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Nutritional evaluation of cassava root meal fortified with roselle seed meal as a replacement for maize on growth response and blood profile of broiler chicks

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***Target Audience:** Nutritionist, Researchers, Poultry farmers and Feed millers.*

Abstract

A major challenge diminishing the profitability and sustainability of the poultry industry is the astronomic increase in price of feed ingredient such as maize which is progressively eroding off the expected profit margin of poultry farmers. A total of two hundred and forty (240), day-old broiler chicks were used in four weeks feeding trial to investigate the effect of fermented cassava root fortified with roselle seed meal as a replacement for maize on growth performance and blood profiles of broiler chicks. Maize is the main energy source for the control diet (T1) while the other five diets (T2, T3, T4, T5 and T6 were partially replaced with varying levels of cassava root meal – roselle seed meal (CRM-RSM) mixture at 10, 20, 30, 40 and 50% inclusion rates respectively. The broiler chicks were weighed and allotted to six dietary treatments of 40 birds each. The groups were replicated four times in a completely randomized design of 10 birds per replicate. Parameters measured for growth response include: Initial weight, final weight, total weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio. Dietary treatments evoked significant ($P < 0.05$) effect on final weight, total weight gain and daily weight gain. Higher statistical ($P < 0.05$) values of 1153.33g and 1193.33g were recorded for final weight in the birds fed 0% and 10% CRM-RSM. Birds fed diets with 20% and 30% CRM-RSM, inclusion revealed similar statistical values 1133.33g and 1116.67g for final weight. With the exemption of neutrophil, graded level of CRM-RSM showed significant ($P<0.05$) influence on haematological parameters determined. Values recorded for packed cell volume PCV ranged between 38.50 – 45.00% and did not follow any specific trend. In conclusion, inclusion of cassava – roselle seed mixture up to 30% replacement level for maize improved growth performance without hazardous effect on starter broiler chicks.

***Keywords:** Cassava; Roselle; Performance; Haematology; Broiler.*

Description of Problem

Intensively reared poultry are invariably fed on diets of high nutrient concentration where nutrient requirements are met with the use of high quality raw materials. One of the major developments in compound feed formulation is the considerably more detailed information relating to the nutritive value of the raw materials available for incorporation into diets. A major problem facing poultry production in Nigeria is high cost of feeds which necessitated the feed manufacturers to frequently vary their formula and the ingredient being used. The astronomic increase in prices of feed ingredients such as maize is progressively slashing off the expected profit margin of livestock farmers in Nigeria and other developing countries across the globe.

Almost 70 percent of world's cassava production comes from five countries in which Nigeria is among (1), though only a small fraction is utilized for animal feeding programs. In Nigeria, due to the scarcity and high cost of conventional ingredients, there is a renewed interest in the use of non-conventional

cheap and easily available ingredients in feeding birds.

Cassava products have been in use for a long time as an energy source in place of cereal grains for livestock (2) but limited by its high fibre content, low protein value and hydrocyanic acid which is deleterious to animal growth and development (3; 4). Fermentation technology has been used as a method of improving the nutritional value of cassava meal by reducing the anti-nutritional factors, high crude fibre content and enriching the protein content in livestock feeds (5)

Cassava peels have been revealed to be a viable ingredient at up to 15% inclusion in the diets of broilers (6) when combined with a variety of locally available feed resources (groundnut cake, cashew nut meal, palm oil and methionine) to meet amino acid requirements. One of limitation of cassava inclusion in the diets of poultry is low protein content at comparative level to maize. Blending cassava root with roselle seed could address the paucity of protein in cassava as the seed is rich in protein. Roselle seeds are readily available as the most economically viable part for farmers is the flower.

Significant reduction in the cost of livestock feed could be sourced and the maize content of feed reduced. It is for this reason that cassava, which is in abundance and cheap is being considered for evaluation in the feeding of broiler chickens. The search for alternative ingredient to maize in poultry industry lead to the investigation of fermented cassava root fortified with roselle seed meal as a replacement for maize on growth response and blood indices of broiler chickens.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry unit of the Teaching and Research Farm of Taraba State University, Jalingo located between latitude 6^{o} 30' and 9^{o} 30' N and longitude 9^{o} 00' and 12^{o} 00' E in Guinea Savannah Zone of Northern Nigeria (7). It has an annual rainfall range of 1000mm – 1500mm, the ambient temperature of the area range between 30 – 38^{o}C with an average of 29^{o}C.

