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PRODUCTIVE PERFORMANCE AND HEMATOLOGICAL INDICES OF BROILER CHICKS FED BIODEGRADED CASSAVA ROOT

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ABSTRACT: To evaluate the performance and hematological indices of broiler chickens fed biodegraded cassava root meal an experiment was conducted in the Poultry Unit of the Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi, Benue State. A total of one hundred and fifty five week-old (Ross 308) finishing broilers was used for the experiment. The birds were assigned randomly into three treatments and each treatment was replicated five times with ten birds per replicate. Cassava root was peeled and chopped into small pieces of about 90-100g and mixed with rumen filtrate (fluid). This was then biodegraded for 24 hours and 48 hours. The biodegraded cassava root meal (BCRM) was used to formulate broiler's diets at a 10% inclusion level to supplement for maize. The diets formulated were T1, T2 and T3 at 0%, 10% (24 hours biodegraded) and 10% (48 hours biodegraded) inclusion, respectively. The birds in each replicate were housed in separate cages in a completely randomized design (CRD). All routine management practices, including recommended vaccinations were strictly observed, feed and water were served *ad libitum* throughout the period of the study which lasted for 28 days. Performance indices such as body weight, body weight gain, feed intake and feed conversion ratio were measured. Hematological parameters were also taken; pack cell volume (PCV), red blood cell (RBC), hemoglobin (HB), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and white blood cell (WBC) differential. Results revealed that there was no significant ($P>0.05$) differences in all the performance indices measured except in feed intake. Feed intake increased with prolonged period of biodegradation across treatments. There was significant ($P<0.05$) differences in the lymphocytes, heterophils and eosinophils across treatments. The study concluded that the dietary supplementation of 10% biodegradable cassava root meal at 24 and 48 hours did not adversely affect the performance/ health status of broiler chicken, however, for profit maximization, 48 hour biodegradation of cassava is recommended.

Keywords: Biodegradation, Broiler Chicken, Cassava Root, Maize, Productive performance.

INTRODUCTION

Feeding farm animal especially the non- ruminant has been a serious problem to livestock farmers. Feed takes the much of production cost; about 70-75% of total cost of production (Abang et al., 2013). This is largely due to the hike in conventional feed stuffs like maize and cereal grains on the whole as a result of stiff competition between man, livestock and, industry (Anoh and Akpet 2013; Abang et al., 2023). The need to look inward in search of feed resources that are available all round, less competed for by animal farmers is being sort for. Cassava is grown in Nigeria all year round; it is always available (Enesi et al., 2022; Obayelu et al., 2022). The yield is impressive; Nigeria is among the countries with highest tons/ metrics of cassava (Enesi et al., 2022; Abang et al., 2023).

Early studies indicated statistically significant growth depression in chicks with increasing amounts of cassava, which led to a recommendation that no more than 10% cassava should be included in chick rations. However, there are several reports on the use of cassava meal in poultry diets in the past few decades with encouraging results (Akinfala et al., 2002; Aderemi et al., 2010): birds fed ensiled cassava peel meal diet had similar feed intake and body weight gain as the control group whereas the FCR of birds on sun-dried cassava peel meal was poor (Obikaonu and Udedibie, 2006). Aderemi et al. (2020) asserted that whole cassava root meal could replace 25% of corn in laying hen diets without negative effect on the performance. In a study by Oyebimpe et al. (2006), 200 g/kg cassava peel meal could replace maize in broiler diets with no reduction in growth performance. However, its' limitation is the presence of anti-nutritional factors especially; hydrogen cyanide, saponins, tannins, oxalate, phytates; processing methods like: fermentation/ soaking, boiling, toasting, sun drying auto cleaving etc. is able to reduce these anti nutrients to a tolerable level (Abang et al., 2018; Odunlade et al., 2020; Gyang et al., 2021). The presence of these anti nutritional factors informed the assay for hematology. Anti-nutritional factors chelates divalent ions (Ca^{2+}, Mg^{2+}, Fe^{2+}, and Zn^{2+}) also react with the charged groups of protein and polysaccharides thereby forming indigestible complexes while the toxic substances interfere with bio availability and utilization. Blood contains several metabolites which provide useful information of nutritional status and clinical investigation of an individual; WHO recommends blood parameters for medical and nutritional assessments (Abang et al., 2017).

