Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

GROWTH PERFORMANCE, FEED COST, BLOOD PARAMETERS, EGG PRODUCTION, AND EGG QUALITY TRAITS OF LAYERS OFFERED CASSAVA ROOT MEAL DIETS SUPPLEMENTED WITH OR WITHOUT ACTIVATED CHARCOAL

Olayeni, Tunji. B.
(SDG 2), Associate Professsor in the Department of Animal Production and Health, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Adedoja, Muiz A.
(SDG 12), Graduate student in the Department of Animal Production and Health, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Ojediran, Taiwo K.*
(SDG 2), Associate Professsor in the Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. (Corresponding Author)

Alabi, Olayinka O.
(SDG 1), Associate Professsor in the Department of Animal Science, Landmark University, Omu-Aran, Nigeria.

Adedoja, Adewale S.
(SDG 8), Principal Instructor in the Department of Science Laboratory Technology, the Oke-Ogun Polythecnic, Saki, Nigeria.

Abstract

The growth performance, cost, haematological and serum parameters, egg production, and egg quality traits of layers offered cassava root meal (CRM) diets supplemented with or without activated charcoal were examined in a 14-week feeding trial. A total of 256 ISA Brown point of lay birds (18 weeks old) were divided into 8 dietary treatments in a completely randomized design. Each treatment was replicated 4 times with 8 birds per replicate in a 2x4 factorial arrangement. A maize-wheat offal-concentrate diet was the control diet. The maize was replaced with CRM at 25, 50, and 75% for activated and non-activated charcoal diets. The values obtained for final live weight and weight change, average daily feed intake, hen-day production, egg weight, and feed conversion ratio, all differed significantly ($p<0.05$) among the groups for treatment effect except egg weight for inclusion and interaction effects. The 75% replacement group also had the least feed intake but similar egg weight with other groups. However, the feed cost reduced ($p<0.05$) as the replacement level of CRM increased down the group. The haemologlobin, white blood cell, mean corpuscular haemoglobin and blood platelets were significantly ($p<0.05$) affected by the various inclusion levels of CRM. For serum parameters, globulin, total protein, Alanine aminotransferase, Alkaline phosphatase and total cholesterol were not significantly ($p>0.05$) affected by activated charcoal supplementation. However, albumin, Aspartate aminotransferase and triglyceride were significantly ($p<0.05$) affected. It was concluded that replacement of maize with CRM with or without activated charcoal supplementation beyond 50% level reduced the feed intake and hen day production of layers, and charcoal supplementation at 40g/kg feed in cassava-based diets gave a better production performance and improved health status of layers.

Index Terms: Charcoal, Chicken, Egg, Haematological parameters, Serum biochemistry

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

1. INTRODUCTION

Africa is currently plagued with food crisis, due partly to the unprecedented rise in human population and the alarming drop in per capita food production particularly in the last decade [1]. The food deficit situation is indeed more serious with protein deficiency when compared with the availability of calories and microelements. In order to be able to provide protein in adequate quantity and quality, the rearing of poultry which represents more than 80% of the total livestock production in Africa [2] appears to be a way of meeting this need. To meet the high demand for animal protein, farmers as well as scientists are looking out for birds that have sufficient potential to augment the availability of this essential protein at a cheaper cost. Layer production plays an important role in this aspect globally [3].

According to Fafiolu [4], a major problem that affects the poultry industries in the tropics is the escalating price of feed ingredients, such as maize and soya bean meal. The seasonal fluctuation in the supply of conventional feed ingredients requires alternative sources to be explored to ensure the optimum performance of the birds. The majority of components in commercial poultry diets comprise cereal grains as the energy source. In this regard, maize is the most commonly used cereal, about 45 to 60% of poultry diets because of its high energy content and low anti-nutritional factors [5]. However, in the production of this concerned cereal grain (maize), it is not adequate for direct human consumption, formulating livestock diets, and other industrial uses. The difficulty of obtaining foreign exchange in many African countries has considerably reduced the imports of maize and other cereals. These shortages have led to an increase in the price of maize and a consequent increase in the cost of production for intensive poultry production enterprises.

The competition for cereals by humans and the livestock industry makes it important to explore the potentials of other energy sources such as cassava root as an alternative to maize in poultry diets [6]. One of such alternatives is cassava. Yet, the ability of cassava to produce cyanide is the basis of its toxicity. Among the processing methods to reduce toxicity is sun drying, grating, soaking in water, fermentation, or a combination of these processes. The use of feed additives (toxin binder) such as activated charcoal can also be implored. And despite the fact that cassava root meal has been found to be an alternative energy source to maize in the diets of livestock and the limitation imposed by cyanide content, little or no information is available on how activated charcoal can be exploited to reduce the effects of cyanide on the egg quality and production.

This work, therefore, explores the potential of cassava root meal as a feed resource with little or no effect of anti-nutritional factors on growth performance, cost, haematological and serum parameters, egg quality, and production under the influence of activated charcoal.

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

2. MATERIALS AND METHODS

2.1 Experimental location and feed preparation

The experiment was conducted at the Poultry Unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Fresh cassava roots of sweet variety (TMS 3052) were procured locally. The cassava roots were cleaned of dirt with the use of water and cut into smaller pieces. They were later sun-dried for a number of days with regular turning until maximum dryness and constant weight were achieved. The dried materials were milled using a hammer mill to obtain cassava root meal (CRM). Four experimental diets were formulated to contain CRM at 0, 25, 50 and 75% levels of replacement for maize and supplemented with activated charcoal at 40g/kg feed. Another four diets containing the same level of CRM as described above were also formulated but without activated charcoal supplementation.

Vital feed® Concentrate for layers produced by Grand Cereals Oil and Mill was used in feed formulation of the experimental diets and it contained the following nutrients/energy: 4% Fat Max., 9% Calcium Min., 30% Protein Min. and 2600kcal/kg metabolizable Energy. A maize-wheat offal-concentrate diet was the control diet.

Table 1: Composition of Experimental Feeds and Their Calculated Nutrient Analysis

Ingredients (%)	Replacement levels of CRM for Maize (%)							
	Activated charcoal				No activated charcoal			
	T1 (0)	T2 (25)	T3 (50)	T4 (75)	T5 (0)	T6 (25)	T7 (50)	T8 (75)
Cassava root meal	-	11.25	22.50	33.75	-	11.25	22.50	33.75
Maize	45.00	33.75	22.50	11.25	45.00	33.75	22.50	11.25
Wheat offal	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Concentrate	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Activated charcoal	+	+	+	+	-	-	-	-
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition								
ME (kcal/kg)	2792.80	2766.48	2740.15	2713.83	2792.80	2766.48	2740.15	2713.83
Crude protein	17.75	16.93	16.10	15.29	17.75	16.93	16.10	15.29
Crude fibre	3.63	3.82	4.00	4.22	3.63	3.82	4.00	4.22
Calcium	3.88	3.43	2.98	2.53	3.88	3.43	2.98	2.53
Phosphorus	0.52	0.51	0.50	0.49	0.52	0.51	0.50	0.49

ME= Meatabolizable energy

2.2 Layers and Management

A total of 256 Isa Brown Point of Lay birds (18 weeks old) were purchased from a reputable farm and used for the experiment. They were weighed individually on arrival, housed in a battery cage pen and habituated for four (4) weeks before the commencement of the feeding trial. The birds were randomly allocated to eight (8) dietary

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

treatments in a completely randomized design. Each treatment was replicated four (4) times with eight (8) birds per replicate. The arrangement of the experiment is a 2 x 4 factorial arrangement. Routine vaccinations and medication schedule were strictly adhered to as required. The birds had access to feed and fresh clean water ad libitum for a period of 14 weeks.

