Performance and blood profile of young doe rabbits fed diets containing two varieties of composite sweet potato (*ipomoea batatas* Lam) meal in a palm kernel-based diets

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Abstract

Eighty-four does of mixed breeds aged 6-8 weeks, weighing 550–600g were used to determine the effect of feeding two varieties of composite sweet potato (*Ipomoea batatas*) root meal (CSPM) on the haematological and serum biochemical indices of rabbits. The rabbits were randomly allocated into seven treatments. T1 was the control while T2, T3, T4, contained 25, 50 and 75 % of maize replaced with CIP440293 CSPM and T5, T6 and T7 contained TIS87/0087 CSPM replaced with 25, 50 and 75 % of maize. The treatments had four replicates each in a Completely Randomized Design (CRD) experiment. The diets contained 10.6-12.6 % crude fibre, 16.4-17.6 % crude protein and 2610-2788 Kcal/Kg metabolizable energy. Parameters measured were growth, haematological and serum biochemical index of the rabbit. The result showed that there were significant ($P < 0.05$) differences on the final weight gain, daily feed intake, daily weight gain, feed cost and survival ability of the rabbits. The FCR was not significantly ($P > 0.05$) different across the dietary treatments. At the end of nine weeks of feeding trial, blood samples were collected from three rabbits per treatment. The results indicate that the dietary treatments had significant ($P < 0.05$) influence on the concentrations of white blood cells and eosinophils. However, there were no significant influence of the diets on other haematological parameters. Total protein, urea, globulin and creatinine were also not affected ($P > 0.05$) by the treatment diets but albumin, cholesterol, glucose, aspartate transaminase (AST), alanine transaminase (ALT) and alkaline phosphatase (ALP) were influenced by the different dietary treatments. These results show that CSPM of two varieties can be included up to 50 % in growing rabbit diets without adverse effect on haematology and serum indices of rabbits.

Keywords: Rabbits, Sweet potato composite meal, haematology, serum biochemistry, performance

Introduction

In the last decade Nigeria has been witnessing a continuous increase in population with an estimated human population to be slightly over 200 million. World Population Prospects prediction that by 2050, Nigeria will displace the United States as the third most populous country in the world after China and India (Campbell, 2018). A Huge population without corresponding increase in livestock production to serve the animal protein needs and its availability to the citizenry can lead to household food insecurity. The soaring

price of animal protein sources in developing countries and in Nigeria particularly has led to increasing search by animal nutritionists for alternative feedstuffs that could replace the major feed ingredients such as cereals. However, there is need to explore every possibility of incorporating unconventional feedstuffs into livestock feeds in order to reduce the cost of feed and maximize returns, and ensuring that the protein requirements of humans are met. Rabbits have a short generation interval and prolific, and its practice of caecotrophy enhances its

Performance and blood profile of young doe rabbits

performance. The cost of rabbit production is low and equally they have a fast growing rate (Oyawoye and Ogunkunle, 1989). Rabbit is a monogastric herbivore and can utilize a wide variety of feed sources (Bamikole *et al.*, 2000). The rabbit is an effective converter of feed to meat and can utilize up to 30% fibre as against 10% by most poultry species (Egbo *et al.*, 2001). Metabolic process effectiveness and dietary intake in livestock is highly dependent on their nutritional status of the feed ingredients. Improved quality meat production can be achieved through proper nutrition, inclusion of feed ingredients at normal or required levels (Etim and Oguike, 2010). Sweet potato (*Ipomoea batatas*) also referred to as the 'global plant', cultivated in more than 100 countries including Nigeria, is an important food security promoting root crop in the world, especially in sub-Saharan Africa (Low *et al.*, 2009). Sweet potato is well adapted to the tropical and subtropical regions. Sweet potato is an excellent source of energy (438 kJ/100 g edible portion) and can produce more edible energy per hectare per day than cereals, such as wheat and rice (Abu *et al.*, 2000, Laurie *et al.*, 2012) and has other advantages, such as versatility, high yield, hardness, and wide ecological adaptability (Laurie *et al.*, 2012). The sweet potato root is reported to have higher protein content than cassava and yams (Oloo *et al.*, 2014). In addition, some varieties of sweet potatoes contain coloured pigments, such as β -carotene, anthocyanin, and phenolic compounds. Sweet potato leaves are recognized to be rich in essential amino acids, such as lysine and tryptophan which are always limited in cereals. Hence, sweet potato can easily replace cereal based diets in livestock nutrition (Mwanri *et al.*, 2011; Oloo *et al.*, 2014). However, sweet potato are marginalized and are underutilized despite their useful potential which is well recognized and exploited elsewhere

(Anyaegbunam *et al.*, 2016). Dietary components have measurable effects on blood components; hence, blood constituents are widely used in nutritional evaluation in animals (Gbore and Akele., 2012). The objective of the study was to evaluate the effect of graded levels of composite sweet potato meal (CSPM) as a replacement for maize on growth, haematology and serum biochemistry of rabbits so as to assess the physiological response of the animals to CSPM based diets.

