)	4.15 ± 0.20 ^a	3.94 ± 0.09 ^{ab}	3.70 ± 0.20 ^{ab}	3.53 ± 0.08 ^b	0.15
Right Leg (%LW)	2.33 ± 0.31	2.14 ± 0.20	2.17 ± 0.23	1.85 ± 0.13	0.22
Left Leg (%LW)	2.31 ± 0.33	2.12 ± 0.19	2.17 ± 0.26	1.81 ± 0.13	0.24
Right Thigh (%LW)	4.47 ± 0.28	5.43 ± 1.13	4.34 ± 0.12	3.71 ± 0.39	0.62
Left Thigh (%LW)	4.51 ± 0.34	5.07 ± 1.07	4.38 ± 0.26	3.92 ± 0.50	0.63
^{abc} means on the same row with same or no superscript are not significantly (P > 0.05) different					

Table 6 showed that there was a significant difference in the percentage liveweight of the kidney and liver. These are organs having direct contact with the blood. Though the feed additive (bitterleaf meal) may have played a role in the liveweight percentage of these organs (liver and kidney), we cannot be absolutely certain that the variation in the liveweight percentage was caused by the inclusion level of BLM in the diet of the broiler chickens; and also, because there was no definite trend in the organs liveweight percentage. The spleen and the gizzard of the control diet, D1, had higher liveweight percentage than those of the test diets containing the leafmeal, but the koilin layer of the test diet containing 7.5% BLM (D4) had a greater liveweight percentage than the other treatments. The percentage

liveweight of the koilin layer may be a determinant of how much work the gizzard underwent in the processing and digesting of the diets.

CONCLUSION

The dress percentage of broiler chickens is a major concern of poultry farmers, and higher inclusion of BLM in the diet (up to 7.5% inclusion level) of finishing broiler chickens resulted in higher dress percentage of the chickens. BLM as an additive could cause a reduction in the blood glucose of the broiler chickens; this further supports the assumption of bitterleaf being anti-diabetic, and the possibility of the plant leaves being used for effective management of symptoms such as hyperglycemia. However, an in-depth physiological research should be carried out to ascertain the true extent to which consumption of bitterleaf can affect the internal organs of monogastrics because it was observed in this study that at 5.0% and 7.5% additive level of BLM inclusion, though the broiler chickens gained weight appreciatively, but the liver had serious lacerations.

It can be recommended that poultry farmers should take advantage of the possible beneficial effects derivable from the use of bitterleaf meal, BLM, in the diet of finishing broiler chickens at additive levels as this will improve the overall chicken meat production. Also, it could answer the need to search for safe growth enhancer, and an alternative replacement of antibiotic growth promoters in poultry diets as suggested by Malematja et al. (2022).

Statements and Declarations

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Both authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Philemon Ogieriakhi and Johnson Oyedeji. The first draft of the manuscript was written by Philemon Ogieriakhi, and Johnson Oyedeji commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

The ethics governing the use and conduct of experiments on animals were strictly observed, and the experimental protocol was approved by the Department of Animal Science, University of Benin. No written approval of research ethics committees was required to accomplish the goals of this study.

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