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Effect of replacing maize with cassava root-forage composite meal in diet on growth performance and production economics of rabbit

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Target Audience: *Animal Scientists, Students and Livestock producers*

Abstract

The study investigated the effect of replacing maize with cassava root-forage composite meal (CR-FCM) in diets on growth performance and production economics of rabbits. The CR-FCM was prepared to be iso-nitrogenous with maize using unpeel cassava root mixed with either cassava leaf meal, Moringa oleifera leaf meal, sweet potato vine meal, or Tridax procumbens leaf meal in the following proportions 1:1.5, 2.95:1, 2.65:1 and 1:1 respectively to separately replace maize in the control diet (T1). Each of the leaf meal in a mixture in diet constitutes experimental treatments T2, T3, T4, and T5 respectively. Thirty weaned mixed breed rabbits were allocated to the experimental diets in a completely randomized design. Rabbits fed T1, T2, T3 and T5 showed no significant (P<0.05) differences in feed intake and weight gain. Body weight gains of rabbit fed T1, T2 and T3 diets were significantly (P<0.05) higher than those fed T4. Feed/gain ratio (3.22) by rabbit fed T3 diets was only significantly (P<0.05) better than those on T4 (3.75) and T5 (3.79). Cost/kg diet, total feed cost, total cost of production and feed cost as percent of total cost of production were reduced, due to the replacement. Gross margin was maximized with T3 and minimal with T4. T4 is therefore recommended for maximum returns.

Keywords: Rabbit; Cassava-root; Unconventional-feedstuff; Forage; Maize

Description of Problem

The highest proportion of cost (65-70%) in livestock production is feeds, this is particularly so for monogastric animals raised under an intensive system (1). The energy source component of the feed constitutes between 45 and 60 percent (2). Of all the cereal grains, maize is the commonly used source of energy in livestock feeds (3). Feed is therefore, an important production inputs and is one of the constraints that limits the development of animal production in Nigeria (4).

Cassava root meal has been documented as one of the alternative energy sources in livestock feeds and its nutritional value could be improved and prepared into composite meal by the addition of peels, vines and leaves that could be fed to rabbits. Cassava root meal, *Moringa oleifera* leaves, *Tridax procumbens*, sweet potatoes vines and cassava leaves could be possible

alternative non-competitive feed ingredients in this regard.

Cassava root is relatively cheaper than maize and is available all year round especially in Benue state. Nigeria is the world largest producer of cassava outputting 156.8% over that of Indonesia the second top producer (5). Cassava yields more carbohydrate per hectare than any other staple food and has the added advantage to societies with limited storage technology that it can be left in the soil for long period after maturity and harvested as needed. Utilization of cassava is limited due to its low protein content, poor amino acid profile (6) and the high content of hydrocyanic acid (HCN). However, inclusion of synthetic amino acids in the animal diets as well as supplementation with richer protein sources have advocated (7, 8).

Forages offer a considerable potential as a major source of energy, protein, minerals and vitamins for herbivorous animals (9). Forages serve as a source of fibre in rabbits' diets and , are essential for normal functioning of the gut health and mobility, caecotrophy and appetite stimulation (10).

The utilization of the cassava root meal (CRM) in combination with other forages in diets of rabbits prompted this study. The objective of this study was to determine the response of rabbits to diets in which cassava root-forage composite meal replaced maize.

Materials and Method

The study was conducted at the Experimental Farm of the School of Animal Technology, Akperan Orshi College of Agriculture Yandev, Benue State, Nigeria. A total of forty weaned mixed crosses of California, New Zealand, American Chinchilla and Dutch rabbits were used for this study. They were aged seven weeks with average weight of 543.50±6.50 g.

The animals were fed diets containing 17% CP and 13% crude fibre for a period of 7 days before commencement of the feeding trial. At the commencement of the experiment, all the rabbits were dewormed with *ivomectin*®. Cassava tubers of TME419 and TMS30572 varieties were purchased from farms within the study area washed, cleaned and efforts were made using knife to produce the optimum cassava chip size for natural drying on cement floor in rectangular shape with dimensions 10 x 10 x 50 mm according to (11). The slices were turned regularly to prevent uneven drying and then milled in a hammer mill with 5 millimetres sieve to produce cassava root meal (CRM).

Leaves of *Moringa oleifera,* cassava, sweet potato vines and *Tridax procumbens* were harvested and air dried under a shade for about 4 – 5 days. The leaves were pounded and milled in a hammer mill with sieve of size 5 millimetre to produce the leaf meals.

