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Growth performance, blood profile and carcass characteristics of broiler chickens fed graded level of wood charcoal-based diets

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***Target Audience:** Farmers, Academics*

Abstract

This study was conducted to evaluate the effect of diet containing graded levels of wood charcoal on growth performance, blood profile and carcass characteristics of broiler chicken. One hundred and eighty chicks were allotted into 5 treatments of 36 birds each and 4 replicates of 9 birds each in a Completely Randomized Design. Five experimental diets were formulated with inclusion of wood charcoal at varying levels in which T_1 (control) had 0%, T_2 (2.5%), T_3 (5.0%), T_4 (7.5%) and T_5 (10.0%). Feed and water were given ad libtum for a period of 8weeks. Data were collected on growth performance, blood profile and carcass characteristics of the chicken. Results showed that there were significant ($P<0.05$) differences in all the growth performance investigated, except for feed conversion ratio and total weight gain. The results showed that live weight, slaughtered weight, eviscerated weight and dressed weights were significantly different ($p<0.05$) among the treatments. However, plucked weight, thigh, wing and breast weights were not significantly different among the treatments. All parameters measured for haematology were not significantly different ($p>0.05$) among the treatments except for haemoglobin, and basophil. The result further revealed that no significant ($P>0.05$) difference was observed on all serum biochemical parameters among dietary treatment except alanine amino transferase. It was concluded that inclusion of wood charcoal had no deleterious effect on growth performance and serum biochemistry of broiler chicken.

***Key words:** Wood charcoal, broiler chicken, Growth, Haematology and Carcass.*

Description of Problem

In the poultry sector, feed remains the most important component of the cost of production. Hence, researchers are continuously looking for ways to minimize feed cost. While improving poultry performance, one of the ways has been the use of growth promoters to improve feed efficiency and poultry health (1). In Nigeria and indeed many other countries, various feeds and additives are incorporated into poultry diets to ensure maximum productivity. Most of the additives are used depending on the ease of use. Moreover, most of these materials are not cited in the scientific literature but are used locally. For instance, some local poultry production in Turkey claimed that 20-25g wood charcoal per kg diet prevents fatness, according to (4,2). Feeding strategy in growing broiler chickens is expected to produce animal with maximum lean body mass, highest feed conversion ratio and maximum body weight.

Charcoal has enormous absorptive properties, it acts curatively on the gastro intestinal tract, absorbing gases such as hydrogen sulphide and ammonia that are

formed, bacterial toxins as well as mycotoxins produced by fungi (5). Charcoal is not digested in the gastro intestinal tract and it binds various substances through physical interactions regardless of whether they are ionized or not. By binding of ammonia, charcoal protects the intestine against alkalization. The mineral contained in charcoal form bases with water lower the surface tension of the digesta and emulsify fat, thereby supporting liver function and enabling digestion and assimilation (11). There were many advantages of adding charcoal to animal diets as it controls lactic acid concentration in the gastro intestinal tract of ruminants, maintaining pH level and micro flora in the rumen steers (17) and pathogenic bacteria was controlled by charcoal. (16) reported that pullets fed activated charcoal gave high economic returns which was attributed to increased mineral intake and utilization enhanced by charcoal supplementation and also improved absorption capacity of charcoal for dietary fat. The health of the gut is one of the major factors governing the performance of birds and thus, the economics of poultry production and the profile of intestinal micro flora play an important role in the gut health (4). Thus, this study sought to assess growth performance, blood profile and carcass characteristics of broiler chickens fed graded level of wood charcoal-based diets.

Materials and methods

Experimental site

The experiment was carried out at the Teaching and Research farm Bora, Federal College of Animal Health and Production Technology, Moor plantation, Ibadan. Ibadan is located on longitude $03^0$51E, latitude$07^0$23N and altitude 65^0S, in the humid zone of rain forest belt 0703.25 of south western Nigeria. Ecologically it is in the rainforest zone experiencing mean annual rainfall of 1220mm and mean temperature of 26^0C with two seasons- the dry and wet season. (19)

Experimental birds and their management

A total number of two hundred (200) unsexed Abor Acre broiler chicks were procured from school's hatchery and one hundred and eighty of the chicks were used for the experiment. Subsequently, at day-old, the birds were acclimatized for 7 days, after which the birds were randomly allotted into 5 treatment groups. The birds were reared on deep- littered pen, feed and water were provided *ad libitum*. Other routine management practices such as vaccination, drug administration and maintenance of cleanliness in and out of the poultry house were strictly adhered to. During the experiment, 100watt bulb lamp was used as heater in the experimental house which was switched on for at least 18hours.