Blood collection

Three rabbits per treatment were bled through the ear vein and their blood collected into two vacutainer tubes for each animal, one contained a calculated amount of ethylene diamine tetraacetic acid (EDTA) for haematological studies and the other sterile vacutainer tubes without EDTA. The second set of tubes were covered and centrifuged, with serum separated out, decanted and deep-frozen for serum biochemical analyses. Packed cell volume (PCV) and erythrocyte counts were determined as described by Ewuola and Egbunike (2008). Total leukocyte counts were determined using Neubauer haemocytometer after appropriate dilution. Blood constants (Mean cell Volume, MCH, Mean cell haemoglobin, MCH and Mean cell haemoglobin concentration, MCHC) were calculated using formulae by Jain (1986). Serum total protein was determined using Biuret method (Kohn and Allen, 1995). Albumin was determined using Bromocresol green (BCG) method (Peter *et al.*, 1982). The globulin concentration was obtained by subtracting albumin from total protein.

Data analysis

Data obtained were subjected to analyses of variance using SAS 9.2 statistical package. Significant differences between treatment means were separated using Duncan's Multiple Range Test.

Table 1: Composition of the experimental diets

Ingredient	Levels of orange flesh CSPM				Levels of white flesh CSPM		
	T1 (0%)	T2(25%)	T3 (50%)	T4 (75%)	T5 (25%)	T6 (50%)	T7 (75%)
Maize	50.0	37.5	25.0	12.5	37.5	25.0	12.5
*CSPM	0.0	12.5	25.0	37.5	12.5	25.0	37.5
Soya bean meal	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Palm kernel cake	19.0	19.0	19.0	19.0	19.0	19.0	19.0
Fish meal	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wheat offal	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Cassava root meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Table Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Bone Meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limestone	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Nutrients (%)							
Crude Protein	16.9	17.3	17.0	17.6	16.7	16.6	16.4
Crude Fibre	10.6	11.1	11.1	12.6	11.0	12.0	12.6
Metabolizable Energy(Kcal/Kg)	2788.0	2760.0	2690.0	2742.0	2780.0	2680.0	2610.0

*CSPM: Composite sweet potato meal

Table 2: The performance of rabbits fed dietary levels of two varieties of composite sweet potato meal-based diets

Parameters	T1	Levels of Orange Flesh CSPM			Levels of White Flesh CSPM			SEM	P-Value
		T2	T3	T4	T5	T6	T7		
Initial Body weight (g)	557.25	590.67	551.56	560.89	569.21	563.17	580.11	5.16	0.1291
Final Body weight (g)	1741.19 ^a	1706.00 ^{ab}	1531.44 ^{bc}	1492.28 ^c	1770.19 ^a	1585.28 ^{abc}	1577.06 ^{abc}	41.19	0.0422
Daily weight gain (g/d)	17.71 ^a	16.56 ^{ab}	11.67 ^{bc}	8.53 ^c	16.70 ^{ab}	10.76 ^c	9.30 ^c	1.46	0.0076
Daily feed Intake (g)	59.23 ^a	50.07 ^{ab}	43.08 ^{bc}	40.05 ^{bc}	48.04 ^{ab}	37.30 ^{bc}	33.78 ^c	3.27	0.0066
Feed Conversion Ratio	3.38	3.36	3.68	4.79	2.89	3.51	3.93	0.22	0.4676
Feed-cost/wk/rabbit(₦)	50.05 ^a	40.46 ^b	36.62 ^{bc}	26.92 ^d	35.64 ^{bc}	37.15 ^{bc}	30.63 ^{cd}	2.79	0.0004
Survivability (%)	91.67 ^a	91.67 ^a	75.00 ^b	58.33 ^d	91.67 ^a	66.67 ^c	58.33 ^d	5.87	0.0001

^{a,b,c} means in the same row with different superscript as significantly different ($p < 0.05$), 1US Dollar=360 Nigeria Naira

**Orange flesh Composite sweet potato (OFCSP), White flesh Composite sweet potato (WFCSP)

Table 3: Hematology of rabbits fed dietary levels of two varieties of composite sweet potato meal based diets