The aim of this study is to evaluate the productive performance and hematological indices of broiler chicks fed biodegraded cassava root.

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MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Experimental Poultry unit of the Teaching and Research Farm of Joseph Sarwuan Tarka University Makurdi, Benue State of Nigeria. Makurdi is the Capital of Benue State located on central Nigeria along the Benue River. It lies within the geographical coordinates of Latitude 7^{0}44` north, and Longitude 8$^0$20` east. The area is warm with a minimum temperature range of 22.71±3.43°C and a maximum range of 39.98±2.43°C (TAC, 2011). It is characterized by two seasons, the dry and wet. The wet season also known as rainy season starts from April to October with minimum break at July under normal basis. The total annual rainfall is estimated from 1371-1321 mm, characterized by warm climate with average temperature and relative humidity (TAC, 2004).

Experimental material

The experimental test ingredient was biodegraded cassava root meal. The cassava root was obtained from local markets around Markurdi metropolis. The rumen content was obtained from the abattoir in North Bank Makurdi in the early hours of the day. It was collected from three different cows and mixed thoroughly to obtain a homogeneous mixture.

Processing of test ingredient

The cassava roots were hand-peeled using kitchen knife and chopped into smaller pieces of about 90 - 100 grams. Rumen content was mixed with water at a ratio of 1:1 (1 kg of rumen content to 1 liter of water) to obtain a filtrate. The filtrate was mixed with the chopped cassava root and packed into air tight bags. The bags were kept under shade with their open ends tied tightly and labeled accordingly. After 24 hours of fermentation, the bags labeled "24" were poured on a concrete floor for sun-drying while this was repeated for the remaining bags at the end of the 48th hour. The biodegraded cassava was dried to a moisture level below 10 percent and was crushed into meal. A fraction was taken for proximate.

Preparation of diets

A total of three experimental diets were formulated. Milled biodegraded cassava root meal was included in the diets at 0%, 10% (24 hours biodegraded) and 10% (48 hours biodegraded) to give diets T1 (control) T2 and T3 respectively to replace maize.

Management of birds

A total of 150 (Ross-308) five week old finishing broiler chickens were obtained from the hatchery's area distributors in Makurdi, Benue State. The birds were assigned randomly into three treatments and each treatment was replicated five times with ten birds per replicate. The birds in each replicate were housed separately. The experimental design used was completely randomized design (CRD). All routine management practices, including recommended vaccinations and medications, were strictly observed throughout the period of the study. A known quantity of feed was served daily, left over was measured to ascertain feed intake. Quantity of feed was increased weekly to enable birds feed ad libitum. The weights of the birds were taken weekly using electronic scale. Feeders and drinkers were washed and disinfected when appropriate. Litter materials were changed when due and replaced accordingly. Other drugs that were given to the birds include: Panteryl (antibiotics) as prophylaxis and vitaminolyte (vitamins). Feed and water were served ad libitum throughout the experimental period. The experiment lasted for 4 weeks (5th-8th).

Table 1 - Composition of broiler finisher diet using biodegraded cassava root meal

Ingredients	Control	24 Hours	48 Hours
Maize	63.75	57.25	7.14
BCRM	-	5.73	6.00
FFSB	17. 69	18.17	4.86
Blood meal	6.63	6.81	5.71
Bone meal	4.42	4.54	6.29
Rice bran	1.00	1.00	1.00
Fish meal	5.00	5.00	5.00
Palm oil	1.00	1.00	1.00
Salt	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Total	100.00	100.00	100.0
Analyzed nutrient			
ME (Kcal/kg)	3290.48	3217.33	3203.15
Crude protein%	20.54	20.13	20.14
Crude fiber%	3.47	3.47	3.48
Ether extract%	7.34	7.10	7.10
Calcium%	1.04	1.05	1.05
Phosphorus%	0.71	0.78	0.69
Lysine%	1.11	1.50	1.10
Methionine%	0.46	2.64	0.21
Ash%	3.36	2.64	1.91