2.3 Data Collection

Records of performance were kept on daily basis. Feed intake was monitored daily. The average feed intake was determined by subtracting the residual feed in the feeders for each replicate at the end of the day after being weighed using the sensitive balance from the total feed served. Then, the feed consumed per replicate was divided by the number of birds for that time. Feed conversion ratio was calculated as quantity of feed consumed/week divided by average eggs weight/week. Hen day production was calculated by dividing total number of eggs produced by total number of birds and multiplying the answer by 100.

Cost examined were feed price per kilogram [7]. For quality traits, eight eggs per treatment were randomly picked from eggs collected during the last day of the week, weighed individually and carefully broken out at the equatorial region into clean smooth container to measure the following internal characteristics: yolk colour, yolk diameter, albumen and yolk heights as well as their respective weights. Egg length and width were measured with vernier calipers and the data was used to compute egg shape index. Egg shape index was calculated by dividing egg width by egg length. The shell thickness was measured by breaking the egg shell into smaller pieces, shell membrane was manually removed and the thickness of the egg shell was measured using a micrometer screw gauge expressed in millimetres. Each egg shell was measured at three different points; the top (narrow end), bottom (broad end) and middle of the eggs and the average calculated. Yolk index was calculated as the ratio of the yolk height to the diameter, and the yolk colour was determined with the aid of Roche colour fan [7].

For haematology and serum parameters, two birds from each replicate were randomly selected and bled through the wing blood veins. Blood sample for hematological analysis were collected into bottle containing ethylene diamene tetra-acetic acid (EDTA) as anti-coagulants while blood sample meant for serum biochemical analysis were collected into bottle free from EDTA. Hematological constituents were determined in the laboratory using an auto-analyzer [8]. The samples were allowed to clot prior to centrifuging the serum to determine serum metabolites such as total proteins, aminotransferases, phosphatase, urea, creatinine, triglyceride, and cholesterol, were determined. The methods employed were as attested by Ojediran and Emiola [8]. These were done on last day of the feeding trial.

2.4 Statistical Analysis

The data obtained were subjected to a one-way analysis of variance (ANOVA) of SAS [9]. Significant means were compared using Duncan’s multiple-range test of same package

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

at probability value less than 5 percent ($p<0.05$).

3. RESULTS

The cassava root meal's proximate composition is shown in Table 2. The observed proximate composition showed that it had 89.42% dry matter, 2.69% crude protein, 4.26% crude fibre, 1.15% ether extract, 82.77% nitrogen free extract, 3.94% ash and 3.58% hydrogen cyanide.

Table 2: Proximate and cyanide composition of cassava root meal

Component (%)	Value (%)	SEM
Dry matter	89.42	0.69
Crude protein	2.69	0.28
Crude fibre	4.26	0.40
Ether extract	1.15	0.17
Nitrogen free extract	82.77	1.87
Ash	3.94	0.48
Hydrogen cyanide	3.58	0.23

SEM=Standard error of mean

The treatment effect of CRM on the performance indices of layers is shown in Table 3. There were significant ($p < 0.05$) differences across treatments in the values obtained for final live weight (FLW), weight change (WC), average daily feed intake, egg weight, hen-day production, feed conversion ratio, and cost of feed per kg. The final live weight recorded were 1530.38, 1672.50, 1583.75 and 1405.63g/b respectively. Birds fed diet with 25% CRM had the highest live weight, followed by those fed diet 0% and 50% CRM while those fed diet with 75% CRM had the least weight ($p<0.05$). Observations on weight changes followed the same pattern. The feed intake in birds fed 0-50% CRM ($p>0.05$) were higher than those fed diet with 75% CRM ($p<0.05$). Birds fed 0-25% CRM had higher hen day production while those fed 50-75% CRD experienced a reduced hen day production. The egg weight of birds fed 25% and 75% CRD differ significantly ($p<0.05$) while those fed other diets compared favourably. The feed conversion ratio (FCR) reduced linearly, although, those fed diets 0-50% had higher FCR while those fed 75% CRM had the least.

Table 3: Treatment effect of CRM on the performance indices of layers

Parameters	% CRM				
	0	25	50	75	SEM
Initial weight (g)	1366.75	1414.75	1395.75	1401.25	27.71
Final live weight (g)	1530.38^{b}	1672.50^{a}	1583.75^{b}	1405.63^{c}	30.77
Weight change (g)	163.63^{b}	257.75^{a}	188.00^{ab}	54.38^{c}	29.85
Average feed intake (g)	107.25^{a}	109.13^{a}	105.50^{a}	97.88^{b}	1.26
Hen day production (%)	91.93^{a}	94.64^{a}	83.48^{b}	75.22^{c}	1.47
Egg weight (g)	49.96^{ab}	51.56^{a}	49.88^{ab}	48.83^{b}	0.79
Feed conversion ratio	2.15^{a}	2.12^{a}	2.12^{a}	2.01^{b}	0.04
Cost per Kg feed (₦)	121.75	115.56	109.38	103.19	0.31

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

abcd: means within the same row bearing different superscripts differed significantly (P< 0.05)

The effect of the supplementation of activated charcoal (AC) on the performance of layers is shown in Table 4. Feed intake and egg weight were not significantly (p > 0.05) affected by activated charcoal supplementation. However, final live weight, weight change and hen day production significantly increased in birds fed diet with AC supplementation likewise the feed conversion ratio was significantly(p<0.05) improved with AC supplementation in layers fed diet.

Table 4: Supplementation effect of activated charcoal on the performance indices of layers

Parameters	Activated charcoal		
	+	-	SEM
Initial weight (g)	1390.69	1398.88	19.59
Final live weight (g)	1580.50^a	1540.63^b	28.83
Weight change (g)	189.81^a	141.75^b	3.25
Average feed intake (g)	103.94	105.94	0.89
Hen day production (%)	87.81^a	84.82^b	1.04
Egg weight (g)	49.76	50.35	0.56
Feed conversion ratio	2.09^b	2.11^a	0.03
Cost per Kg feed (₦)	132.47	92.47	0.22

ab: means within the same row bearing different superscripts differed significantly (P< 0.05)

+: Charcoal supplementation

-: Non-charcoal supplementation

Table 5 presented the interaction effect of CRM and AC supplementation on the performance indices of layers. Birds fed diets with activated charcoal had depressed average feed intake and feed conversion ration among the diets (p<0.05) with significant differences within treatment at 0% CRD inclusion. Birds fed 25% CRM with or without AC supplementation competes favourably (p > 0.05) with those fed the control diets for all performance indices evaluated among treatments. However, birds fed 75% CRM recorded the lowest value for performance indices evaluated (final live weight, weight change, average feed intake, and hen-day production) with or without AC supplementation.

Table 5: Interaction effect of CRM and activated charcoal supplementation on the performance indices of layers

Parameters	Charcoal supplementation	% CRM				SEM
		0	25	50	75	
Initial weight (g)	+	1360.00	1399.50	1394.50	1408.75	2.36
	-	1372.75	1430.00	1397.00	1395.75	2.41
Final live weight (g)	+	1557.00	1645.00	1672.50	1447.50	2.91

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

	-	1503.75^{b}	1700.00^{a}	1495.00^{b}	1463.75^{b}	2.33
Weight change (g)	+	197.00^{ab}	245.50^{a}	178.00^{b}	38.75^{c}	2.27
	-	131.00^{ab}	270.00^{a}	98.00^{ab}	68.00^{b}	2.51
Average feed intake (g)	+	103.50^{ay}	108.50^{a}	106.50^{a}	97.25^{b}	1.62
	-	111^{ax}	109.75^{a}	104.50^{b}	98.50^{c}	1.51
Hen day production (%)	+	92.34^{a}	96.87^{a}	85.72^{b}	76.34^{c}	1.65
	-	91.52^{a}	92.41^{a}	81.25^{b}	74.11^{b}	1.70
Egg weight (g)	+	50.25	51.71	48.88	48.20	1.23
	-	49.67	51.42	50.88	49.46	0.63
Feed conversion ratio	+	2.06^{y}	2.11	2.18	2.02	0.05
	-	2.24^{ax}	2.14^{ab}	2.06^{bc}	1.99^{c}	0.04
cost per Kg feed (₦)	+	141.75	135.56	129.38	123.19	0.44
	-	101.75	95.56	89.38	83.19	0.44

^{abcd}: means within the same row bearing different superscripts differed significantly (P< 0.05)

^{xy}: means within the same column bearing different superscripts differed significantly (P< 0.05)

Table 6 showed the treatment effect of CRM on the egg quality traits of layers. Significant differences (p<0.05) were observed in the values for egg shape index, egg weight, shell surface area and albumen weight across all treatments. However, all other egg quality parameters measured were not significantly (p>0.05) influenced. The 25% CRM group had the highest (p<0.05) value for egg weight and shell surface are among the CRM treatment groups. However, 75% CRM group recorded the highest value for albumen proportion (61.16%) while the least value was recorded in 50% CRM group (58.39%). Similarity (p>0.05) was however observed between the control group and 25% CRM group for all egg quality parameters measured.