Experimental birds and management

A total number of 240 day-old unsexed broiler chicks of commercial strain (Cobb 500) were purchased from a reputable hatchery. The chicks were weighed and allotted to six dietary treatment groups of four replicates each in a Completely Randomized Experimental Design. Each replicate consists of 10 chicks, to have a total of 40 birds per treatment group. The birds were brooded for two weeks. Birds were reared on deep litter housing system. Routine vaccinations and medications were strictly followed and feed and water were provided *ad libitum*.

Source and processing of test ingredient

Fresh cassava roots were purchased from a reputable farm in Jalingo environment. The cassava roots were washed, peeled and sliced into small pieces. Sliced fresh cassava roots were fermented for 5 days under an air-tight environment, sun dried (for 2-3 days) and packed in a sack for ration formulation. Roselle seeds were spread on a concrete floor and sun dried until they become crispy. The sun dried seeds were pulled together and milled. Cassava roots were milled, in a 2mm sieve harmer mill and mixed at a ratio of 1kg cassava root meal with 200g roselle seed, and used to replace maize at varying proportions in the basal diet.

Experimental diets

The experimental diets were formulated to meet (8) minimum nutrient requirement. Maize is the main energy source for the control diet (T1) while the other five diets (T2, T3, T4, T5 and T6 were partially replaced with varying levels of fermented sundried cassava root – roselle seed meal at 10, 20, 30, 40 and 50% inclusion rates respectively as shown in Table 1.

Table 1: Percentage composition of broilers starter diets (0-4 weeks)

FCR-RSM levels:	0% T1	10% T2	20% T3	30% T4	40% T5	50% T6
Ingredients:						
Maize	48.00	43.20	38.40	33.60	28.80	24.00
FCR-RSM	0.00	4.80	9.60	14.40	19.20	24.00
Soya bean meal	31.10	31.10	31.10	31.10	31.10	31.10
Groundnut cake	8.60	8.60	8.60	8.60	8.60	8.60
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Lime stone	1.00	1.00	1.00	1.00	1.00	1.00
DL-Methionine	0.2	0.2	0.2	0.2	0.2	0.2
L-Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis:						
ME (kcal/kg)	2990.50	2988.50	2985.50	2983.50	2981.50	2980.50
Crude protein (%)	23.11	23.31	23.50	23.72	23.81	23.86
Crude fibre (%)	3.46	3.58	3.57	3.59	3.61	3.62
Ether extract (%)	8.45	8.45	8.45	8.45	8.45	8.45
Ca (%)	1.21	1.21	1.21	1.21	1.21	1.21
P (%)	0.51	0.51	0.51	0.51	0.51	0.51
L-Lysine (%)	1.32	1.32	1.32	1.32	1.32	1.32
DL-Methionine (%)	0.59	0.59	0.59	0.59	0.59	0.59

FCR-RSM = Fermented Cassava Root – Roselle Seed Meal.

Data Collection

Performance characteristics

The initial weights of the birds were taken on arrival. The live weights of the birds as well as the feed consumption of each replicate were measured weekly. Feed conversion ratio for each replicate was determined by dividing the feed intake by the weight gain.

$$Feed\ intake/bird\ (g) = \frac{Quantity\ of\ feed\ fed - Quntity\ of\ feed\ left\ over}{Number\ of\ birds\ \times 28\ days}$$

$$Daily\ weight\ gain\ (g) = \frac{Final\ live\ weight - Initial\ weight}{Number\ of\ birds\ \times 28\ days}$$

$$Feed\ conversion\ ratio\ = \frac{Quantity\ of\ feed\ consumed}{Weight\ gain}$$

Haematological analysis

At 28 days of age, blood samples were drawn from the wing vein of 4 birds per treatments that is one from each replicate. 2ml of blood sample was transferred into a bottle containing Ethylene Diamine Tetra Acetic Acid (EDTA) anticoagulant for haematological analyses. The following parameters were determined: Packed Cell Volume (PCV), White Blood Cell (WBC), Haemoglobin (Hb), Red Blood Cell (RBC), Mean Cell Haemoglobin Concentration (MCHC), Mean Cell Haemoglobin (MCH) and Mean Cell Volume (MCV).