Experimental Design

After 7 days of acclimatization, the birds were randomly allotted into 5 treatment groups which were replicated four times with 9 birds per replicate in a completely randomized design.

Experimental Diets

Five experimental diets were formulated for both starter (1-4 weeks) and finisher (4-8 weeks) phases. Diet I was designated as the control without wood charcoal while diets 2 contained 2.5% of wood charcoal, diets 3 contain 5.0% of wood charcoal, diet five (5) contain 7.5% of wood charcoal and diet 5 contain 10.0% of wood charcoal. The ingredients composition of experimental diets for starter and finisher phases are presented in Tables 1 and 2 respectively.

Table 1: Gross composition of broiler starter diets

Ingredient (kg)	T1 (0%)	T2 (2.5%)	T3 (5.0%)	T4 (7.5%)	T5 (10.0%)
Maize	55.00	51.00	50.00	50.00	43.50
Groundnut cake	3.80	3.05	3.00	3.00	6.50
Soya meal	30.00	30.75	30.20	28.20	27.20
Wood charcoal	0.00	2.50	5.00	7.50	10.00
Wheat offal	6.00	6.00	4.60	3.60	4.60
Fish meal (72%)	2.50	2.50	2.50	2.50	2.50
Di−calcium phosphate	1.90	1.90	1.90	1.90	1.90
Vegetable oil	0.00	1.50	2.00	2.50	3.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Crude protein (%)	22.48	22.92	23.51	23.94	23.98
Metabolizable energy (Kcal/kg)	2910.10	2836.12	2801.01	2767.79	2712.94

*Vitamin and mineral premix 0.1%, Vitamin premix 0.1%, B- Complex 0.02%, Choline 0.05% and Salt 0.3%, Trace mineral Premix supplied mg. Kg^{-1}diet: Mg 300; Mn, 55; I, 0.4; Fe, 56; Zn, 30; Cu, 4. The vitamin premix supplied per kg diet: Vit. A, 8250 IU; Vit D3, 1200 ICU; Vit. K, 1mg; Vit E, 40 IU; Vit. B1, 2mg; Vit. B2. 4mg; Vit B12; 10mcg; niacin; 60mg; pantothenic acid; 10mg; choline, 500m

Table 2: Gross composition of broiler finisher diets

Ingredients (kg)	T1 (0%)	T2 (2.5%)	T3 (5.0%)	T4 (7.5%)	T5 (10.0%)
Maize	58.40	55.40	53.40	51.40	51.40
Groundnut cake	25.40	25.90	26.40	26.90	26.90
Wood charcoal	0.00	2.50	5.00	7.50	10.00
Vegetable oil	0.00	1.50	2.00	2.50	3.00
Fish meal (72%)	2.50	2.50	2.50	2.50	2.50
Wheat offal	10.00	8.50	6.00	5.50	2.50
Di calcium phosphate	3.00	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Metabolizable energy (Kcal/kg)	2861.10	2850.02	2840.10	2850.10	2880.02
Crude protein %	21.38	21.33	21.30	21.20	21.33

*Vitamin and mineral premix 0.1%, Vitamin premix 0.1%, B- Complex 0.02%, Choline 0.05% and Salt 0.3%, Trace mineral Premix supplied mg. Kg^{-1}diet: Mg 300; Mn, 55; I, 0.4; Fe, 56; Zn, 30; Cu, 4. The vitamin premix supplied per kg diet: Vit. A, 8250 IU; Vit D3, 1200 ICU; Vit. K, 1mg; Vit E, 40 IU; Vit. B1, 2mg; Vit. B2. 4mg; Vit B12; 10mcg; niacin; 60mg; pantothenic acid; 10mg; choline, 500m

Chemical analysis of test material and diets

Samples of wood charcoal used and experimental diets were analyzed for proximate composition in the Laboratory using standard methods outlined by (3). The moisture, crude protein, ether extract, crude fibre, ash and nitrogen free extract (NFE) contents were determined.