Table 6: Treatment effect of CRM on the egg quality traits of layers

Parameters	% CRM				
	0	25	50	75	SEM
Egg shape index	0.68^{b}	0.69^{a}	0.66^{c}	0.67^{bc}	0.01
Egg weight (g)	49.96^{ab}	51.56^{a}	49.88^{ab}	48.83^{b}	0.79
Shell weight (%)	13.86	14.59	14.03	13.38	0.53
Shell thickness (mm)	0.37	0.33	0.33	0.32	0.02
Shell surface area (cm^2)	62.84^{ab}	64.23^{a}	62.76^{ab}	61.83^{b}	0.69
Albumen weight (%)	59.01^{b}	59.92^{ab}	58.39^{b}	61.16^{a}	0.65
Haugh unit	75.46	75.19	75.47	76.42	0.78
Yolk weight (%)	27.13	25.37	27.54	25.37	0.81
Yolk index	0.45	0.48	0.48	0.48	0.03
Yolk colour	8.98	8.58	8.44	8.33	0.27

^{abc}: means within the same row bearing different superscripts differed significantly (P< 0.05)

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

Table 7 showed the supplementation effect of activated charcoal on the egg quality traits of layers. No significant ($p>0.05$) differences were observed in all the egg quality parameters measured as a result of activated charcoal supplementation.

Table 7: Supplementation effect of activated charcoal on the egg quality traits of layers

Parameters	Activated charcoal		
	+	-	SEM
Egg shape index	0.68	0.68	0.00
Egg weight (g)	49.76	50.35	0.56
Shell weight (%)	14.15	13.77	0.37
Shell thickness (mm)	0.36	0.32	0.01
Shell surface area (cm^2)	62.11	62.06	0.74
Albumen weight (%)	59.95	59.29	0.46
Haugh unit	75.17	76.09	0.55
Yolk weight (%)	25.79	26.92	0.57
Yolk index	0.47	0.48	0.01
Yolk colour	8.51	8.66	0.19

+: Charcoal supplementation

-: Non-charcoal supplementation

The interaction effect of CRM and AC supplementation on the egg quality traits of layers is expressed in Table 8. There were significant differences ($p<0.05$) in the egg shape index of layers fed different experimental diet with and without AC supplementation. Feeding of CRM did not affect ($p > 0.05$) the egg shell thickness of various treatments in the supplemented group but reduced ($p<0.05$) in the non-supplemented group. Similarity ($p>0.05$) was observed in the egg weight, shell surface area, albumen height, haugh unit, yolk weight, yolk shape index and yolk colour of both AC supplemented and non-supplemented group at various CRM levels. However, birds fed 75% CRM had value of egg's albumen weight higher ($p<0.05$) than other treatments in the AC supplemented group except 25% CRM. In all egg quality parameters evaluated, similar ($p>0.05$) values were obtained for both group supplemented with or without activated charcoal against the various CRM levels.

Table 8: Interaction effect of CRM and activated charcoal supplementation on the egg quality traits of layers

Parameters	Charcoal supplementation	% CRM				SEM
		0	25	50	75	
Egg shape index	+	0.69^{ab}	0.70^{a}	0.67^{b}	0.68^{ab}	0.01
	-	0.69^{a}	0.68^{ab}	0.67^{ab}	0.67^{b}	0.01
Egg weight (g)	+	50.25	51.71	48.88	48.21	1.24
	-	49.67	51.42	50.88	49.46	0.63
Shell weight (%)	+	13.64	15.56	14.21	13.21	0.80
	-	14.07	13.62	13.84	13.55	0.44

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

Shell thickness (mm)	+	0.40	0.35	0.33	0.35	0.03
	-	0.35[a]	0.31[b]	0.33[ab]	0.29[b]	0.01
Shell surface area (cm^2)	+	63.09	64.35	61.86	61.27	1.10
	-	62.58	64.11	63.65	62.39	0.60
Albumen weight (%)	+	59.16[b]	59.91[ab]	59.05[b]	61.67[a]	0.61
	-	58.86	59.92	57.73	60.65	1.10
Haugh unit	+	75.73	73.36	74.71	76.90	1.10
	-	75.18	77.02	76.23	75.94	0.86
Yolk weight (%)	+	27.20	24.34	26.65	24.94	0.90
	-	27.06	26.40	28.43	25.80	1.21
Yolk index	+	0.44	0.47	0.48	0.49	0.02
	-	0.47	0.49	0.48	0.47	0.01
Yolk colour	+	9.13	8.25	8.21	8.46	0.30
	-	8.83	8.92	8.67	8.21	0.40

[ab]: means within the same row bearing different superscripts differed significantly ($P < 0.05$)

Table 9 showed the treatment effect of cassava root meal (CRM) on the haematological indices of layers. The haemologlobin (Hb), white blood cell (WBC), mean corpuscular haemoglobin (MCH) and blood platelets were significantly ($p<0.05$) affected by the various inclusion levels of CRM. However, no significant ($p>0.05$) differences were observed in the packed cell volume (PCV), red blood cell (RBC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC). Birds fed diets with 0% and 25% CRD had significantly different ($p<0.05$) haemoglobin value while those fed diets 50-75% CRD compared favourably. This trend is similar for mean corpuscular haemoglobin. Birds fed 0% CRD had the least white blood cell count compared ($p<0.05$) with those fed diets with 25-75% CRD which had higher values. Birds fed 25% and 50% CRD had significantly higher ($p<0.05$) platelet count while those fed 0% and 75% CRD had lower values.

Table 9: Treatment effect of CRM on the haematological indices of layers

Parameters	% CRM				
	0	25	50	75	SEM
Packed cell volume (%)	30.72	29.59	27.37	28.08	2.62
Red blood cell ($x10^6/mm^3$)	1.87	2.04	1.82	1.92	0.15
Haemoglobin (g/dL)	4.90[b]	7.57[a]	6.58[ab]	6.88[ab]	0.82
White blood cells ($x10^3/mm^3$)	176.60[b]	191.77[a]	193.99[a]	201.69[a]	7.92
Mean corpuscular volume(μ^3)	148.13	155.12	151.86	152.68	2.23
Mean corpuscular haemoglobin (µµg)	36.25[b]	38.56[a]	37.06[ab]	37.47[ab]	0.55
Mean corpuscular haemoglobin concentration (%)	24.13	24.77	24.49	24.37	0.47
Plateletes(x $10^3/mm^3$)	99.50[b]	107.88[a]	108.63[a]	98.50[b]	2.47

[ab]: means within the same row bearing different superscripts differed significantly ($P < 0.05$)

Table 10 shows the supplementation effect of activated charcoal on the haematological indices of layers. Charcoal supplementation significantly ($p<0.05$) increased the values

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

of PCV and decreased WBC while supplementation effect did not affect ($p>0.05$) RBC, Hb, MCV, MCH, MCHC and platelets.