Parameters	T1	Levels of orange flesh CSPM			Levels of white flesh CSPM			SEM	P-Value
		T2	T3	T4	T5	T6	T7		
PCV (%)	30.50	30.50	29.50	28.50	29.00	29.00	30.00	0.30	0.86
RBC ($\times 10^6/\text{mm}^3$)	4.65	5.35	4.72	4.95	4.75	5.08	4.85	0.09	0.75
Hemoglobin(mg/100 mL)	10.17	10.17	9.84	9.50	9.64	9.67	10.00	0.10	0.85
WBC ($\times 10^7/\text{mm}^3$)	1.30 ^{ab}	1.13 ^{abc}	1.06 ^{bc}	1.34 ^a	1.06 ^{bc}	1.04 ^{bc}	1.02 ^c	0.05	0.08
Blood Platelets ($\times 10^3/\text{l}$)	188.50	162.50	185.50	200.00	195.00	173.00	163.00	5.69	0.38
Lymphocytes (%)	54.00	52.50	55.50	51.00	60.00	52.50	58.50	1.26	0.51
Neutrophils (%)	37.5	40.00	37.50	42.00	34.00	39.50	35.00	1.26	0.66
Monocytes (%)	4.0	4.00	2.50	3.50	3.50	3.00	4.50	0.25	0.82
Eosinophils (%)	4.50 ^a	3.5 ^{ab}	4.5 ^a	3.5 ^{ab}	2.5b ^c	5.00 ^a	2.00 ^c	0.42	0.01
MCV (fl)	65.59	57.01	62.5	57.58	61.05	57.09	61.86	1.24	0.21
MCHC (g/dL)	33.34	33.34	33.36	32.87	33.24	33.43	33.33	0.07	0.46
MCH (pg)	21.38	19.39	20.29	22.11	20.14	18.99	20.3	0.41	0.51

^{abc} Means with the same superscript in the same row are not significantly ($P > 0.05$) different, SEM- standard error of means

Performance and blood profile of young doe rabbits

Table 4: Serum Biochemistry of rabbits fed varying dietary levels of two varieties of composite sweet potato meal based diets

Parameters	T1	Levels of orange flesh CSP			Levels of white flesh CSP			SEM	P-Value
		T2	T3	T4	T5	T6	T7		
Total Protein(g/dL)	6.21	7.71	6.37	6.10	6.44	8.92	5.29	0.46	0.6163
Albumin (g/dL)	3.16 ^{bdc}	3.46 ^{abc}	2.79 ^d	3.09 ^{cd}	3.26 ^{abc}	3.54 ^{ab}	3.62 ^a	0.11	0.0092
Globulin (g/dL)	3.05	4.24	3.57	3.010	3.19	5.39	1.68	0.44	0.6430
Cholesterol(mmol/L)	95.00 ^{cd}	95.67 ^{cd}	130.34 ^b	175.33 ^a	112.67 ^{cb}	93.34 ^{cd}	70.34 ^d	12.88	0.0016
AST (iu/L)	28.34 ^a	18.19 ^b	15.36 ^b	18.37 ^b	13.05 ^b	18.90 ^b	15.27 ^b	1.87	0.0249
ALT (iu/L)	25.46 ^a	18.30 ^{ab}	8.320 ^c	14.94 ^{bc}	14.01 ^{bc}	13.24 ^{bc}	9.52 ^c	2.18	0.0127
ALP (iu/L)	37.73 ^{ab}	41.82 ^{ab}	39.09 ^{ab}	36.82 ^{ab}	49.78 ^a	28.18 ^b	36.59 ^{ab}	2.45	0.2437
Blood Urea(mmol/L)	21.61	21.18	21.54	19.38	21.83	20.48	21.47	0.33	0.8003
Creatine(µg/dL)	1.10	1.55	1.10	1.350	1.10	1.150	1.25	0.06	0.2200
Glucose(mg/dL)	24.99 ^{cd}	25.76 ^{cd}	31.42 ^b	34.92 ^a	29.98 ^{bc}	26.51 ^{cd}	21.25 ^{dc}	1.73	0.0016

^{abc} Means with the same superscript in the same row are not significantly ($P > 0.05$) different, SEM- standard error of means
CSPM: Composite sweet potato meal, AST: Aspartate Transaminase, ALT: Alanine Transaminase, ALP: Alkaline phosphatase

