Effect of different additives on growth performance and reproductive traits of growing pullets fed diets from two varieties of cassava root meal

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Abstract

Cassava is higher in supply of carbohydrates than maize and can potentially replace maize as a veritable energy source in poultry diets. A five-week experiment was conducted to investigate the effect of dietary supplementation of two varieties of cassava root meal (CRM) with various additives on growth performance and reproductive traits of pullets. Two hundred and forty 16-weeks old point of lay birds were allotted to eight dietary treatments in a 2x4 factorial arrangement of white (TME 419) and yellow (ITA/IBD/1368) CRM supplemented with no additive, amino acids (methionine and lysine), enzyme and amino acids+enzyme (A.A+Enz). Growth measurements were recorded from 17 weeks till the start of lay at 21 weeks old and data on reproductive traits were also recorded in each treatment. Variety effect showed improved ($p < 0.05$) live weight gain at a reduced cost in growing pullets fed with diets containing white cassava than yellow. Supplementing white cassava root meal (WCRM) and yellow cassava root meal (YCRM) with additives did not promote growth of the pullets. Pullets fed with diet containing WCRM supplemented with A.A laid the first egg at an earlier age with lower ($p < 0.05$) body weight. In conclusion, feeding white cassava root meal with no additive to growing pullets improved live weight at a reduced cost, although supplementing white cassava root meal with amino acids resulted in the birds coming to lay earlier.

Keywords: Additives, cassava, pullets, performance, reproductive traits

Effet de différents additifs sur les performances de croissance et les caractéristiques de reproduction des poulettes en croissance nourries avec des régimes à base de deux variétés de farine de racine de manioc

Résumé

Le manioc est plus riche en glucides que le maïs et peut potentiellement remplacer le maïs en tant que véritable source d'énergie dans l'alimentation des volailles. Une expérience de cinq semaines a été menée pour étudier l'effet de la supplémentation alimentaire de deux variétés de farine de racine de manioc (CRM) avec divers additifs sur les performances de croissance et les caractéristiques de reproduction des poulettes. Deux cent quarante oiseaux de point de ponte âgés de 16 semaines ont été répartis en huit traitements diététiques dans un arrangement factoriel 2x4 de CRM blanc (TME 419) et jaune (ITA/IBD/1368) supplémenté sans additif, d'acides aminés (méthionine et lysine), enzyme et acides aminés+enzyme (A.A+Enz). Les mesures de croissance ont été enregistrées à partir de 17 semaines jusqu'au début de la ponte à 21 semaines et des données sur les traits de reproduction ont également été enregistrées dans chaque traitement. L'effet de variété a montré une amélioration

($p < 0,05$) du gain de poids vif à un coût réduit chez les poulettes en croissance nourries avec des régimes contenant du manioc blanc plutôt que du jaune. La supplémentation de farine de racine de manioc blanche (WCRM) et de farine de racine de manioc jaune (YCRM) avec des additifs n'a pas favorisé la croissance des poulettes. Les poulettes nourries avec un régime contenant du WCRM supplémenté en AA ont pondé le premier œuf à un âge plus précoce avec un poids corporel inférieur ($p < 0,05$). L'ajout d'acides aminés à la farine de racine de manioc blanc a permis aux oiseaux de pondre plus tôt.

Mots-clés : Additifs, manioc, poulettes, performances, caractères reproducteurs

Introduction

The food-feed competition between man and animals created by increased global demand for cereal grains as staple food (for man) and feed (for animals) has justified the exploration of cheaper, alternative energy feedstuffs (Oyebimpe *et al.*, 2006; Bhuiyan *et al.*, 2012). Cassava (*Manihot esculenta* Crantz) root is a cheap and sustainable energy feedstuff with potential to replace most conventional cereal grains in the tropics (Oso *et al.*, 2014). Cassava root is rich in digestible starch, gross energy content (El-sharkawy, 2012) and has been used to a limited extent in poultry nutrition (Idowu *et al.*, 2007; Raphael *et al.*, 2013; Oso *et al.*, 2014). However, the major limitations to its maximal utilization as energy feedstuff in poultry ration consist of high fibrous content (of its peel), the presence of hydrocyanide (HCN) residues, reduced protein levels, poor protein quality and reduced concentration of sulphur containing amino acids (Banea-Mayambue *et al.*, 1997). During cassava processing which converts cyanide to a less toxic thiocyanate, the enzyme 'rhodnase' contained in cassava root utilizes the constituent methionine and other sulphur containing amino acids as sulfur donor (Cardoso *et al.*, 2005). Thus, sulphur amino acids become grossly deficient in cassava-based diets fed to poultry birds. Hence, to harness the rich energy potential of cassava root maximally in poultry nutrition, it is essential to supplement cassava root-based diets with limiting amino acids.