Table 10: Supplementation effect of activated charcoal on the haematological indices of layers

Parameters	Activated charcoal		
	+	-	SEM
Packed cell volume (%)	32.41^{a}	25.47^{b}	1.85
Red blood cell (x10^{6}/mm^{3})	2.03	1.79	0.11
Haemoglobin (g/dL)	7.11	5.86	0.58
White blood cells (x10^{3}/mm^{3})	195.02^{b}	211.82^{a}	5.60
Mean corpuscular volume(µ^{3})	150.26	153.63	1.58
Mean corpuscular haemoglobin(µµg)	37.22	37.45	0.39
Mean corpuscular haemoglobin concentration (%)	24.75	24.13	0.33
Platelets (x 10^{3}/mm^{3})	105.50	101.75	1.75

^{b}: means within the same row bearing different superscripts differed significantly ($P< 0.05$)

+: Charcoal supplementation

-: Non-charcoal supplementation

Interaction effects of CRM and activated charcoal supplementation on the haematological traits of layers is shown in Table 11. Birds fed the control and experimental diets with activated charcoal showed significant ($p<0.05$) differences in the values for packed cell volume (PCV) obtained; birds fed the control diets with AC supplementation had the highest ($p<0.05$) value (35.47%) of PCV while the lowest value (23.94) was recorded in birds fed 75% cassava root meal (CRM) without AC. However, for non-supplemented groups, similarity ($p>0.05$) was observed in PCV among the various treatments, while significant differences ($p<0.05$) were recorded in the PCV of the supplemented group against the non-supplemented group for the different CRM levels as the former was better than the latter.

With or without charcoal supplementation, both red blood cell (RBC) and haemaglobin (Hb) values remained the same ($p>0.05$) for all CRM inclusion levels among the treatment groups. Interaction effect did not affect ($p>0.05$) both RBC and Hb values at all CRM levels. The white blood cell count (WBC) significantly increased ($p<0.05$) as a result of feeding CRM. The effect was more pronounced in the absence of AC supplementation. Replacement of CRM for maize with AC supplementation did not affect the mean corpuscular volume (MCV) of the birds but increased ($p<0.05$) the mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) at 25% CRM level. Similarity ($p>0.05$) was however observed for MCH and MCHC values among the various treatments within the non supplemented group. Birds fed CRM based diet had an increase in the value for blood platelet in the presence of AC though 25 and 75% were similar to control while only 25% CRM without supplement was higher than control among the other group. The interaction effect significantly ($p<0.05$) influenced the platelet count

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

at 25% and 50% CRM levels for both supplemented and non-supplemented group.

Table 11: Interaction effect of CRM and activated charcoal supplementation on the haematological indices of layers

Parameters	Charcoal suplementation	% CRM				SEM
		0	25	50	75	
Packed cell volume (%)	+	35.47^{ax}	34.11^{ax}	27.85^{bx}	32.23^{abx}	1.21
	-	25.97^{y}	25.07^{y}	26.89^{y}	23.94^{y}	1.28
Red blood cell (x10^6/mm^3)	+	1.88	2.25	1.84	2.17	0.16
	-	1.86	1.83	1.79	1.67	0.21
Haemoglobin (g/dL)	+	5.15	8.88	6.88	7.53	0.80
	-	4.65	6.25	6.29	6.24	1.10
White blood cells (x10^3/mm^3)	+	170.09^{b}	191.56^{ab}	194.75^{ab}	223.67^{a}	1.56
	-	196.42^{b}	208.63^{b}	213.44^{ab}	228.79^{a}	1.38
Mean corpuscular volume(μ^3)	+	148.50	152.15	150.53	149.86	1.44
	-	147.75^{b}	158.08^{a}	153.20^{ab}	155.50^{ab}	1.39
Mean corpuscular haemoglobin (μμg)	+	36.55^{b}	39.31^{a}	36.78^{b}	36.26^{b}	0.56
	-	35.95	37.81	37.35	38.70	0.71
Mean corpuscular haemoglobin Concentration (%)	+	24.48^{b}	25.90^{a}	24.64^{b}	23.98^{b}	0.23
	-	23.79	23.63	24.35	24.76	0.71
Platelets(x 10^3/mm^3)	+	99.50^{b}	102.00^{b}	118.25^{a}	102.25^{b}	1.64
	-	99.50^{b}	113.75^{a}	99.00^{b}	94.75^{b}	1.85

^{ab}: means within the same row bearing different superscripts differed significantly (P< 0.05)

^{xy}: means within the same column bearing different superscripts differed significantly (P< 0.05)

Table 12 shows the treatment effect of CRM on the serum traits of layers. Similarities (p>0.05) were observed between the control and the CRM treated groups for the values of albumin, globulin, total protein, aspartate amino transferase (AST) and total cholesterol. The values of alanine amino transferase (ALT) of the control diet was significantly lower (p<0.05) than all the CRM treated groups with the 75% CRM group having the highest value (45.54IU/L). However, the 50% CRM group had the significantly (p<0.05) lower value of alkaline phosphatase (24.47 IU/L) compared to others while the highest (p<0.05) value (37.29 IU/L) was recorded in the control diet though statistically similar to all CRM treatments except the 50% CRM group. The replacement of CRM for maize significantly (p<0.05) lowered the values obtained for trighyceride.

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

Table 12: Treatment effect of CRM on the serum biochemical indices of layers

Parameters	% CRM				
	0	25	50	75	SEM
Albumin (g/dL)	1.69	1.79	1.83	1.73	0.08
Globulin (g/dL)	1.46	0.78	1.01	1.45	0.16
Total protein (g/dL)	3.15	2.57	2.84	3.18	0.24
Alanine aminotransferase (IU/L)	34.92^{b}	41.40^{ab}	43.50^{a}	45.54^{a}	1.19
Aspartate aminotransferase (IU/L)	65.61	63.71	74.16	67.36	3.42
Alkaline phosphatase (IU/L)	37.29^{a}	31.15^{ab}	24.47^{b}	34.65^{a}	2.33
Triglyceride (mg/dL)	152.36^{a}	70.03^{b}	71.96^{b}	66.78^{b}	3.72
Total cholesterol (mg/dL)	55.57	54.10	58.95	68.85	7.35

^{abc}: means within the same row bearing different superscripts differed significantly (P< 0.05)

The supplementation effect of activated charcoal on the serum traits of layers is presented in Table `13. Globulin, total protein, ALT, ALP and total cholesterol were not significantly (p>0.05) affected by activated charcoal supplementation. However, albumin, AST and triglyceride were significantly (p<0.05) affected. AST and triglyceride significantly increased (p<0.05) as a result of charcoal supplementation whereas; it lowered the albumin level from 1.79g/dL to 1.73g/dL.

Table 13: Supplementation effect of activated charcoal on the serum biochemical indices of layers

Parameters	Activated charcoal		
	+	-	SEM
Albumin (g/dL)	1.73^{b}	1.79^{a}	0.05
Globulin (g/dL)	1.37	0.98	0.12
Total protein (g/dL)	3.10	2.77	0.17
Alanine aminotransferase (IU/L)	38.79	40.39	0.84
Aspartate aminotransferase (IU/L)	70.47^{a}	59.95^{b}	3.83
Alkaline phosphatase (IU/L)	33.77	30.01	1.65
Triglyceride (mg/dL)	94.63^{a}	85.93^{b}	2.63
Total cholesterol (mg/dL)	61.51	57.23	5.20

^{ab}: means within the same row bearing different superscripts differed significantly (P< 0.05)

+: Charcoal supplementation

-: Non-charcoal supplementation

Table 14 showed the interaction effect of CRM and activated charcoal supplementation on the serum biochemical indices of layers. The albumin and globulin of the birds in both the activated charcoal (AC) supplemented and non-supplemented group were affected (p<0.05) as a result of dietary treatments whereas interaction effect only affected (p<0.05) the 50% and 75% CRM group as a result of charcoal supplementation. Similarity (p>0.05) was observed in the values for total protein, aspartate amino transaminase and total

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

cholesterol among various treatments within the AC supplemented and non-supplemented groups. Similarly, there was no statistical difference ($p>0.05$) between the AC supplemented group against the non-supplemented group for the various CRM levels.