Premix supplied per kilogram Vit A: 10000000IU; Vit D3: 2000001U; Vit K3: 2000mg; Vit B1: 3000mg; Vit B2: 5000mg; Niacin: 45000mg; Calcium panthothenate: 10000mg; Vit B6: 4000mg., Vit B12: 20mg; Choline chloride: 300000; Folic acid: 1000mg; Biotin: 50mg; Manganese: 300000mg; Iron: 120000mg; Zinc: 80000mg; Copper: 8500mg; Iodine: 1500mg; Cobalt: 300mg; Selenium: 120mg; Antioxidant: 120000mg. BCRM=Biodegraded cassava root meal; FFSB=Full fat Soybean; ME=Metabolizable energy; T1=Control diet; T2=24 hours BCRM; T3=48 hours BCRM.

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Data collection

Performance indices

Productive performance indices were measured according to the methods of Abang et al. (2023).

Blood samples and preparation for hematological indices

This was carried out according to the methods of Abang et al. (2017).

Ethical approval

All authors hereby declared that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

Statistical analysis

Data collected were subjected to one-way Analysis of Variance (ANOVA) using Special Package for Social Science (SPSS) version 22.0 statistical software. Significant means were also separated using Duncan's Multiple Range Test of the same package at 5% probability level.

RESULTS

Performance

The result of the growth performance of broiler finisher birds fed biodegraded cassava root meal-based diets is shown in Table 3. There were no significant (P>0.05) differences in all the growth parameters measured across treatment groups. This revealed that birds served BCRM competed favourably with birds fed sole maize grains. The impressive performance showed that the use of rumen fluid in biodegradation of cassava root meal results in effective utilization of the diets. This confirms the position of Adeyemi et al. (2008), whose reports showed that cassava root meal can completely replace maize in broiler diets without adverse effects on utilization, but, contradicts the results of Nsa et al. (2016), who observed a depressive growth in broilers fed cassava. The non-significant (P>0.05) difference observed in feed intake reveals the palatability of feed; this is a pointer to the fact that the anti-nutritional factors present in cassava were adequately handled by the microbes from rumen fluid. Akinmutimi (2004) and George and Sese (2012) had similar results of high feed intake when birds were served biodegradable cassava root meal. However, Aderemi (2010) and Ogbamgba and George (2015) had a contrary report; feed intake was observed to have decreased with increased levels of supplementation across treatments, probably because of the higher fiber and Hydrogen cyanide (HCN) contents of diets. More so, the dustiness of the feed associated with cassava peel/root meal and low palatability, could also be the reason for the reduction in feed consumption of birds fed diets with high levels of cassava meal.

The feed cost savings per gram meat (₦) was recorded to be (0.01) at 48 hours of biodegradation. This infers that, the inclusion of T3 in finisher diet resulted in saving 0.01 kobo for every gram of meat produced.

The result of profit ranged from ₦465.90 - ₦1071.40, RNI ranged from 0.39-0.91, with the highest profit margin and RNI recorded with birds served 48 hours BDCR. Birds serve 24 hours BDCR recorded the least values probably because of the highest amount of feed consumed as well as time of biodegradation; perhaps not sufficient enough to reduce HCN present in cassava root which subsequently affected their body weight. The highest BCR was recorded with birds served 48 hours BDCR, followed by birds fed control diet. It is worthy of note that a BCR greater than one signifies viability of an enterprise. However, all treatments recorded BCR greater than one implying that, no losses will be incurred when these treatments are used in finisher broiler production.

Table 2 - Productive performance of finisher broiler chickens fed diet containing biodegraded Cassava root meal.