Supplementation of fibrous feed ingredients with feed additives like enzyme improves utilization of the feed and reduces intestinal viscosity, thereby improving gut health and nutrient digestibility (Abdulrashid *et al.*, 2007; Kayode, 2009). **The use of cellulase will reduce the nutrient encapsulating effect of cell walls which, will in turn, result in an increase in protein, starch and available energy** (Slominski, 2011). The conventional white cassava roots and products are deficient in β -carotene and other carotenoids (Omole, 1977; Khajarearn and Khajarearn, 2007) which are needed in poultry diet to prevent *in vivo* oxidative stress with the attendant effects on animal products (Ngikie *et al.*, 2014). Yellow cassava on the other hand contains β -carotene, which is a precursor to vitamin A. β -carotene will enhance nutritional properties of yellow cassava and this could take care of some of the deficiencies that may be associated with lack of β -carotene and other carotenoids in white cassava. Previous studies (Aderemiet *et al.*, 2012; Raphael *et al.*, 2013; Akapo *et al.*, 2014; Oso *et al.*, 2014) on the practical inclusion of whole cassava root meal as energy feedstuff in feed for poultry have limited information on the use of biofortified (yellow) cassava in the feed of poultry. This study therefore, is aimed at investigating the effect of **synthetic amino acids (methionine and lysine)** and cellulase enzyme supplementation of unpeeled white and yellow cassava root meals (WCRM and YCRM respectively) on the growth performance and reproductive traits of

growing pullets.

Materials and method

Experimental location

The experiment was carried out at the Poultry Unit of Sustainable Livelihood and Development Network for Africa (SLIDEN AFRICA), Alagbede village, Abeokuta ($7^{\circ}10'2''$ N, $3^{\circ}21'2''$ E), Ogun State, Nigeria, West Africa. This region lies within the humid Southwestern part of Nigeria with mean annual rainfall of 1039mm, 35.7°C temperature and altitude of 76m above sea level (Google Earth, 2020).

Preparation of Cassava root meal

Freshly harvested white cassava variety (TME 419) and yellow cassava variety (ITA/IBD/1368) were gotten from the Federal University of Agriculture, Abeokuta farm for the study. Each variety was thoroughly washed with clean water (to be free of dirt and sand) and chipped into smaller pieces as described by Oso *et al.* (2010). The chipped cassava tubers obtained from each variety were sun-dried separately until they reached a moisture content of approximately 10–12 per cent. The dried chips were collected, bagged, stored, and subsequently milled (2.5-mm sieve) separately to obtain the WCRM and YCRM. The processed cassava root meals were later mixed with other feed ingredients to formulate the experimental diets.

Chemical Composition of white and yellow Cassava Root meals

Samples of the cassava root meals were analysed to determine their chemical constituents using the method described by the Association of Official Analytical Chemists (Horwitz, 2005). Gross energy (GE) content of the meal were determined using the Bomb Calorimeter, while metabolizable energy (ME) was estimated using the formula of NRC (1994) for calculating ME of feed ingredients for poultry bird $\{\text{ME} = 26.7(\text{Dry matter}) + 77(\text{Ether extract}) - 51.22(\text{Crude fibre})\}$. The

fibre fractions that included the neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) were determined according to the methods of Van soestet *al.* (1991). Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL. Also, the cyanide content of the samples was determined following the methods of Bradbury *et al.* (1991). Mineral content Ca, P, Cu, Mg, Mn, and Zn as well as β -carotene of the cassava root meals were determined using Horwitz (2005) and (Association of Official Analytical Chemists [AOAC] 1997), respectively (Table 1).