An increase was recorded in the value for alanine amino transaminase as a result of feeding CRM in both supplemented and non-supplemented group whereas, replacement of CRM for maize decreased ($p<0.05$) the total triglyceride of birds in both supplemented and non-supplemented group. Birds fed 50% CRM recorded the lowest value for the liver enzyme alkaline phosphates (ALP) either with AC supplementation or no supplementation. Nevertheless, the value for ALP recorded at feeding 25% CRM is greater ($p<0.05$) with charcoal supplementation than that recorded with no charcoal supplementation.

Table 14: Interaction effect of CRM and activated charcoal supplementation on the serum biochemical indices of layers

Parameters	Charcoal supplementation	% CRM				SEM
		0	25	50	75	
Albumin (g/dL)	+	1.71^{b}	1.81^{b}	2.05^{ax}	2.12^{ax}	0.04
	-	1.66^{ab}	1.77^{ab}	1.62^{by}	1.34^{cy}	0.11
Globulin (g/dL)	+	1.46^{b}	0.83^{c}	0.91^{c}	1.52^{ax}	0.07
	-	1.48^{a}	0.73^{c}	1.10^{b}	1.38^{aby}	0.03
Total protein (g/dL)	+	3.17	2.64	2.96	3.64	0.32
	-	3.14	2.50	2.72	2.72	0.25
Alanine aminotransferase (IU/L)	+	34.98^{b}	43.13^{a}	44.21^{a}	45.24^{a}	1.44
	-	34.86^{b}	39.67^{ab}	42.79^{a}	45.85^{a}	1.45
Aspartate aminotransferase (IU/L)	+	66.45	69.55	82.18	63.71	1.59
	-	64.78	57.87	66.13	51.02	1.30
Alkaline phosphatase (IU/L)	+	37.44^{a}	38.52^{ax}	24.67^{b}	34.46^{ab}	1.87
	-	37.14^{a}	23.78^{by}	24.28^{b}	34.84^{a}	1.77
Triglyceride (mg/dL)	+	156.94^{a}	79.81^{bx}	76.15^{b}	65.65^{b}	1.12
	-	147.77^{a}	60.26^{by}	67.79^{b}	67.91^{b}	0.92
Total cholesterol (mg/dL)	+	55.51	57.07	63.19	70.27	1.66
	-	55.64	51.13	54.72	67.44	1.81

^{abc}: means within the same row bearing different superscripts differed significantly ($P< 0.05$)

^{xy}: means within the same column bearing different superscripts differed significantly ($P< 0.05$)

4. DISCUSSION

The competition for maize being because of the uses as food, feed and feedstock for alternative fuel caused price hike. This had called for the search for alternatives as feed resources. Cassava root is rich in calories. It had been reported to replace maize in livestock feeds [10]. [11], [12] but for the hydrogen cyanide [13] which necessitates

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

processing such as drying, soaking, grating, grounding, fermentation, dehydration, among other treatments [14]. Cassava root meal is low in protein but high in energy and is considered an energy source [15], and processing employed had been proved to influence the proximate composition [12] and [16].

The average daily feed intake of a bird is the expression to the total feed consumed for egg production and metabolic activities. With exclusion of the 75% CRM diet (which recorded a decrease), daily feed intake remained the same as the level of cassava root meal increased in the experimental diets. The findings on feed intake, final live weight and weight change which decreased at 75% CRM level was a likelihood of poor utilization of CRM due to probable residual level of hydro-cyanide in the diet. Cyanide has been implicated in protein utilization in animal [17]. It was also reported that cyanide causes reduction in growth rate by inhibiting intra-thyroidal uptake of iodine, causing increase in secretion of thyroid stimulating hormone (TSH) and thereby causing a reduction in thyroxin level which is necessary for growth [18]. This was partially similar to previous findings where a decrease in daily feed intake as the inclusion level of cassava increased in the experimental diet of the layers [19], [20] and [21]. The result of this experiment agreed with the report of Oladunjoye et al. [22] who observed a similarity in feed intake of birds fed cassava peel meal and maize based diet up to a substitution level of 70%.

The similarity observed in hen day production between layers on diets 1 and 2 is an indication that the inclusion of CRM in layer diets up to 25% adequately maintained body weight, which helped in sustaining efficiency of egg production. Aderemi et al. [23] showed that feeding egg type chicken with supplemented cassava root seviate had no adverse effect on hen day production. However, the results showed that when the CRM replacement increased beyond 25%, the hen day production decreased, this perhaps could be attributed to reduced feed intake which negatively affected egg production of layers [24]. Li et al. [25] reported a significant correlation between daily feed intake, egg production and egg weight; it was reported that a reduction in feed intake decreased egg weight. The lower feed intake observed in 75% CRM group could be responsible for the lower egg weight recorded in birds fed diet 4.

The reduction observed in the unit cost of feed as the level of cassava root meal increased in the diet can be attributed to the lower price of cassava root meal compared to that of maize. The lower value observed for feed cost is in agreement with the report of Obikaonu and Udedibie [26] that inclusion of cassava meal in pigs and poultry resulted in significant economic benefits.

There was no mortality among the treatment birds throughout the duration of the experiment. The zero mortality suggests that the various replacement levels of CRM for maize were not deleterious to the health of the laying hens.

The use of activated charcoal supplementation on the layers fed cassava root meal based diet did not affect egg weight. Prolonged ingestion of activated charcoal substantially did not increase feed intake. This is contrast to the report of Olayeni [27] who fed activated charcoal to grower pigs and recorded an increase in their feed intake. Banner et al. [28]

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

observed that lambs on a basal diet of alfalfa pellets supplement with a charcoal–barley mix ate more Sagebrush than lambs supplemented only with barley. Kutlu et al. [29] had also reported a significant increase in feed intake of birds fed diet with activated charcoal supplementation. In this study, birds on activated charcoal supplementation performed better in terms of hen day production, final live weight and weight change. This can be attributed to the ability of activated charcoal to capture cyanide present in CRM which might have hindered the efficient absorption and utilization of nutrient for growth. This has helped to adequately maintain good body weight, which helps in sustaining efficiency of egg production.

The interaction effect of cassava root meal and activated charcoal supplementation was also significant on the average daily feed intake (ADFI), hen day production (HDP) and feed conversion ratio (FCR). The reduction in feed intake of birds fed CRM with or without AC beyond 50% might be associated with increased presence of anti-nutritional factors which according to Tewe [30] naturally reduced feed intake. The lower feed intake might be responsible for the subsequent depressed egg production and perhaps the probable imbalance in amino acid content and protein profile of CRM based diets.

The similarity observed in the shell thickness is validated with earlier report by Enriquez and Ross [31] who reported that there was no negative effect on egg shell thickness due to the addition of CRM at the levels of 10, 25 and 50%. The non-significance of shell thickness implied that all the dietary treatments were adequate in calcium which was similar to a finding that cassava based diet did not interfere with calcium metabolism in the laying hen [32]. Shell thickness is a function of the calcium and phosphorus levels in layer ratio.

Similarity was also observed in the yolk colour but it reduced linearly as the level of CRM replacement increased. The colour of egg yolk largely depends on the pigments including carotenes and xantophylls from diets as laying hens cannot synthesize the pigments. The xantophylls in corn is a great contributor of yolk pigmentation [33]. The numerical decreases in yolk colour can be attributed to increasing level of CRM being fed largely at the expense of corn which relatively reduces the xantophyll concentration. Aderemi et al. [34] observed that the inclusion of whole cassava meal did not affect egg shell thickness and yolk weight, but yolk colour was decreased as the whole cassava meal inclusion increased beyond 12.5%. Yolk weight and index were not affected by the dietary treatment and are within acceptable values [35], [36]. The yolk index is a measure of the standing up quality of the yolk.