Serum biochemical analysis

At the end of 28th day of the experiment, 2 ml of blood sample was collected through the wing vein from one chicken per replicate into a clean syringe and put in sterilized plane bottle. Commercially available kits (Randox Laboratories Ltd) were used for analysis of serum biochemical indices. Parameters determined include: Total protein, albumin,

globulin, glucose, uric acid, aspartate aminotransferase, alanine aminotransferase and creatinine.

Statistical analysis

Data collected were subjected to One–way Analysis of Variance (ANOVA) in a Completely Randomized Design using SAS (9) while significant means were separated using Duncan's Multiple Range Test at 5% level of significance.

Results and Discussion

Growth response

The results of growth response of starter broiler chicks fed with graded levels of cassava root meal fortified with roselle seed meal (CRM-RSM) as a replacement for maize are presented in Table 2.

Varying inclusion levels of cassava root meal elicited significant influence on growth response of starter broiler chicks. Dietary treatments evoked significant ($P < 0.05$) effect on final weight, total weight gain and daily weight gain. Higher statistical ($P < 0.05$) values of 1153.33g and 1193.33g were recorded for final weight in the birds fed 0% and 10% CRM-RSM. Birds fed diets with 20% and 30% CRM-RSM, inclusion revealed similar statistical values 1133.33g and 1116.67g for final weight. Lower values 1123.33 and 1003.33g were obtained for final weight in the birds fed 40% and 50% CRM-RSM as replacement for maize respectively. The observation is at variance with report of (10) who found that weight was not affected by diet containing 50% CRM. Amino acid is a key to tissue build up, decreased values obtained in the study with increased level of CRM could be attributed to poor bioavailability of amino acid in cassava. The protein in cassava has higher arginine content while methionine, threonine, cysteine, phenylalanine, isoleucine and proline are low (11 and 12). Total and daily weight gain followed similar trend with final weight. Birds fed with 0% and 10% CRM-RSM inclusion as replacement for maize showed higher ($P < 0.05$) values at comparative level across dietary treatments. Birds fed 50% CRM-RSM inclusion revealed least ($P < 0.05$) value of 837.02g for total weight gain. Similarly, daily weight gain showed least ($P < 0.05$) value of 39.85gfor birds fed 50% CRM-RSM inclusion.

This reduced performance observed in the birds fed 50% CRM inclusion could be attributed to high fibre content in cassava and poor amino acid profile. A strong negative correlation between the fibre fractions and nutrient digestibility and utilization has been reported (13 and 14). Inclusion of whole cassava plant meal up to 25% in broiler starter diet resulted to growth impairment at comparative level to control 0% cassava (15).

Dietary treatments had no significant ($P < 0.05$) effect on feed intake. Total and daily feed intake did not follow any specific pattern. Though not significantly ($P < 0.05$) different, feed conversion ratio (FCR) increased with increasing level of CRM-RSM. The observation in this study supported the report (16) who reported poor FCR in birds with cassava chips compared to maize based control diet.

Haematological indices

The results of haematological indices of starter broiler chicks fed graded inclusion levels of cassava root meal-roselle seed meal (CRM-RSM) mixture is presented in Table 3. With the exemption of neutrophil, graded level of CRM-RSM showed significant ($P<0.05$) influence on parameters determined. Values recorded for PCV ranged between 38.50 – 45.00% and did not follow any specific trend. PCV values obtained in this study were within the normal range (24 – 45%) reported in the literature (17). However, the values were higher than 24.5 – 29.0% reported for PVC by (18). Birds fed with diets containing 30% (T4) and 40% (T5) CRM – RSM revealed higher ($P < 0.05$) statistical values of 42.00 and 45.00% for PCV at comparative level across dietary treatments. Sufficient crude protein in the diet

contributed to higher PCV because net protein furnishes body with required amino acid needed for physiological activities such as biosynthesis of body protein including blood protein. The normal value recorded for PCV in this study indicated increased availability of protein, energy thus improving broiler performance (19). Highest (P<0.05) value of 45.00% recoded for PCV in this study suggested that the birds were normally hydrated. PCV greater than 56% is an indicator of polycythemia caused by dehydration (20).