Experimental birds and management

Two hundred and forty, 16-weeks old point of lay, “Isa Brown[®]” experimental birds were distributed randomly to each of eight dietary treatments in three replications of 10 birds per replicate. They were put in standard battery cage with automatic nipple drinkers. The birds were weighed and fed the dietary treatments immediately after caging, standard routine management and vaccination schedules were observed. Feed and water were given ad libitum. Records of feed intake, weight gain and feed conversion ratio were taken weekly on all birds (replicates) from 17 weeks. Growth performance measurements were recorded from 17 weeks till the pullets started to lay at 21 weeks old. Data on reproductive traits (day at which first egg was laid, weight of first egg, age of the birds at first lay of egg etc.) were also recorded for each treatment.

Dietary treatments

White and yellow cassava root meals separately replaced 30 per cent of maize as the basal diet in the experimental diets, with different types of additives as follows: there was no additive in one of the diets (control) while the remaining three contained recommended levels of synthetic amino acids (15g methionine and 5g lysine),

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exogenous enzyme (3g cellulase), and a combination of both amino acids and enzyme. There were eight dietary treatments laid out in a 2 × 4 factorial arrangement (i.e. two varieties of cassava and four types of additives) as indicated below;

-Dietary Treatment 1: WCRM + No additive

-Dietary Treatment 2: WCRM + Synthetic amino acids

-Dietary Treatment 3: WCRM + Exogenous enzyme

-Dietary Treatment 4: WCRM + Synthetic amino acids+Exogenous enzyme

-Dietary Treatment 5: YCRM + No additive

-Dietary Treatment 6: YCRM + Synthetic amino acids

-Dietary Treatment 7: YCRM + Exogenous enzyme

-Dietary Treatment 8: YCRM + Synthetic amino acids+Exogenous enzyme

These were incorporated into the experimental diets as shown in Table 2.

Table 1: Chemical composition of white (TME 419) and yellow (ITA/IBD/1368) cassava root meals

Parameters	White cassava	Yellow cassava
Proximate components (%)		
Dry matter content	90.42	91.33
Crude protein	2.20	3.56
Ether extract	0.76	0.52
Crude fibre	1.26	1.09
Ash	2.34	2.90
Nitrogen free extract (NFE)	83.77	82.98
β carotene (µg/100 g)	15.42	349.01
Gross energy (MJ/kg)	14.80	14.46
Hydrocyanide HCN (mg/kg)	26.60	25.40
Fibre fractions (%)		
Nitrogen detergent fibre (NDF)	26.59	24.95
Acid detergent fibre (ADF)	15.58	14.06
Acid detergent lignin (ADL)	3.37	2.53
Hemicellulose	11.01	10.89
Cellulose	12.21	11.53
Mineral content (mg/g)		
Ca	3.55	3.72
P	0.80	0.90
Cu	0.28	0.32
Mg	0.40	0.46
Mn	0.14	0.22
Zn	0.11	0.10

Table 2: Gross composition of experimental diets fed to growing pullets (g/kg)

Ingredients	WCRM				YCRM			
	1	2	3	4	5	6	7	8
Maize	315	315	315	315	315	315	315	315
WCRM	135	135	135	135	-	-	-	-
YCRM	-	-	-	-	135	135	135	135
Soya Bean Meal	162	162	162	162	162	162	162	162
Wheat Offal	329	329	329	329	329	329	329	329
Bone Meal	30	30	30	30	30	30	30	30
Limestone	20	20	20	20	20	20	20	20
Methionine	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lysine	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Premix (Growers)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Common Salt	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Additive (Amino Acid)	-	*	-	-	-	*	-	-
Additive (Enzyme)	-	-	**	-	-	-	**	-
Additive (Amino Acid + Enzyme)	-	-	-	***	-	-	-	***
TOTAL	1000	1000	1000	1000	1000	1000	1000	1000
Determine analyses								
Metabolized Energy (Kcal/kg)	2627.52	2639.96	2631.79	2627.57	2626.47	2628.79	2636.00	2623.21
Crude Protein (%)	17.23	17.45	17.30	17.54	17.28	17.49	17.41	17.59
Crude Fibre (%)	5.38	5.34	5.44	5.32	5.29	5.28	5.15	5.37
Ether Extract (%)	2.70	2.30	2.55	2.48	2.34	2.55	2.25	2.40