Results and discussion

The results of the growth performance of doe rabbits to the experimental diets are presented in Table 2. Rabbits on T1(0%) recorded the highest final body weight of 1741.19g which was significantly ($P < 0.05$) higher than what rabbits on the different levels of sweet potato composite meal of the two varieties obtained. The final weight gain was between 1492.28-1770.19g was superior to 1220.60-1288.60g that was obtained by Olabanji *et al.* (2007) who fed weaned rabbits with different levels of wild sunflower leaf blood meal mixture but within ranges 1544.83-2088.83g obtained by Tiough *et al.* (2016) who fed rabbits with diet contained cassava root-forage composite meals. The daily weight gain of T1(0%) rabbit was also significantly ($P < 0.05$) higher than that of all other treatments which followed a similar trend with the daily feed intake where T1(0%) had a value of 59.23g which was significantly ($P < 0.05$) higher than that of all other treatments. The daily feed intake was between 33.78-59.23g which was lower than 66.28-83.24g and 48.24-74.36g reported by Shaahu and Tiough (2019) and Shaahu *et al.* (2017), respectively. The daily weight gain ranged from 8.53-17.71g was

higher than that of 4.95-5.23g reported by Uchegbe and Iyeghe-Erakpotobor (2015) who fed rabbits with sweet potato vine based diet supplemented with methionine and lysine, and also higher than and 9.04-12.94g reported by Shaahu and Tiough (2019) who fed rabbits sweet potato vine-cassava composite meal. The Feed Conversion Ratio (FCR) value was not significantly different across the treatments groups, the values were higher than each other. The rabbits on T5(25% of the white flesh sweet potato composite meal) has the lowest FCR value of 2.89 when compared with other treatments groups while T4(75% of the orange flesh sweet potato composite meal) has the highest FCR value of 4.79. The feed conversion ratio ranged 2.89-4.79 and its within the range 2.67-8.73 reported by Shaahu *et al.* (2014). The significantly better feed conversion ratio for rabbits maybe attributed to lower feed intake and higher weight gains for rabbits. The orange flesh composite meal appeared to have a better performance which agrees with the findings of Olaleru *et al.* (2017). The novel characteristics of sweet potato, particularly orange-fleshed variety potential nutritional benefits in both human diet and could further be incorporated in livestock feed at

different levels depending on the dietary requirement and age of the livestock. The feed-cost per week per rabbit value was significantly different across the dietary treatment groups. The rabbits on T1(0%) had the highest value of ₦50.05 while T4(75% of the orange flesh sweet potato composite meal) had the lowest value of ₦26.92. The reduction in the feed cost observed with an increase in the composite sweet potato in the diet was due to the comparable lower price of the sweet potato root relative to maize. This result agrees with the findings of Tiough *et al.* (2016) that cost of root crops products is more economical and of a higher quality to use. The survival ability across the dietary treatment was significantly different, with T1(0%) and T2(25% of the orange flesh sweet potato composite meal) having the highest value of 91.67 while T4(75% of the orange flesh sweet potato composite meal) and T7(75% of the white flesh sweet potato composite meal) had the lowest survival value of 58.33. The slight but consistent reduction in survival ability as composite sweet potato replaced maize may have been due to the presence of unidentified inhibitors of digestive and / or metabolic processes as suggested by Gerspacio (1978).

The haematological and serum biochemical parameters is shown in Table 3 and 4 and has been previously documented in Olaleru *et al.* 2019. The haematological response of does to the dietary treatments containing varied levels of composite sweet potato meal is as shown in Table 3. All the haematological parameters differential counts of rabbits examined were not significantly ($P > 0.05$) influenced by dietary treatments except the white blood cell and Eosinophils which were higher in T6 (50%) and T1(0%) than the other five treatments. The similarities in the value of Hb, PVC, RBC, MCV, MCH,

MCHC could be related to the nutritional adequacy and suitability of the test ingredients. All the haematological parameters measured in the experiment were within the normal physiological ranges reported for rabbits (Jenkins, 1993; Hillyer, 1994). There were significant ($P < 0.05$) differences in the mean values of the various biochemical components of doe studied (Table 4). The Albumin, Cholesterol, AST, ALT, ALP and Glucose values were all significantly different. The values obtained reveals that cholesterol in the diet containing 75 % replacement of maize with orange flesh composite meal was significantly ($P < 0.05$) higher (175.33 mmol/L) than all other treatments. This may be due to the high level of total soluble sugar present in the orange fleshed sweet potato variety, that becomes dissolved into the blood stream of the rabbits. The serum biochemical variables of doe presented in the study were similar to the results of Van Praag (2004). This observation agrees with the results of Elamin *et al.* (2011) who reported that sweet potato has the potential to improve feed conversion ratio of local rabbit and have no negative effects on the blood constituents.

Conclusion

The findings showed that the two varieties contained appreciable amount of nutrients and had great potential for growth improvement and can boost rabbit nutrition and performance. However, comparatively the orange flesh composite sweet potato attained higher daily weight gain and slightly higher feed intake which worked synergistically to improve the performance of rabbits to prevent disease conditions associated with some major nutrient deficiencies. It was shown that orange flesh composite sweet potato has a better overall performance when compared to the white flesh composite sweet potato but both

varieties could replace maize up to 50 % without any detrimental effect on the performance, haematology and serum biochemistry of rabbits.

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Performance and blood profile of young doe rabbits

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