Table 2: Effect of graded levels of cassava root meal fortified with roselle seed meal (CRM-RSM) on growth response of starter broiler chicks (1 – 4 weeks)

FCR-RSM levels:	0% T1	10% T2	20% T3	30% T4	40% T5	50% T6	SEM
Parameters:							
Initial weight (g)	166.30	166.14	166.22	166.20	166.30	166.31	0.04
Final weight (g)	1153.33^{ab}	1193.33^{a}	1133.33^{abc}	1116.67^{abc}	1023.33^{bc}	1003.33^{c}	19.38
Total weight gain (g/bird)	987.03 ^{ab}	1027.19^{a}	967.11^{abc}	950.46^{abc}	857.03^{bc}	837.02^{c}	19.40
Daily weight gain (g/bird)	47.00^{ab}	48.91^{a}	46.05^{abc}	45.26^{abc}	40.8^{bc}	39.85^{c}	0.92
Total feed intake (g/bird)	1753.33	1840.00	1813.33	1860.00	1816.67	1703.33	20.00
Daily feed intake (g/bird)	83.49	87.61	86.34	88.57	86.50	81.11	0.95
FCR	1.78	1.79	1.87	1.95	2.12	2.03	0.04
Cost/kg gain (#/kg)	586.89	557.89	560.37	558.11	578.91	527.34	10.72

^{abc} Mean on the same row having different superscripts were significantly (P<0.05) different.

White blood cell (WBC) ranged between 20.90 – 37.40 x 10^9/L. The values obtained for WBC did not follow any specific pattern. Birds on 20% (T3) and 50% (T6) recorded least (P<0.05) values of 20.90 x 10^9/L and 21.81 x 10^9/L respectively. The values recorded for WBC in this study were close to values 19.43 – 30.40 x 10^9/L recorded in the literature (21). These normal values suggested that the birds were healthy. High white blood cells indicate acute or chronic inflammation in the tissue (20). White blood cells are known to fight defects thus animals with low WBC are exposed to high risk. Normal range value obtained in this study indicated that birds were capable of producing antibodies for phagocytosis.

Red blood cells (RBC) showed range (P<0.05) values of 2.77 – 3.88 x 10^{12}/L. This observation is close to the range values reported in the literature (22). Mean corpuscular volume (MCV) and mean Corpuscular haemoglobin concentration (MCH) followed similar trend. Birds fed 20% (T3) CRM-RSM recorded 36.00pg for MCH at comparative level across dietary treatments. Range values 110.55 – 153.05fl obtained for MCH in this study were close to 90 – 140fl reported for birds in the literature (17). Ranged values 36.11- 48.40pg obtained for MCH in this study was close to 39.11pg reported by (22). MCH is an indicator of blood carrying capacity of RBC. Normal value for MCH suggested that birds were efficient in the respiratory functions (23).

With the observation in this study, a range of 31.80 – 56.75g/dl were recorded for mean corpuscular haemoglobin concentration (MCHC). Birds fed 10% (T2) of CRM-RSM mixture revealed highest (P<0.05) value of 56.75g/dl at comparative level across dietary treatment. Range value obtained in this study is close to 33 – 47g/dl reported for MCHC in the literature (17). The least value 31.80g/dl recorded in this study suggested adequate mineral in the diet.

MCHC value less than 29g/dl indicates iron or mineral deficiencies (20). Retention of energy intake was shown to be associated with elevation of MCHC values (22)

Close range values 13.00 – 15.15g/dl were recorded for haemoglobin (Hb) with the control diet (T1) having the least value. Values recorded for birds on diets T1, T2, T3 and T6 were statistically (P<0.05) similar at comparative level across dietary treatments. Range values obtained for (Hb) in this study were close to 7 – 13g/dl reported for normal chickens (24). This observation suggested adequate oxygen carrying capacity. Haemoglobin concentration is useful in detecting anaemia in avian species in general (25). Range (P<0.05) values 42.00 – 83.50% were recorded for lymphocyte with birds on control diet showing the least. Birds fed higher replacement levels 20%, 30%, 40% and 50% (T3, T4, T5 and T6) showed higher similar (P<0.05) values at comparative level across dietary treatment. This observation could be attributed to physiological adjustment against negative antigens as a result of anti-nutritional factor as reported by (26) in broiler chickens fed cassava peel diets. The absence of basophils among the WBC differentials as observed in this study suggested that birds were healthy without any diseases, as basophiles are rare in blood circulation except in case of severe infections (27).