Aina and Fanimo [37] reported that shell thickness, Haugh unit and shell weight were not affected by the dietary supplementation of 52.3% cassava. Saparattananan et al. [38] indicated that feeding cassava or corn basal diets had similar egg shell thickness and Haugh unit. This corroborates the observed similarity in Haugh unit across all treatments. The Haugh unit values recorded for the four treatments groups were within the range of freshly-laid eggs [34]. Haugh units of 72 and above are indications of freshness in eggs: an index of ability of albumen to remain viscous. Egg shape index is defined as the ratio

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

of width to length of the egg, and it is an important criterion in determining egg quality. Alkan et al. [39] established a significant negative correlation between the egg shape index and shell thickness.

Activated charcoal supplementation had no significant effect on all internal egg quality characteristics measured. This agreed with the findings of Kutlu et al. [29]. The similarity observed might be related to the fact that the major components of charcoal are calcium, potassium and magnesium [29]. Hence it possesses no other nutritional quality than to improve the shell thickness. Kutlu et al. [29] stated that the major components of charcoal are calcium, potassium and magnesium and they have no effect on the internal egg quality characteristics. This corroborates the result obtained in this study as no difference was observed statistically among various CRM levels with or without activated charcoal. Previous authors [22], [34], and [40] also reported no significant differences in the egg quality traits of layers fed various cassava products up to 50% level.

Similarities in the values of packed cell volume (PCV) among the treated groups suggested no deleterious effect on their health status as they all fell within the range of normal healthy growing chickens [41]. Packed cell volume is involved in the transport of oxygen and absorbed nutrients. The same trend was observed for red blood cell (RBC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) since they were not significantly different. This result is however contrary to the result of Oyewumi [40] who reported significant differences in the values of PCV and MCV. The haemoglobin (Hb) values showed an increase as a result of replacement of cassava root meal (CRM) for maize. However, values were within the normal range for healthy birds as postulated by Jain [42]. The low value of Hb in treatments 1, 3 and 4 suggest iron deficiency (anemia)as evidenced by the report of Graiter et al. [43] observed a direct relationship between dietary iron, Hb, PCV and serum iron.

Replacement of cassava root meal for maize significantly increased the white blood cell count of the birds. The rise that was observed could be due to anti-nutritional factors possibly residual hydrocyanic acid in these diets. This result disagrees with Oyewumi [40] who reported no significant difference in white blood cell count of layers fed cassava grit meal. The lower WBC of layers fed control diet could be speculatively associated with superior nutrition, though it has not been shown to be directly predicated on the nutritional plane of the individual.

Mean values for MCH are significantly higher in birds fed CRM. The MCH reflects the haemoglobin concentration of red blood cell and may be used to diagnose the type of anemia present in an animal. Variation could be due to the differences in CRM levels of diet and production performance. High platelet concentration observed in 25% CRM group and 50% CRM group suggested that the process of clot formation will be shorter resulting to lower loss of blood in the case of any injury and also helps in wound healing [44].

Utilization of activated charcoal supplementation has not been able to provoke any appreciable influence on PCV, Hb, RBC, WBC and platelet either below or above

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

literature values as cited by Jain (1986), though significant increase in the value of WBC and platelets was observed, whereas MCH value was depressed. The decrease in the value of WBC as a result of charcoal supplementation is probably as a result of its capacity of neutralizing or reducing the cyanide present in CRM and also promotes an environment in the gut where influence or effects of anti-nutritional factors or toxins were minimized [45]. However, almost all haematological parameters assayed were not significantly influenced by the diet and were all in the normal range reported by Mitruka and Rawnsley [41].

Interaction of CRM and activated charcoal was able to reduce the values of PCV as the level of CRM increased beyond 25% in the supplemented group but did not affect those birds within the non-supplemented group and this observation is significantly better for those birds fed diets supplemented with activated charcoal. The observation could be related to the effect of activated charcoal to counteract the effect of HCN in cassava based diets. Olayeni [27] reported a significant decrease in the values of PCV when different levels of CRM with or without activated charcoal supplementation were fed to finishing pigs. According to Isaac et al. [47], PCV is involved in the transport of oxygen and absorbed nutrients. Hence, increased PCV showed a better transportation and thus resulted in an increased primary and secondary polycythemia. All values reported for PCV were however within the literature range cited by Mitruka and Rawnsley [41].

White blood cell concentration significantly increased with or without supplementation as CRM inclusion levels increased in the diet of the layers. However, activated charcoal supplementation caused a rise in the value of 25% CRM level. The increament experienced was due to the cyanide effect as the animals are probably exposed to high risk of toxicity. However, the numerical decrease (at all CRM level) in the supplemented group suggested that charcoal was able to reduce the effect of HCN and the birds were able to generate antibodies in the process of phagocytosis and have high degree of resistance to HCN toxicity.

The serum biochemical indices of the experimental birds indicated the roles of cassava root meal and its crude fibre content in layer's diets. Madubuke and Ekenyem [48], Ikeagwu,[49] and Isikuwenu et al. [50], observed that the consumption of different types of feed by any species of animal had some measurable effects on the blood (plasma) and the constituents of the animal blood. Also, Iheukwumere et al. [51] also indicated that any feed consumed by an animal could be used to determine the metabolic state of the animal as well as the quality of the feed.

The similarities recorded in Albumin, globulin and total protein values showed that the birds fed the experimental diets had good plane of nutrition. The result agrees with the result obtained for broilers fed cassava enhanced with dried cage layer waste and fermented with rumen filtrate diet [52]. Higher albumin concentration in the serum of any animal indicates high plane of nutrition ([53]. Total serum protein had been reported as an indication of the protein retained in the animal body [51], [54], [55]. However, these values were lower than the ranged values documented by Mitruka and Rawnsley [41].

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

This might be attributed to poor utilization of the protein fed to the experimental birds.

Oladunjoye et al. [55] observed that feeding cassava peel based diet lowered the cholesterol level as a result of high fibre content in the diet. However, in the current study, similarity was observed in the serum cholesterol levels. Triglycerides are synthesized in the intestinal mucosa and in the liver from the digestion of dietary components and the absorption of fatty acids. Serum triglyceride levels of poultry are influenced by sex, diet, and hormonal factors [56]. In the present study, significant reduction was observed in the triglyceride levels of all birds fed CRM in an apparent trend. This is not in agreement with the report of Tewe and Bokanga [57] who reported a higher fat deposition in birds that received cassava containing diets.

Although, a measurement of enzyme activities in serum is very important diagnostic tool of diseases, the wide range of activity make it difficult to interpret [58]. Aspartate amino transaminase is a very sensitive, non-specific biomarker of liver disease in birds. Conversely, ALT is of poor diagnostic value in birds due to its existence in many tissues [58]. In this study, activated charcoal supplementation had a positive influence on the marker enzymes ALT and ALP while it lowered the triglyceride.

Effect of CRM and AC on the albumin and globulin of the birds were inconsistent, although the effect of charcoal supplementation at 50% and 75% was more pronounced. This showed that charcoal supplementation was able to counteract the effect of HCN in cassava based diets. The alanine aminotransaminase (ALT) increased while the alkaline phosphatase decreased up to 50% CRM inclusion levels in both the supplemented and non-supplemented group. The increase in the values of ALT is an indication that protein synthesis and energy status quo of the body performance of the birds were sustained. It also indicated the normal functioning of the liver despite the ingestion of cassava based diets was attained. All values reported were within the reported range [41].

The lower triglyceride value that was observed in the blood of birds fed cassava root meal with or without activated charcoal supplementation could be due to the fibrous nature of CRM and its inclusion level [59]. This effect had been attributed to the use of lipid-based moiety for energy generation rather than body fat formation [60]. However at 25% CRM level, the superiority of the supplemented group over the non-supplemented group might be related to the effect of activated charcoal to attenuate cyanide toxin which might have improved the nutrient availability as a result of less anti-nutritional factor.