Five treatment diets were formulated and designated T1-T5. T1 served as the control diet containing maize grain as the main energy source while T2, T3, T4 and T5 had maize replaced with cassava root-forages composite meals (CR-FCM). The four CR-FCM were prepared in the ratios of 1:1.5, 2.95:1, 2.65:1 and 1:1 respectively, using cassava leaf meal, *Moringa* leaf meal, sweet potato leaf meal

and *Tridax procubens* as forages sources to provide crude protein value similar to maize and these were added to the diets to replace maize in T2, T3, T4 and T5 respectively (Table 1).

Thirty weaned mixed breed rabbits were allocated to five experimental diets with 6 rabbits per treatment in a completely randomized design. Each rabbit served as a replicate and the rabbits were individually fed weighed amounts of their group diet to appetite, daily, and fresh water was offered *ad libitum* throughout the period of the study that lasted 56 days. The left over feeds was collected and weighed before another day's feeding to determine actual intake. Rabbits were weighed weekly to determine body weight changes. Feed conversion ratio was calculated by dividing feed intake by the corresponding body weight gain. Cost of total feed intake was determined as product of total feed intake and the cost per kg diet, while feed cost per unit weight gain was calculated as the product of the feed conversion ratio and the feed cost per kg of each diet based on the prevailing market prices of each of the feed ingredient. The total cost of production was calculated to include the cost of weaned rabbits and feed consumed only. This was based on the assumption that the other cost (fixed and variable) are similar across the treatment groups. Revenue was calculated by multiplying the price per kg rabbit and the total weight gain by the rabbit, while gross margin was determined by subtracting cost of production from revenue. Cost saving was obtained by subtracting the cost incurred for each parameter by rabbits fed the CR-FCM from the cost incurred by those fed the control diet. Cost benefit ratio, which is the indication of profit or loss incurred was calculated by dividing the cost of production by the revenue generated from sales of rabbits. Data collected on each parameter was subjected to analysis of variance (ANOVA) for Complete Randomized Design (CRD) using the Statistical Package for Social Sciences, tenth version (SPSS 15) software, and where significant differences were indicated among treatment means, they were separated using Duncan's multiple range tests.

Results

The growth performance of the rabbits is presented in Table 2. Rabbits fed T1, T2, T3 and T5 gave similar ($P>0.05$) responses with regard to feed intake and body weight gain and were significantly ($P<0.05$) higher than those fed T4 diet. However, those fed T4 and T5 had similar ($P>0.05$) body weight gain. The feed intake of rabbits fed T1 and T2 were similar and significantly ($P<0.05$) higher than those fed T4 diet. Rabbits fed T3, T4 and T5 diets also had similar ($P>0.05$) feed intake. The feed to gain ratio for rabbit fed T3, T1 and T2 diets were similar ($P>0.05$) and significantly ($P<0.05$) better than for those on T4 and T5 diets.

The production economics of rabbits fed cassava root-forage composite meal in diet is shown in Table 3. The cost of one kg of the control diet was ₦108.60 which was higher than those of the test diets which cost between ₦77.24 and ₦77.26. This results to cost saving of ₦31.34 to ₦31.36 due to replacement of maize with the composite meals.

Cost of feed which is a product of cost per kg diet and total feed intake was also higher for the control diet than any of the test diets. The total cost of feeding with cassava root-sweet potato forage meal diet was lower than any other experimental diets. A range of cost saving of ₦73.33 to ₦135.13 per rabbit was achieved due to replacement of maize by cassava root-forage composite meal in rabbit diets.

The amount of money required to produce one kg live weight was ₦377.46 for rabbits fed the control diet. Replacement of maize in the diets with the composite meals caused a reduction of ₦100.95, ₦123.84, ₦87.90 and ₦84.95 for T2, T3, T4 and T5 respectively. The total cost of production was reduced by ₦127.32 to ₦189.13 from ₦996.46, as maize was replaced with the composite meals in diet. Cost saving was maximized when T4 diet was fed to rabbits and minimized when rabbits were rabbits fed T2 diet

Percent feed cost ranged from 34.63 to 39.47 % of the cost of production of those rabbit fed the test diets, and 47.27 % of the cost of production of rabbits fed the control diet. The feed cost as percent of total cost of production was significantly ($P<0.05$) higher for rabbits fed the control diet than those of the composite meal diets. The prevailing market price per kg live weight of rabbit was ₦1000.00, and that of weaned rabbit was ₦500/rabbit. The total cost of production (TCP) which is taken as the cost of weaner rabbits and cost of feed for T1 was higher than the rest of the CR-FCM diets. The cost saving as replacement value of CR-FCM for the control diet ranged from ₦127.32 (T2) to ₦151.62 (T5). Feed constitute 48.53% of the total cost of producing rabbits fed maize diet and between 39.01% to 40.77% for the those fed the CR-FCM diets. Revenue accrued from sale of the rabbits fed control diet was less those fed T2 and T3 but higher than those fed T4 and T5 diets.