Parameters	Control	24 Hours	48 Hours	SEM	P-value
Initial body weight (g)	726.00	660.00	664.00	15.57	0.153
Final body weight (g)	3000.89	2877 .05	2910.11	41.92	0.122
Total body weight gain (g)	2274.00	2217.05	2246.11	38.17	0.157
Average daily weight gain (g)	32.49	31.67	32.08	1.36	0.157
Total feed intake (g)	4333[a]	41 62[a]	3831[b]	10.73	0.112
Average daily feed intake (g)	61.90[a]	59.46[b]	54.73[b]	3.60	0.112
Feed conversion ratio	1.91	1.88	1.7 1	0.24	0.162
Cost of feed/weight gain (#/g)	0.26	0.26	0.25	-	-
Feed cost savings/g meat (#/g)	-	0	0.01	-	-
Profit: TR-TC	817.84	465.90	107.1.4	-	-
BCR: TR/TC	1.69	1.40	1.91	-	-
RNI: Profit/TC	0.69	0.39	0.91	-	-

ab= means with different superscript within same row are significantly different (p<0.05); SEM= Standard Error of Mean; BCR= Benefit cost ratio; RNI= Return to Naira invested; TR= Total Revenue; ,TC= Total Cost

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Hematology

The result of the hematological parameters of broiler chicken fed biodegraded cassava root meal is presented in Table 4. There was no significant (P>0.05) difference in PCV, RBC, WBC, Hb, MCV, MCH, MCHC and Monocytes across treatments. The value for pack cell volume (PCV) ranged from 31.20-32.00%, RBC (3.14-3.28) while WBC (21.02-21.92), Hb (10.38-10.80) MCH (32.02-32.86) for MCHC (33.26-33.75). These values fell within the normal reference ranges as reported by Bounous and Stedman (2000) and Talebi et al. (2005) indicating that the birds had no traces of anemia. Non-significant (P>0.05) difference in the values of PCV, RBC and WBC was also observed by Adeyemi et al. (2008) when cassava root was fermented with rumen filtrate. However, the results of leucocytes, heterophils and eosinophils were significantly (P<0.05) different across treatment groups. The value of lymphocytes was within the recommended reference value of 31.00-72.00% reported by Scholtz et al. (2009). It was observed that, the levels of heterophils and eosinophils decreased across treatments with birds fed diets containing BCRM having the least values, however, all the values were within the normal reference ranges. Since lymphocytes, heterophils and eosinophils are components of the white blood cell; the values obtained did not give an indication of any disease or stress condition resulting from the dietary treatments. Fafiolu et al. (2014) reported that the birds with higher leucocytes count could perform their phagocytic functions for optimal immunity levels and would cope successfully under stress conditions. Also, Talebi et al. (2005) reported that birds with high leukogram counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases. Lymphocytes offer a more versatile means of defense as they are capable of recognizing different foreign invaders thereby producing cytokines, lymphokines, and ultimately, antibodies with specificity for antigens.

Table 3 - Hematological indices of broiler chicken fed diet containing biodegraded cassava root meal.

Parameters	Control	24 Hours	48 Hours	SEM
PCV %	31.20	32.00	32.00	0.43^{NS}
RBC $\times 10^{12/l}$	3.14	3.22	3.28	0.06 ^{NS}
WBC $\times 10^{12/l}$	7.02	7.50	7.92	0.18 ^{NS}
HB/dl	10.38	10.68	10.80	0.14 ^{NS}
MCV fl	99.36	99.38	99.25	0.18 ^{NS}
MCH pg	32.86	33.22	33.02	0.38 ^{NS}
MCHC g/dl	33.26	33.37	33.75	0.12 ^{NS}
Lymphocytes %	42.20^{c}	44.60^{b}	47.20^{a}	0.68*
Heterophil %	53.60^{a}	51.00^{b}	50.20^{b}	0.70*
Eosinophil %	2.40^{a}	0.40^{b}	1.00^{b}	0.30*
Basophil %	0.00	0.00	0.00	0.00 ^{NS}
Monocyte %	1.40	1.00	1.60	0.34 ^{N}

^{abc} = means with different superscripts within same row are significantly different (P<0.05). NS= non significance, T1= Control diet, T2= Diet containing biodegraded level of cassava root meal at 24 hours of fermentation, T3= Diet containing biodegraded level of cassava root meal at 48 hours of Fermentation, SEM= Standard error of mean. PCV= pack cell volume; RBC= red blood cell; WBC= white blood cell; HB= hemoglobin; MCV= mean corpuscular volume; MCH= mean corpuscular hemoglobin; MCHC= mean corpuscular hemoglobin concentration.