Each 2.5kg Premix contains 1.25kg Vitamin Premix: (Vit.A 8,000,000 I.U; Vit. D3 1,700,000 I.U; Vit.E 5,000mg; Vit.K3 1,500mg; Vit.B2 3,000mg; Vit.B6 1,000mg; Vit.B12 5mg; Vit. B1 1,000mg; Niacin 15,000mg; Calpan 5,000mg; Folic Acid 200mg; Biotin 20mg and Antioxidant 125,000mg.), 1.25kg Mineral Premix: (Manganese 45,000mg; Iron 25,000mg; Choline Chloride 100,000mg; Copper 3,000mg; Iodine 1,000mg; Selenium 100mg; Cobalt 100mg; Zinc 35,000mg.)

WCRM – White Cassava Root Meal YCRM – Yellow Cassava Root Meal

* = Methionine and Lysine ** = Cellulase *** = Methionine and Lysine + Cellulase

Data collection and growth performance characteristics

The pullets were weighed per replicate at the beginning of the experiment and subsequently on a weekly basis. Weight gain was determined by the difference in the body weights of two consecutive weighing for each replicate group. The values obtained were divided by number of birds to obtain weight gain per pullet. Known quantity of feed was given to each replicate group at the beginning of each week and the left over at the end of 7 days was subtracted from the amount given to obtain the feed consumed. Cumulative feed intake was the

summation of the feed consumed within a period. This was recorded as the total feed consumed per number of bird. Feed:gain ratio was calculated as feed intake per g of body weight gain.

Cost-benefit determination

The prevailing market prices of the feed ingredients at the experiment were used to estimate the unit cost of the experimental diet. Feed cost per kilogramme and cost per kilogramme of weight gain were calculated.

Reproductive traits

Age at first egg was determined by the number of days since hatching of pullet to when it lays the first egg. Weight of first egg

was measured by weighing the first egg (s) laid with a sensitive Mettler–Toledo® PB 3002 Electronic scale with an accuracy of 0.01g. Where more than one egg was laid, the average egg weight was determined by dividing the pooled weight of the eggs by the number of eggs. At first egg, the birds per replicate were weighed; the average body weight taken was used as the body weight at first egg.

Statistical analysis

Data generated were **analysed** by analysis of variance technique using the Statistical Analysis System computer package (Statistical Analysis System Institute [SAS Institute], 1999). Differences between significant mean values **were** separated using Duncan's multiple range test (Duncan, 1955).

Statistical Model:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + E_{ijk}$$

Where

Y_{ijk} = observed values of dependent variable

μ = population mean

A_i = main effect of cassava varieties (White and Yellow)

B_j = main effect of additives (Non, Amino acid, Enzyme, Amino acid + Enzyme)

$(AB)_{ij}$ = interaction effect of cassava varieties and additives

E_{ij} = random residual error

Results

The chemical composition of white cassava root meal (WCRM) and yellow cassava root meal (YCRM) (average of four determinations) as shown in Table 1 revealed that the dry matter content of the two cassava varieties used in this study differ, with values of 90.42% and 91.33% for WCRM and YCRM, respectively. White cassava root meal recorded higher values for crude fat and crude fibre content while 3.56% crude protein in YCRM is higher than 2.20% crude protein recorded for WCRM. The ash and β -carotene content

(2.90% and 349.01 μ g/100 g, respectively) obtained for YCRM were higher than the values obtained for ash and β -carotene content in WCRM. The NFE value recorded for WCRM (83.77%) is higher than 82.98% NFE recorded for YCRM. White cassava root meal (WCRM) showed higher values for NDF (26.59%), ADF (15.58%) and ADL (3.37%) compared to those of YCRM (NDF 24.95%, ADF 14.06% and ADL 2.53%). It also had higher HCN 2.66 mg/kg content while the HCN content of YCRM was 2.54 mg/kg. Values of the minerals Ca, P, Cu, Mg, and Mn measured in YCRM were 3.55, 0.80, 0.28, 0.40, and 0.140, respectively, which were higher than the mineral contents recorded in WCRM except for the value of Zn which was similar to that obtained in YCRM. The gross energy value obtained for WCRM (3537.10 kcal/kg) is higher than the gross energy recorded for YCRM.