Table 3: Proximate Composition of Wood Charcoal used

Parameters (%)	
Moisture	7.00
Dry matter	93.00
Crude protein	2.62
Crude fibre	45.00
Ether extract	3.00
Ash	14.00
Nitrogen free extract	28.38
Gross energy (MJ/Kg)	2762

Data collection

Growth Performance: Data were collected on daily and weekly basis for feed and growth performance. The following parameters were measured: **Weight gain** was determined as the final weight – Initial weight. **Feed intake** was calculated on a daily basis as weight of feed offered – leftover feed weight. **Feed conversion ratio** was calculated as feed intake / weight gain.

Carcass characteristics: At the end of 56 days, 3 birds were randomly selected from each treatment, starved of feed for 12 hours, slaughtered, eviscerated and the carcass weight determined. The dressing percentage was calculated as:

Dressing % = carcass weight/ live weight x 100

Haematological and Serum biochemical parameters: Two birds were selected from each replicate and blood samples were collected from jugular vein puncture with a 5ml needle, in which 2ml were dispense into a sterilized tubes containing EDTA (ethylenediamine tetra acetic acid) for determination of haematological parameter and the remaining 3ml into a plain sample bottle for determination of serum biochemical indices.

Statistical analysis

Data were analyzed using ANOVA for a completely randomized design according to (15). Treatment means were separated using Duncan multiple range test 5% level of significance.

Results and Discussion

The proximate composition of wood charcoal (WC) shown in Table 3, revealed that the composition falls within the range for activated charcoal. Hence the nutrient (proximate) composition of WC are very high in crude fibre, ash and gross energy.

Result of growth performance of broiler chickens fed graded levels of WC is presented in Table 4. The result showed that there were significant effects ($p<0.05$) of WC supplements on final weight; average weight gained, average daily intake, and average daily weight of the birds. However, birds fed 10% of WC supplement recorded highest values of final weight; average weight gained, average daily intake, and average daily weight. Highest value of feed intake was also recorded for birds fed 2.5% of WC supplement. This was better than the value reported by (13) which recorded a lower value in similar experiment. The result further revealed that there were no significant effects ($p>0.05$) of WC supplements on feed conversion ratio (FCR) and mortality, with lowest FCR obtained in

10% WC diet and highest in 0% WC diet. The increase in feed consumption for birds in wood charcoal based diets is an attempt to maintain nutrient intake by consuming more feed. This is in contrast with the findings of (10). The improvement in feed conversion ration (FCR) observed in this study had been attributed to reduce overall maintenance requirement caused by a transient decrease in basal metabolic rate. However, the improved FCR can also be related to higher feed consumed and the enlargement of the gastrointestinal tract that occurs after the period of the study. This is in agreement with the findings of (9).

Table 4: Effect of Diet Containing Graded level of Wood Charcoal on Growth Performance of Broiler Chicken

Parameters (g)	T_1 (0%)	T_2 (2.5%)	T_3 (5%)	T_4 (7.5%)	T_5 (10%)	SEM (±)
Initial Weight	178.92	180.69	178.55	176.55	178.89	1.57
Final Weight	1850.57^{d}	2216.67^{ab}	2183.33^{b}	2150.00^{c}	2233.35^{a}	50.71
Total Weight Gain	1671.65^{d}	2035.98^{ab}	2004.78^{b}	1973.45^{c}	2054.46^{a}	40.05
Average Daily Weight gain	29.85^{d}	36.36^{ab}	35.80^{b}	35.24^{c}	36.69^{a}	1.45
Total Feed Intake	3819.74^{e}	4623.42^{b}	$4282,24^{c}$	4471.28^{a}	4150^{d}	96.41
Av Daily Feed Intake	68.21^{d}	82.63^{a}	76.47^{b}	76.84^{b}	74.11^{c}	3.46
Feed Conversion ratio	2.28	2.27	2.13	2.26	2.02	0.08
Mortality %	2.00	0.00	1.66	0.00	1.66	0.38

^{a,b,c,d} means along the same row with different superscript are significantly different ($P<0.05$)