Table 3: Effect of graded levels of cassava root meal fortified with roselle seed meal (CRM-RSM) on haematological indices of starter broiler chicks (1 – 4 weeks)

FCR-RSM levels:	0%	10%	20%	30%	40%	50%	
	T1	T2	T3	T4	T5	T6	SEM
Parameters:							
Packed cell volume (%)	39.50^{bc}	41.50^{bc}	38.50^{c}	42.00^{ab}	45.00^{a}	40.50^{bc}	0.60
White blood cell (×10^{9}/l)	28.40^{ab}	37.40^{a}	20.90^{c}	28.59^{ab}	24.68^{abc}	21.81^{c}	2.57
Red blood cell (×10^{12}/l)	2.77^{b}	2.81^{b}	3.88^{a}	3.04^{ab}	3.17^{ab}	2.87^{b}	0.13
Mean corpuscular volume (fl)	143.15^{a}	153.05^{a}	110.55^{b}	140.10^{a}	143.50^{a}	144.95^{a}	4.28
Mean corpuscular haemoglobin (pg)	47.35^{a}	46.55^{a}	36.00^{b}	46.55^{a}	47.96^{a}	48.40^{a}	1.51
Mean corpuscular haemoglobin concentration (g/dl)	33.00^{b}	56.75^{a}	31.80^{b}	33.25^{b}	33.00^{b}	33.40^{b}	3.03
Haemoglobin (g/dl)	13.00^{b}	13.40^{b}	13.50^{b}	14.20^{ab}	15.15^{a}	13.80^{b}	0.19
Lymphocyte (%)	42.00^{c}	57.50^{bc}	76.00^{a}	83.50^{a}	72.50^{ab}	82.50^{a}	3.94
Neutrophil (%)	25.00	28.00	24.00	26.50	27.50	25.62	3.97

^{abc} Mean on the same row having different superscripts were significantly (P<0.05) different.

Serum biochemical indices

Table 4 showed the results of serum biochemical indices. Dietary treatments had significant (P<0.05) influence on total protein, uric acid and creatinine. The values (p<0.05) ranged between 30.50 – 41.75g/dl for total protein and were within the normal range (17). Total protein is a reflection of protein quality in the diet and high value indicate sufficient in the blood of the bird. Uric acid values 124.45 – 194.03mmol/L were recorded for uric acid. The values were significantly similar with exception of birds on T5. Values of 24.75 – 46.20mmol/L recorded for creatinine were significantly similar except for birds on T1 and T6 at comparative level across dietary treatment. The significant variation in

values recorded for uric acid in birds suggested greater catabolic activities in tissue and birds survived at expense of body reserve (26).

Table 4: Effect of graded levels of cassava root meal fortified with roselle seed meal (CRM-RSM) on serum biochemical indices of starter broiler chicks (1 – 4 weeks)

FCR-RSM levels:	0% T1	10% T2	20% T3	30% T4	40% T5	50% T6	SEM
Parameters:							
Total protein (g/l)	34.56^{b}	30.50^{b}	32.63^{b}	30.60^{b}	30.95^{b}	41.75^{a}	1.29
Albumin (g/l)	13.23	12.56	11.20	12.16	11.60	13.85	0.40
Globulin (g/l)	21.33	17.94	21.43	18.44	16.35	27.90	1.04
Aspartate amino-transferase (iu/l)	79.00	85.33	75.00	83.73	75.00	79.50	1.86
Alanine amino-transferase (iu/l)	8.00	9.33	7.33	8.33	7.50	8.50	0.36
Uric acid (mmol/l)	194.03^{a}	169.17^{ab}	152.30^{ab}	169.70^{ab}	124.45^{b}	150.00^{ab}	8.31
Glucose (mmol/l)	10.73	10.80	12.03	10.50	10.60	11.63	0.28
Creatinine (mmol/l)	24.75^{b}	42.85^{a}	46.20^{a}	39.05^{ab}	32.45^{ab}	28.33^{b}	2.38

^{ab} Mean on the same row having different superscripts were significantly ($P<0.05$) different.

Conclusion and Applications

1. Graded inclusion levels of cassava root meal – roselle seed meal (CRM-RSM) mixture improved weight gain among the parameters measured for starter broiler chicks.
2. CRM-RSM mixture could replace maize up to 30% replacement level for improved growth performance in term of feed conversion ratio and cost per kg gain.
3. Varying inclusion levels of CRM-RSM mixture could be fed to starter broiler chicks without any hazardous effect.
4. Graded inclusion levels of CRM-RSM mixture revealed normal haematological indices and non-significant effect on liver enzymes which suggested normalcy of blood profile and healthy chicks.

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