The result of main effects of cassava varieties and additives on the performance of growing pullets as presented in Table 3 showed that the birds fed with either white or yellow cassava root meal (CRM) varieties had no significant ($p > 0.05$) effect on final weight, weight gain, feed intake, cost of feed per kg diet and total cost of feed consumed. FCR and cost of feed per kg weight gain values (6.55 and N641.61) recorded were however significantly higher ($p < 0.05$) for the growing pullets fed YCRM diets. The main effect of additives had no significant ($p > 0.05$) effects on the final weight values of the birds. Growing pullets fed CRM diets with no additive recorded higher ($P < 0.05$) values for weight gain (444.17g) and recorded lower ($p < 0.05$) values for feed intake (2663.57g), FCR (6.02), cost of feed per kg diet (N94.50), cost of feed per kg weight gain (N568.96) and total cost of feed consumed (N251.57) compared to the inverse results obtained with the groups of birds fed diets with different additives.

The interaction effects of cassava varieties

and additives on the performance of growing pullets is presented in Table 4. There was no significant difference ($p>0.05$) in the final weight values of the growing pullets with the different diets fed, whereas there were significant ($p<0.05$) differences in the values obtained for other

performance parameters. All groups of growing pullets fed WCRM diets recorded higher ($p<0.05$) weight gain values compared to the groups of birds fed YCRM diets. The birds fed WCRM with no additive recorded the highest numerical value (455.00g).

Table 1: Main effects of cassava varieties and additives on the performance of growing pullets (16 – 21 weeks)

Parameters	Varieties				Additives					
	White	Yellow	SEM	P-value	no additive	A.A	Enzyme	A.A+Enz	SEM	P-value
Initial live weight/bird (g)	1201.67	1190.83	9.03	0.409	1186.67	1198.33	1213.33	1186.67	12.13	0.425
Final live weight/bird (g)	1635.83	1608.75	9.97	0.085	1630.83	1608.33	1624.17	1625.83	14.82	0.738
Total weight gain/bird (g)	434.17	417.92	7.80	0.101	444.17 ^a	410.00 ^b	410.83 ^b	439.17 ^{ab}	9.31	0.003
Daily weight gain/bird (g)	15.51	14.93	0.28	0.101	15.86 ^a	14.64 ^b	14.67 ^b	15.68 ^{ab}	0.33	0.003
Total feed intake/bird (g)	2701.67	2726.78	19.11	0.333	2663.57 ^b	2716.73 ^{ab}	2721.22 ^{ab}	2751.37 ^a	24.30	0.013
Daily feed intake(g/b/d)	96.49	97.38	0.68	0.333	95.13 ^b	97.03 ^{ab}	97.33 ^{ab}	98.26 ^a	0.87	0.013
FCR	6.24 ^b	6.55 ^a	0.12	0.029	6.02 ^b	6.64 ^a	6.64 ^a	6.28 ^{ab}	0.14	0.007
Cost of feed/kg diet (₦)	97.97	97.97	0.85	0.035	94.50 ^d	96.10 ^c	99.90 ^b	101.50 ^a	0.00	0.000
Cost of feed/kg weight gain (₦)	611.94 ^b	641.61 ^a	13.37	0.029	568.96 ^b	638.35 ^a	662.93 ^a	636.85 ^a	13.67	0.000
TCFC (₦)	264.82	267.17	3.54	0.352	251.57 ^c	261.05 ^b	272.11 ^a	279.24 ^a	2.38	0.000

^{a,b,c,d} means with the same superscripts along the rows are not significantly different ($p<0.05$).