5. CONCLUSION

In conclusion, replacement of maize with CRM with or without activated charcoal supplementation beyond 50% level reduced the feed intake and hen day production of layers while replacement of 25% CRM for maize gave a better performance relative to maize based diet and therefore optimum for increased production. Most egg quality traits evaluated were not affected by feeding CRM with or without activated charcoal supplementation and were within acceptable ranges while the inclusion and feeding of CRM based diet affected some haematological and biochemical indices of layers.

However, activated charcoal supplementation improved these effects for better performance. It is recommended that further investigations need to be carried out to compare various supplementation levels of activated charcoal in the diets of layers most especially diets that contain ingredients with anti-nutrients at higher inclusion levels.

References

1. FAO (Food and Agriculture Organization). Food Outlook Global Market Analysis. 2018. http://www.fao.org/docrep/011/ai474e06.htm.
2. E.F. Gueye , and F.U. Jio (2015). The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. Outlook on Agriculture, vol 29, pp 129-136, 2015.
3. R. Amumueller. Certified production of commercial turkeys. World Poultry Magazine Production on Turkeys, vol. 10, no. 18, 2008
4. A.O. Fafiolu, et al. Adebule. Performance and egg quality assessment of laying hens fed malted sorghum sprouts base diets. Proceedings of the 9th Annual Conference of Animal Science Association of Nigeria; Abakaliki, Nigeria: Ebonyi State University; Pp. 33-5. 2004.
5. Donkoh, and V. Attoh-Kotoku. Nutritive value of feedstuffs for poultry in Ghana: chemical composition, apparent metabolizable energy and ileal amino acid digestibility. Livestock Research for Rural Development, vol. 21, no. 32, pp 1-9. 2009.
6. M. Bhuiyan, L.F. Romero, and P. Iji. Maximizing the energy value of cassava products in diets for broiler chickens. In Proceedings of the 23rd Annual Australian Poultry Science Symposium). Sydney, Australia: Poultry Research Foundation, University of Sydney. Pp. 272-275, 2012. Retrieved from http://e-publications.une.edu.au/1959.11/12591
7. T.K. Ojediran et al. Replacement value of cassava vinasse meal for maize on growth performance, haematological parameters and organoleptic properties of Japanese quails (Coturnix japonica). Acta fytotechn et zootechn, vol 22, no. 1, pp 7–12, 2019.
8. T.K. Ojediran and I.A. Emiola. Effect of processing and level of inclusion of processed-fermented Jatropha curcas(L) kernel meals on the performance of starter broiler chicks. Trop. Agric. (Trinidad), vol. 95, no. 1. pp. 55-66, 2018.
9. SAS Institute Inc. SAS/STAT. User’s Guide Version 8 for Windows. Cary NC, USA: SAS Institute Inc. 2000.
10. M. Anaeto and L.C. Adighibe. Cassava Root Meal as Substitute for Maize i Layers Ration. Revista Brasileira de Ciência Avícola, vol. 13, no. 2, pp 153-156, 2011. DOI:10.1590/S1516-635X2011000200010
11. B. Odo, and A. Nnadi. Growth Response of Quails (Coturnix coturnix japonica) to Varying Levels of Cassava (Manihot esculenta) Tuber Meal as a Replacement for Maize (Zea mays). American Journal of Experimental Agriculture, vol. 4, no. 12, pp 1898-1903, 2014. DOI: 10.9734/AJEA/2014/11412
12. Uguru, J. O., Amah, U. J., Umoren, E. P., Unigwe, C. R., Obinna-Echem, P. C., Onainor, E. R., Torhemen, M. and Ucheji, C. C. Carcass traits, nutrient composition and sensory properties of broiler chickens fed diets containing graded levels of fermented cassava (Manihot esculenta Crantz) tuber meal as replacement for maize meal. Nig. J. Anim. Prod., vol. 49, no. 1, pp 268- 283, 2022. https://doi.org/10.51791/njap.v49i1.3426
13. Peroni, N., Kageyyama, P.Y., Begossi, A. Molecular differentiation, diversity, and folk classification of sweet and bitter cassava (Manihot esculenta) in Caicara and Caboclo management system (Brazil). Genetic Resources and Crop Evolution, vol. 54, no. 6, pp 1333-1349, 2007.

https://doi.org/10.1007/s10722-006-9116-2

14. Chandrasekara, A. and Kumar, T.J. Roots and Tuber Crops as Functional Foods: A Review on Phytochemical Constituents and Their Potential Health Benefits. International Journal of Food Science, Article ID 3631647, pp 1-15, 2016. https://doi.org/10.1155/2016/3631647
15. Regnier, C. Valorisation des ressources alimentaires tropicales (feuilles et tubercules) chez le porc. These (INRA Antilles-Guyane, Unite de Recherches Zootechniques - URZ, 2011.
16. Ojediran, T. K., Ganiyu, B., Muhammed, A. and Emiola, I. A. (2022). Egg production, economic indices, and external and internal egg quality parameters of laying Japanese quails (Coturnix japonica) fed palm (Elaeis guineensis) kernel cake. Animal Sciences and Genetics, vol. 18. no. 2, pp 1-11, 2022.
17. Oluokun, J.A. Performance of Growing Rabbits fed a Low Protein Diet supplemented with Urea or Roasted Soyabean meal. Journal Animal Production Research, vol. 17, pp 89-99, 2011.
18. Tewe, O.O. Indices of Cassava Safety for Livestock Feeding: Being paper in International ACTA Horticulture Workshop on Cassava Safety. IITA Ibadan Pp 241-248, 1994.
19. Salami, R.I. and Odunsi, A.A. Evaluation of processed cassava peel meal as substitutes for maize in the diets of layers. International Journal of Poultry Science, vol. 2, no. 2, pp 112-116, 2003.
20. Matanmi, O., Akinfala, E.O., Aderibigbe, A.O. and Akinsuyi, M.A.. Evaluation of the Nutritive Value of Whole Cassava plant Meal (WCPM) as a Replacement for Maize in Cockrel Chicks Diets in the Humid Tropics. Ife Journal of Agriculture, vol. 21, pp 167-175, 2005.
21. Banjoko, O.S., Agunbiade, J.A., Awojobi, H.A., Adeyemi, O.A. and Adebayo, M.O. Nutritional evaluation of layers diet based on cassava products and soya beans as influenced by protein supplementation and processing. Proceedings of the 33rd Annual conference of the Nigerian Society for Animal Production (NSAP). March 16-20. Olabisi Onabanjo University, Nigeria. pp 373-376, 2008.
22. Oladunjoye, I. O., Ologhobo, A. D. and Olaniyi, C. O. Nutrient composition, energy value and residual antinutritional factors in differently processed breadfruit (Artocarpus altilis) meal. Afr. J. Biotechnol. 9 (27): 4259-4263, 2010.
23. Aderemi, F.A., Alabi, O.M. and Lawal, T.E. Utilization of whole cassava meal by egg laying type chicken. Proceedings of the 11th Annual Conference of Animal Science Association of Nigeria (ASAN). September 18-21, 2006, IART, Ibadan, Nigeria. pp 73-75, 2006.
24. Degen, A.A., Kam, M. and Rosenstrauch, A. (1988) Efficiency of utilizationof energy for egg production in feed-restricted single comb White Leghorn hens.Journal Agricultural Science, vol. 111, pp 303-308, 1988.
25. Li, F., Xu LM, Shan AS, Hu JW, Zhang YY, Li YH. Effect of daily feed intake in laying period on laying performance, egg quality and egg composition of genetically fat and lean lines of chickens. Br Poult Sci. Vol. 52, no. 2, pp163-8. 2011. doi: 10.1080/00071668.2011.559455. PMID: 21491238.
26. Obikaonu, H. O. and Udedibie, A. (2008). Comparative evaluation of sun-dried and ensiled cassava peel meals as substitute for maize in broiler starter diets. International Journal of Agriculture and Rural Development, vol. 7, no. 2, pp 52-55, 2008. DOI: 10.4314/ijard.v7i2.2641
27. Olayeni, T.B. Nutritive value of cassava root meal supplemented with or without activated charcoal in weaning – growing pig diets. Ph.D Thesis, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Pp 245-256, 2016.
28. Banner, R.E., Rogosic, J., Burritt, E.A. and Provenza, F.O. Supplemental barley and activated charcoal increase intake of Sagebrush by lambs. Journal of Range Management, vol. 53, pp 415-420. 2000.
29. Kutlu, H.R., Unsal I. and Gorgulu M. Effects of providing directory wood (oak) charcoal to broiler chicks

and laying hens. Animal Feed Science and Technology, Elsevier. Vol. 90, pp 213-226, 2000.