Result of carcass characteristics of broilers is presented in Table 5. It indicated that live weight, slaughter weight, dressed weight, Eviscerated weight, Head, organ (Gizzard) were significantly affected by the dietary treatments ($p<0.05$). There was no significant ($p>0.05$) difference across the dietary treatment in Plucked weight, Thigh, Liver, Heart and Spleen. The highest values for Plucked weight was recorded in 2.5% WC diet (T_2), while the lowest value was in 10% WC diet (T_5) and highest values for eviscerated weight were obtained from birds fed diet T_2 (2.5% WC) which was not significantly ($p>0.05$) differently from those fed the diet T_4 (7.5% WC). These values were however, significantly ($p<0.05$) higher than those fed 0%, 5.0% and 10.0% of wood charcoal (WC). The highest eviscerated and dressed weights was obtained in birds fed diet T_2 (2.5% WC) and the diet T_4 was indicated that birds on these two diets produced more edible meat than others. This was a result of better utilization of the nutrient in the diet T_2 and T_4 with no anti-nutritional factors. This result is in line with (8) which says wood charcoal prevented fatness and improved growth performance of broiler chicken. The highest gizzard weight was obtained in birds fed diet T_5 and similar Kidney weights obtained at 0% and 10.0% wood charcoal. This could be linked to the roles of these organs in elimination of metabolic wastes and toxins from the body. This result agrees with the gizzard functions which are primary organs of bio transformation in animals.

Table 5: Effects of Diet Containing Graded Level of Wood Charcoal on Carcass and organ characteristics of Broilers Chicken

Parameters (%)	T1 (0%)	T2 (2.5%)	T3 (5.0%)	T4 (7.5%)	T5 (10.0%)	SEM (±)
Live weight (g)	1866.67	2316.67	2183.33	2100.00	2283.33	50.71
[1]Slaughtered weight	96.47	98.57	96.67	97.60	97.77	0.28
[1]Plucked weight	94.60	95.67	90.87	91.31	87.77	1.19
[1]Eviscerated weight	80.23	83.43	78.69	82.54	80.07	0.70
[1]Dress weight	65.97	68.37	63.40	65.83	66.17	0.51
[1]Breast weight	18.03	20.20	19.60	20.83	19.67	0.34
[1]Wings weight	8.57	8.43	8.27	8.63	8.47	0.13
[1]Thigh weight	12.07	12.90	12.00	12.37	12.47	0.15
[1]Back weight	13.03	12.50	11.60	11.53	12.67	0.23
[1]Neck weight	6.30	6.00	6.13	5 .80	5.67	0.11
[1]Head weight	2.90	2.43	2.43	2.60	2.10	0.10
[1]Shank weight	4.33	4.30	4.67	4.80	4.27	0.12
[1]Drum weight	11.63	12.03	11.20	11.43	11.43	0.15
[1]Gizzard weight	2.57	2.07	2.83	2.53	2.93	0.10
[1]Liver weight	1.93	1.57	1.57	1.67	1.87	0.06
[1]Kidney weight	0.59	0.52	0.49	0.65	0.57	0.03
[1]Lung weight	0.71	0.65	0.62	0.74	0.75	0.02
[1]Spleen weight	0.07	0.07	0.10	0.09	0.07	0.01
[1]Heart weight	0.31	0.45	0.44	0.49	0.48	0.03

[abc]: mean along the same row with different superscripts are significantly different ($p<0.05$)
1: Expressed as % of live weight

The result of haematological indices as presented in Table 6 revealed that the haematological indices of the birds were not significantly ($p<0.05$) affected by dietary treatments except for Basophil and Haemoglobin. The lowest values for Haemoglobin were recorded in birds fed 2.5% wood charcoal diet. However, the significant values of these haematological parameters across the dietary treatments coupled with values of PCV, Basophil and RBC which fell within the recommended for normal range of chicken (12) was an indication of adequate nutrition for these birds. (7) and (14) also reported lower values of haematological parameters and attributed the lower values to inadequate nutrients.

Table 7 shows the serum biochemistry of broiler chicken fed diet containing graded of wood charcoal. All the parameters measured in serum biochemical indices has no significant effect ($P>0.05$) except Alanine amino transferase, which are significant ($P<0.05$) affected by the dietary treatment in the present study, the values were within the normal range for the birds, (12). However, this finding is in agreement with (6), which recorded similar values but a slight deviation from normal ranges. There was a significant increase in the total protein levels across the dietary treatment as compared to control. This is in agreement with (2) that reported high total protein in birds supplemented with DL- methionine and herbal methionine. (18) also recorded significantly higher levels of serum in total protein and globulin of broiler birds fed a diet treated with turmeric powder at a rate of 1g/kg. Total protein is an important serum marker, which seems to be related to a better ability of hepatocytes to synthesize protein,

high plasma protein has been attributed to good protein for tissue development even after the animal has reached its maximum capacity for depositing tissue.