FCR = Feed conversion ratio TCFC = Total cost of feed consumed AA = Amino acids AA + Enz = Amino acids + Enzyme

Table 4: Interaction effects of cassava varieties and additives on performance of growing pullets (16 – 21 weeks)

Parameters	WCRM				YCRM					SEM	P-value
	no additive	A.A	Enzyme	A.A + Enz	no additive	A.A	Enzyme	A.A + Enz			
Initial live weight (g)	1198.33	1206.67	1220.00	1181.67	1175.00	1190.00	1206.67	1191.67	6.35	0.700	
Final live weight (g)	1653.33	1620.00	1635.00	1635.00	1608.33	1596.67	1613.33	1616.67	7.55	0.728	
Total weight gain/bird (g)	455.00 ^a	413.33 ^{ab}	415.00 ^{ab}	453.33 ^{ab}	433.33 ^{ab}	406.67 ^b	406.67 ^b	425.00 ^{ab}	5.65	0.013	
Daily weight gain/bird (g)	16.25 ^a	14.76 ^{ab}	14.82 ^{ab}	16.19 ^{ab}	15.48 ^{ab}	14.52 ^b	14.52 ^b	15.18 ^{ab}	0.20	0.013	
Total feed intake/bird (g)	2623.80 ^b	2697.17 ^{ab}	2716.43 ^{ab}	2769.27 ^a	2703.33 ^{ab}	2736.30 ^{ab}	2734.00 ^{ab}	2733.47 ^{ab}	13.48	0.026	
Daily feed intake (g/b/d)	93.71 ^b	96.33 ^{ab}	97.02 ^{ab}	98.90 ^a	96.55 ^{ab}	97.73 ^{ab}	97.64 ^{ab}	97.62 ^{ab}	0.48	0.026	
FCR	5.78 ^b	6.53 ^a	6.55 ^a	6.11 ^{ab}	6.26 ^{ab}	6.75 ^a	6.73 ^a	6.44 ^a	0.09	0.040	
Cost of feed/kg diet (₦)	94.50 ^d	96.10 ^c	99.90 ^b	101.50 ^a	94.50 ^d	96.10 ^c	99.90 ^b	101.50 ^a	0.00	0.000	
Cost of feed/kg weight gain (₦)	546.26 ^c	627.72 ^{ab}	653.61 ^{ab}	620.16 ^{ab}	591.67 ^{bc}	648.98 ^{ab}	672.25 ^a	653.53 ^{ab}	9.75	0.005	
TCFC (₦)	247.81 ^d	259.17 ^c	271.24 ^{ab}	281.05 ^a	255.33 ^d	262.93 ^{bc}	272.99 ^{ab}	277.42 ^a	2.48	0.000	

^{a,b,c,d} means with the same superscripts along the rows are not significantly different ($p<0.05$).

FCR = Feed conversion ratio TCFC = Total cost of feed consumed dAA = Amino acids AA + Enz = Amino acids + Enzyme

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The results of the main effects of cassava varieties and additives on reproductive traits (body weight, age at first lay and weight of first egg) of growing birds are shown in Table 5. Cassava varieties had no significant ($p>0.05$) effect on the age at maturity, body weight and egg weight of the birds. Main effect of additives also showed no effect ($p>0.05$) on the age at first lay and weight of first egg. However, the body weight of the birds at first lay, in the group of birds fed CRM diets with no additive was not different ($p>0.05$) from those recorded for the birds in the group fed CRM diets with additives. In the group of birds fed CRM with additives, birds fed CRM diets with amino acids recorded lower ($p<0.05$) body weight of the birds at first lay, this is

different from what was recorded in the groups of birds fed CRM with enzyme and those with amino acids + enzyme. Table 6 shows the result of the interaction effect of cassava varieties and additives on the reproductive traits (body weight, age at first lay and weight of first egg) of growing birds. It was observed from the result that the age at maturity of growing birds were lower ($p<0.05$) for all the birds fed the different diets except those fed WCRM diets supplemented with enzyme which had numerical higher value of 155.17 days. The birds fed WCRM diets supplemented with amino acids recorded lower body weight at first lay (1638.33g). There was no significant difference ($p>0.05$) in the values recorded for weight of eggs of the birds.