CONCLUSION

The study concluded that the dietary supplementation of 10% biodegradable cassava root meal at 24-hour and 48 hours did not adversely affect the performance/health status of broiler chicken, however, for profit maximization, 48-hour biodegradation of cassava is recommended.

DECLARATIONS

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Authors' contribution

F. B. P. Abang performed conceptualization, writing, original draft preparation, review and editing. K. U. Anoh performed conceptualization and evaluation of manuscript before submission. E. D. Izuki performed conceptualization and evaluation of manuscript before submission. E. E. Nsa performed conceptualization and evaluation of manuscript before submission. N. Ijoko performed conceptualization and evaluation of manuscript before submission.

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Conflict of Interests

The authors declare that there is no conflict of interest.

REFERENCES

Abang FBP, Archibong EE, Izuki ED, Antyev M and Ate-bia M (2023). Carcass and Organ Characteristics of Broiler Chicken Fed Diets containing Fermented Mango Kernel Composite Meal. Journal of Science Technology and Education, 11(2): 50-55. http://www.atbuftejoste.net/index.php/joste/article/view/1785

Abang FBP, Ayuk AA, and Okon BI (2013). Growth performance of growing Japanese quail (*Coturnix coturnix japonica*) fed 48 hours fermented taro cocoyam *(Colocasia esculenta var esculenta)* as a replacement for maize. Indian Journal of Research (PARIPEX), 2(8): 288-290. Article link

Abang FBP, Attah S and Zoo E (2017). Effect of replacing bone ash with fresh water snail (*Pila Ampullacea*) shell ash on haematological indices of weaner rabbits. Annual Research and Review in Biology, 21(2): 1-7. https://journalarrb.com/index.php/arrb/article/view/26393

Abang F, Egahi J, and Hamber TS (2018). Cost effectiveness of Anak broiler *Gallus gallus domesticus* chick fed fermented mango mangifera indica kernel composite meal as an alternative energy source. London Journal of Research in Science: Natural and Formal, 18(3): 61-65. Article link

Aderemi F (2010). Utilization of graded levels of biodegraded cassava peels in broiler ration. Electronic Journal of Environmental, Agriculture and food chemistry, 9(4): 672-678. https://www.cabdirect.org/cabdirect/abstract/20103323917

Aderemi FA, Tewe OO, Adesehinwa AO (2000). Utilization of cassava root and leaves in diets for layers. Tropical Veterinary, 18: 213-219. Google Scholar

Adeyemi OA, Eruvbetine D, Oguntona T, Dipeolu M, and Agunbiade JA (2008). Feeding broiler chicken with diets containing whole cassava root meal fermented with rumen filtrate. Archivos de zootecnia, 57(218): 247-58. https://www.redalyc.org/pdf/495/49515018017.pdf

Akinfala EO, Aderibigbe AO and Matanmi O (2002). Evaluation of the nutritive value of whole cassava plant as replacement for maize in the starter diets for broiler chicken. Livestock Research for Rural Development. 14: Article #56. http://www.lrrd.org/lrrd14/6/akin146.htm

Akinmutimi AH (2004). Evaluation of sword bean (*Canavalia gladiata*) as alternative feed resources for broiler chickens. Living stone England, pp. 37-85.