Table 6: Effect of diet containing graded level of wood charcoal on haematological indices of broiler chicken

Parameter	T1 (0%)	T2 (2.5%)	T3 (5%)	T4 (7.5%)	T5 (10%)	SEM (±)	Normal Range
PCV (%)	31.00	26.00	30.67	32.00	30.00	0.96	24.50−45.20
HB (g⁄dl)	10.17	8.33	10.07	10.60	9.600	0.31	7.40−13.10
RBC (x10^6⁄ul)	3.40	2.81	3.19	3.41	3.42	0.13	1.45−4.10
WBC (x10^6⁄ul)	18.57	18.62	18.95	17.42	16.20	0.49	9.20−31.00
PLATELET (x10^6)	175.67	135.67	180.33	128.00	430.67	8.63	140−480
LYMPH (%)	65.00	65.67	70.33	67.67	68.00	1.23	42.90−81.20
HETERO (%)	29.00	23.33	22.67	26.67	24.67	1.42	15.60−43.90
MONO (%)	3.33	3.84	2.67	3.33	4.00	0.21	0.06−0.94
EOS (%)	2.67	3.33	4.00	3.67	3.67	0.34	2.00−9.00
BASO (%)	0.00	0.00	1.00	0.67	0.00	0.16	0.36−1.32

[ab]: mean of different superscripts are significantly different ($p<0.05$)
**: normal range of haematological indices
Source: Mitruka and Rawnsley (1977).
PCV: Packed Cell Volume, HB: Haemoglobin, RBC: Red Blood Cell, WBC: White Blood Cell, LYMPH: Lymphocyte, HETERO: Heterophil, MONO: Monocyte, EOS: Eosinophil, BASO: Basophil

The result also shows a reduction in serum urea value recorded across all dietary treatment as compared with control treatment (14.49mg/dl) indicates no observable muscular wastage as a result of inadequate protein. Creatinine was higher in 7.5% and 10% WC (0.95mg/dl) than the control (0.68mg/dl) but were within the normal range values, which is a pointer to unimpaired kidney functions. Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) are pointers of the condition of the liver. They are low in the blood when the liver is normal and high when the liver is damaged. ALT was significantly higher in birds consumed 7.5%WC when compared to control and others dietary treatment but below the normal range values.

Table 7: Effect of wood charcoal on serum biochemistry indices of broiler chicken

Parameters	T_1 (0%)	T_2 (2.5%)	T_3 (5%)	T_4 (7.5%)	T_5 (10%)	SEM (±)	Normal Range **
Glucose (mg⁄dl)	90.09	90.92	92.25	94.00	84.24	4.36	152-182
Urea (mg⁄dl)	14.49	9.57	9.96	12.04	15.49	1.06	1.50-6.30
Creatinine (mg⁄dl)	0.68	0.94	0.91	0.95	0.95	0.05	0.90-1.85
AST (iu⁄l)	8.79	8.77	5.59	6.35	9.65	0.91	88.0-208
ALT (iu⁄l)	2.08	2.99	2.23	6.49	3.03	0.59	9.50-37.2
Total protein (g⁄dl)	3.00	3.57	3.40	3.69	3.88	3.43	5.20-60.90
Albumin (g⁄dl)	1.94	1.44	2.06	1.61	0.74	1.20	2.10-3.45
Globulin (g⁄dl)	1.06	2.13	1.34	2.08	3.15	2.43	0.50-1.80
Cholesterol (mg⁄dl)	199.57	145.02	135.90	206.49	146.75	12.96	52.0-148

[a,b] means along the same row with different superscript are significantly different ($P<0.05$)
** Normal range of serum biochemical indices
Source: Mitruka and Rawnsley (1977)
AST= Aspartate Amino Transferase
ALT= Alanine Amino Transferase

Conclusion and Application

Based on the result of this study, it was concluded that wood charcoal:

1. Had a significant effect on most growth characteristics of broiler chicken except feed conversion ratio with the birds in 10% WC having the highest values.
2. Reduced the mortality level in all treatments except for the control with highest values.
3. Addition of wood charcoal also aids digestion of feed and lowered the total cholesterol at all level of inclusions.
4. At all levels of inclusion had no deleterious effect on the broiler chicken.

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