Table 5: Main effects of cassava varieties and additives on reproductive traits of growing pullets

Parameters	Varieties				Additives					
	White	Yellow	P-value	SEM	no additive	A.A	Enzyme	A.A+Enz	SEM	P-value
Average age at first lay (days)	147.46	147.42	0.418	1.57	147.08	145.33	149.25	148.08	2.18	0.678
Average body weight at first lay (g)	1685.83	1689.92	0.795	13.35	1686.50 ^{ab}	1645.00 ^b	1695.00 ^a	1725.00 ^a	14.88	0.015
Average weight of first egg (g)	46.96	45.58	0.591	1.64	47.08	44.33	47.92	45.75	2.34	0.745

^{a,b} means with the same superscripts along the rows are not significantly different ($p<0.05$).

AA = Amino acids AA + Enz = Amino acids + Enzyme

Table 6: Interaction effects of cassava varieties and additives on reproductive traits of growing pullets

Parameters	WCRM				YCRM				SEM	P-value
	Control	AA	Enzyme	AA+Enz	Control	AA	Enzyme	AA+Enz		
Average age at first lay (days)	143.67 ^b	143.50 ^b	155.17 ^a	147.50 ^{ab}	150.50 ^{ab}	147.17 ^{ab}	143.33 ^b	148.67 ^{ab}	1.09	0.049
Average body weight at first lay (g)	1666.67 ^{abc}	1638.33 ^c	1721.67 ^a	1716.67 ^{ab}	1706.33 ^{ab}	1651.67 ^{bc}	1668.33 ^{abc}	1733.33 ^a	9.24	0.031
Average weight of first egg (g)	49.33	43.17	50.67	44.6	44.83	45.50	45.17	46.83	1.15	0.809

^{a,b,c} means with the same superscripts along the rows are not significantly different ($p<0.05$).

WCRM = White cassava root meal YCRM = Yellow cassava root meal AA = Amino acids AA + Enz = Amino acids + Enzyme

Discussion

The low feed intake observed with the growing pullets fed diet containing WCRM supplemented with no additive could be due to the relatively higher energy (GE) content

of the white cassava variety when compared with yellow variety. It has been established (Akinfala, *et al.*, 2002; Ugweneet *al.*, 2005). that birds consume to satisfy their energy requirement first. Hence, birds tend to eat

less of high energy diet. The trend of this research disagrees with previous findings using cassava peel meal in broiler chickens and layers diets (Odunsiet *et al.*, 2001; Sogunle *et al.*, 2007). Better feed conversion ratio observed with growing pullets fed diets containing WCRM supplemented with no additive compared with other treatments suggested the non-relevance of the additives in promoting growth at this phase. Diet containing WCRM with no additive was the most economical diet to yield a kilogram weight gain of growing pullet. This implied that it is more cost effective to use WCRM with no additive to yield greater weight gain in growing pullets. The pullets fed with diets containing WCRM supplemented with A.A laid the first egg at an earlier age with lower body weight. This implies that supplementing WCRM with amino acids, helped the pullets to come to lay earlier. This could be attributed to better utilization of protein due to the amino acidssupplemented (Oso *et al.*, 2017). Egg weight at first lay was not different among the treatments, meaning that the weight of the first eggs laid was not influenced by dietary treatment supplemented with or without additives. Raphael *et al.* (2013) reported that replacing maize with cassava root meal in pullet diets had no negative effect on egg weight at first lay.

Conclusion

It was concluded from this study that, the live weight of the growing pullets improved and at a reduced cost, when fed diets containing white cassava root meal with no additive than when fed with yellow cassava root meal with no additive. Further supplementation of both white cassava root meal and yellow cassava root meal diets with additives also, did not improve the live weight of the pullets. The pullets fed with diet containing white cassava root meal supplemented with amino acids laid the first egg at an earlier age with lower body

weight. Supplementing diet containing white cassava root meal with amino acid made up for the shortage of protein content and poor amino acid profile in cassava by enhancing the nutritional properties and rich energy potential of white cassava root meal maximally which resulted in the birds coming to lay earlier.

Recommendation

To achieve early lay, white cassava root meal supplemented with amino acid can replace 30% of maize in basal diet of growing pullets.

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