Anoh KU and Akpet SO (2013). Growth response of broiler chickens fed diets containing blood meal with enzyme supplementation as a replacement for fish meal. Journal of Agriculture and Veterinary Science, 4(4): 31–34. DOI: https://doi.org/10.9790/2380-0443134

Bounous DI and Stedman NL (2000). Normal hematology: chicken and turkey. In: Felman BF, Zinkl JG and Jaw NC. Eds. Scham's Veterinary Hematology. 5th Edition Lippinco U, William and Wilkins, Philadelphia. USA, 1147-1154. https://www.scirp.org/(s(lz5mqp453edsnp55rrgjct55.))/reference/referencespapers.aspx?referenceid=2015674

Enesi RO, Pypers P, Kreye C, Tariku M, Six J, Hauser S (2022). Effects of expanding cassava planting and harvesting windows on root yield, starch content and revenue in southwestern Nigeria. Field Crops Research, 286: 108639. DOI: https://doi.org/10.1016/j.fcr.2022.108639

Fafiolu AO, Otakoya IO, Adeleye OO, Egbeyale LT, Alabi JO and Idowu OMO (2014). Comparing the blood profile of two strains of broiler chickens with varying intervals of post hatch feeding. Nigeria Poultry Science Journal, 11: 198-203. Google Scholar

George OS and Sese BT (2012). The effect of whole cassava meal on broiler carcass weight and the optimal inclusion rate of whole cassava meal in broiler production. Science and Engineering Research; Science Education Development Institute, 2: 184-189. https://www.scirp.org/(s(czeh2tfqyw2orz553k1w0r45))/reference/referencespapers.aspx?referenceid=1459049

Gyang IY, Abang FBP, and Shaahu DT (2021). Growth performance and digestibility of starter broiler chicks fed diets containing different duration of fermented baobab (*Adansonia Digitata*) seed meal. European Journal of Agriculture and Food Science, 3(4): 38-42. https://www.ejfood.org/index.php/ejfood/article/view/332

Minitab Statistical Software (2014).Version16, Minitab Inc. P.A. USA.

Nsa EE, Wogar GA and Akpab I A (2016). Comparative evaluation of composite cassava root meal, palm oil and grayfish waste mixture as substitute for maize in broiler chicken diet. American Journal of Experimental Agriculture, 11(4): 1-7. https://journaljeai.com/index.php/jeai/article/view/513/1028

Obayelu OA, Obayelu AE, and Tunrayo Awoku I (2022). Technical efficiency and socioeconomic effects on poverty dynamics among cassava-based farming households in rural Nigeria. Contemporary Social Science, 17(2): 99-116. DOI: https://doi.org/10.1080/21582041.2021.1981425

Obikaonu HO and Udedibie A (2006).Comparative evaluation of sun-dried and ensiled cassava peel meals as substitute for maize in broiler starter diet. International Journal of Agriculture and Rural Development, 7(2):52-55. https://doi.org/10.4314/ijard.v7i2.2641

Odunlade TA, Oluremi OIA and Abang FBP (2020). Effect of nutrient composition of biodegraded sweet orange fruit peel on growth performance of starter broiler chicks. Animal and Veterinary Sciences, 8(5): 104-109. DOI: http://dx.doi.org/10.11648/j.avs.20200805.11

Oyebimpe K, Fanimo AO, Odgui OO and Biobaku WO (2006).Response of broiler and maize to cassava peel and maize offal in cashew nut meal-based diets. Achivos de Zootecnia, 55(211): 301-304. https://www.redalyc.org/pdf/495/49521111.pdf

Scholtz N, Halle I, Flachowsky G, and Sauerwein H (2009). Serum chemistry reference values in adult Japanese quail (*Coturnix coturnix japonica*) including sex-related differences. Poultry science, 88(6): 1186-1190. DOI: https://doi.org/10.3382/ps.2008-00546

TAC (2004 & 2011). Makurdi Weather Elements Records: Nigeria Air force Tactical Air Command, Makurdi Meteorological Station Makurdi, Nigeria. www.facebook.com>hqnigeriaairforce>posts>naf-tactical-air-com

Talebi A, Asri-rezaei S, Rozeh-Chai R and Sahreai R (2005). Comparative studies on hematological values of broiler strains (Ross, Cobb, Arbor-acres and Arian). International Journal of Poultry Science, 4:573-579. https://web.archive.org/web/20070307062504id_/http://www.pjbs.org:80/ijps/fin381.pdf

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