30. Tewe, O.O. Sustainability and development paradigms from Nigeria's livestock industry. Inaugral lecture, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria, 1997.
31. Enriquez, F.Q. and Ross, E. Cassava root meal in grower and layer diets. Poult. Sci. Vol. 51, pp 228–232, 1972
32. Lawal, O.O. (1992). Cassava utilization in laying hens. B. Agric Thesis, University of Agriculture, Abeokuta, Nigeria. 1992.
33. Lumpkins, B., Batal, A. and Gale, N. Use of distillers dried grains plus solubles inlaying hen diets. The Journal of Applied Poultry Research, vol. 14, pp 25-31, 2005
34. Essien, A.I. Egg quality traits and their interrelationships as affected by storage method and duration of storage in the humid wet climate. Beitr. Trop. Land with Sch Vet. Med. 28 H3: pp 345-353, 1990.
35. Essien, A.I. Eboh, L. and Emurashe, S.E. Models for the prediction of quality parameters of table eggs stored under different conditions. Nigeria Journal of Animal Production, vol. 23, pp 179-184, 1996.
36. Aina, A.B.J. and Fanimo, A.O. Substitution of maize with cassava and sweet potato meal as the energy sources in the ration of layers. Pertanica Journal of Tropical Agricultural Science, vol. 20, pp 163-167, 1997.
37. Saparattananan, W., Kanto, U., Juttuornpong, S, and Engkkagul, A. Utilization of cassava meal and cassava leaf in layer diets on egg quality and protein content in egg. Proceedings of 43th Kasetsart University Annual Conference; Bangkok. Thailand. Pp.43-52, 2005.
38. Alkan, S., Karabağ, K., Galiç, A., Karsli, T. and Balcioğlu, M. S. Effects of selletion for body weight and egg production on egg quality traits in Japanese quails (Coturnix coturnix japonica) of different lines and relationships between these traits. Kafkas Univ. Vet. Fak. Derg. Vol. 16, no. 2,pp 239-244, 2010
39. Aderemi, F.A., Adenowo, T. K. and Oguntunji, A. O. Effect of Whole Cassava Meal on Performance and Egg Quality Characteristics of Layers. Journal of Agricultural Science, vol. 4, no. 2, pp 195-200, 2012. DOI: 10.5539/jas.v4n2p195
40. Oyewumi, S.O. Performance, egg quality and haematological characteristics of layers fed cassava grit meal. Transnational Journal of Science and Technology, vol. 3, no. 8, pp 50-57, 2013.
41. Mitruka,B.T. and Rawnsley H. Clinical, biochemicaland haematological value in normal experimental animals. Mason publishing, N.Y., U.S.A., pp. 171–174, 1977.
42. Jain, N.C. Scanning electron micrograph of blood cells. In: Schalm's Veterinary haematology. 4th ed. P Lea & Febiger. Philadelphia: pp 4 63-70, 1986.
43. Graiter, P.L., Goldsby, J.B. and Nichaman, M. Haematologlobins and haematocrits: are they equally sensitive in detecting anemia. American Journal of Clinical Nutrition, vol. 34, pp 61-64, 1981.
44. Etim, N. Haematological parameters and factors affecting their values. Journal of Agricultural Science, vol. 2, no. 1, pp 37-47, 2014
45. Owosibo, A.O., Odetola, O.M., Odunsi, O.O.,Adejinmi, O.O. and Lawrence-Azua, O.O. Growth, haematological and serumbiochemistry of broilers fed probiotics baseddiets. African journal of agriculture, vol. 8, no. 41, pp 5076-5081, 2013.
46. Isaac L.J., Abah G., Akpan B., Ekaette I.U. *Haematological properties of different breeds and sexes of rabbits.* Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria, pp. 24–27, 2013.
47. Soetan, K. O., Akinrinde, A. S., and Ajibade, T. O. Preliminary studies on the

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 08 | 2023
DOI 10.17605/OSF.IO/73SF8

haematologicalparameters of cockerels fed raw and processed guinea corn (Sorghum bicolor). Proceedings of38th Annual Conference of Nigerian Society for Animal Production, pp 49-52, 2013.

48. Madubuike, F.N. and B.U.Ekenyem.Non Ruminant livestock production in the tropics, gust- chuks graphic center, Owerri Nig. Pp 156, 2001.
49. Ikeagwu, C.O. Effect of corn cob as maize supplement in finisher broiler diets. M.Sc. Thesis, Imo State University Owerri, Nigeria. 2000
50. Isikwenu, J.O., et al. Effect of dietary fibre (maize cob) levels on growth performance of broiler birds. In: Proceedings Conference Nigeria Society of Animal Production. 19-23 March Umudike, pp 160-163, 2000.
51. Iheukwumere, F.C. et al. Performance, nutrient utilization and organs characteristics of finisher broiler fed cassava leaf meal Manihot esculenta crastz) Pakistan Journal of Nutrition. Vol. 7, no. 1, pp 13-16, 2008.
52. Adeyemi, O.A., Eruvbetine, D., Oguntona, T., Dipeolu, M.and Agunbiade, J.A. Feeding broiler chicken with diets containing whole cassava root meal fermented with rumen filtrate. Archeology and Zootechnology, vol. 57, pp 247-258, 2008.
53. Esonu, B.O., et al. Performance and blood chemistry of weaner pigs fed raw mucuna (Velvet bean) meal. Tropical Animal Production Investment, vol. 4, pp 49-54, 2001.
54. Akinola, A.O. and S.S. Abiola. Blood chemistry and carcass yield of cockerels fed melon husk diets. Tropical Journal of Animal Science, vol. 2, pp 39-44, 1991.
55. I.O. Oladunjoye, O.O. Ojebiyi, and O.A. Amao. Effect of feeding processed cassava (Manihot esculenta Crantz) peel meal based diet on the performance characteristics, egg quality and blood profile of laying chicken. Agricultura Tropica et Subtropica, vol. 43, no. 2, pp 119-126, 2010.
56. M. Hochleithner. Biochemistries. In: Ritchie BW, Harrison GJ, Harrison LR (eds) Avian medicine: Principles and application. Wingers Publishing, Lake Worth, pp 223–245, 1994.
57. O.O. Tewe, and M. Bokanga. Cost-effective cassava plant-based rations for poultry and pigs. Proceedings of the ISTRC, Africa Branch (IITA). 11-10 November 2001, Ibadan, Nigeria, 2001.
58. K.E.Harr. Clinical chemistry of companion avian species: a review. Veterinary Clinical Pathology (Vet Clin Pathol), vol. 31, no. 3, pp 140-151, 2002.
59. L. Brown, et al. Cholesterol-lowering effects of dietary fiber: a meta-analysis. Am J Clin Nutr., vol. 69, pp 30–42., 1999.
60. E.O. Akinfala, O., Matanmi, and A.A.Fatufe. (2007). Effect of residual cyanogenic glucosides in cassava based diets on serum metabolites of cockerels chicks. Proceedings of the 32ndAnnual conference of the Nigerian Society for Animal Production (NSAP), March 18 21. University of Calabar, Nigeria, pp. 105–107, 2007.