The difference between the revenue generated and the cost of production (gross margin) was less than that obtained for T2 and T3, but greater than that obtained for T4 and T5 respectively.

Cost/benefit ratio was less than one in the all the experimental treatment with T3 having the lowest value with a cost benefit ratio of 0.68. All the test diets had better cost benefit ratio than rabbits fed the control diet safe those of T4 (0.81).

Discussion

Using *Moringa* in the mixture with cassava root supported more weight gain than using sweet potato vine meal. The daily weight gains of 20 – 23 g/day attained by rabbits fed control, cassava leave meal, *Moringa*, and *tridax* diets were higher than values reported by (12) and (13) who replaced maize with composite mango fruit reject meal and *Mucuna pruriens* meal respectively. The best performing group of rabbits by (12) and (13) attained 17g/day which is comparable to the lowest daily gain recorded in this study, even though the feed intake was higher than that reported by (12) and (13), FCR of 3.2-3.79 has confirmed a better performance by rabbits in this study compare to 3.71-4.27 (11). The difference in the performance among the treatment groups may be as a result of differences in nutrient utilization, which is a function of

nutrient quality, since all the diets met the nutrient requirement of the rabbits. (14) reported a high profile of vitamins and minerals and a rich amino acid profile in *Moringa oleifera*. This may have caused efficient use of the high metabolizable energy found in cassava root meal and hence the significantly higher body weight gain in the treatment that received the combination of cassava root meal and *Moringa oleifera*, indicating the potential complementary effects of this composite meal. The results of the present study agrees with that of (15) who conducted a trial to simulate complete replacement of maize by sun-dried cassava tuber meal, brewer's dried grain and palm oil mixed at ratios 6:3:1 in the diet of layers and obtained similar results of growth performance. Similarly, (16) reported higher weight gain with diets containing 5 and 10% *Moringa oleifera* in combination with cassava root meal constituting 20% of the diet. The significantly better feed to gain ratio from rabbits fed T3 diet is due to lower feed intake and higher body weight gain. Feed to gain ratio is an indicator of conversion ability of feed by animals to flesh. All rabbits fed the test diets yielded the same result with the control group in this respect. Rabbits on the cassava root mixed with *Moringa* diet however, had the best feed conversion ratio which perhaps might be an indication of a better efficiency of nutrient utilisation by these group than those on T4 and T5 diets respectively.

The low cost of feed is an indication that cassava as an alternative energy source for animal feed is cheaper than maize, and the replacement of maize in diet with cassava and/or cassava based feed ingredients will reduce cost of feed and consequently cost of production.

Cost of feed is a product of feed intake and cost per kg diet, and this was low in T4 due to low feed intake and high in T1 due to the combine effect of cost per kg diet and the high feed intake by the group. This is usually the results whenever cheaper alternative feed material that are equally nutritious and palatable are used to replace the more expensive feed stuff (17, 18).

Result of the present study showed similar feed intake by rabbits fed T1, T2, T3 and T5, but due to the differences in the cost per kg diet and also the different levels of utilization of the diets, rabbits fed T3 diet required lower cost to gain a unit of weight. For similar reason, there was a cost saving of between ₦84.97 - ₦100.95 due to replacement of maize with the other composite diets.

The highest reduction in the cost of production observed among rabbits fed T4 diet was due to the low feed intake by the group because cost of feeding these rabbits was only 36.09 % of the total cost of production. This however is not the best indices to judge the gains of production because performance was compromised. A lower value of 26.57 to 28.88 % for production cost due to feeding of rabbits was reported (19). This is cheaper than the values (36.01% - 40.77%) obtained for production cost due to feed of rabbits on the test diets. It would be expected that there may be more returns from sale of rabbits fed T4 diets, as the total feed cost, and total cost of production was less ($P<0.05$) for this group of rabbits, but this

was not so due to the significantly less weight gain by the group; the weight gain of the rabbits and therefore, feed utilization is directly implicated in this regard. Revenue less total cost of production was higher, and there was more return from the production of T3 rabbits than T4 and T5 which is also a reflection of the differences in weight gain among the treatment groups.

Conclusions and Applications

1. Rabbits fed experimental diets produced similar ($P<0.05$) response with regard to feed intake (73.92 – 79.54) and weight gain (19.83 - 23.10) safe for those fed T4 diet.
2. The feed to gain ratio (3.22) by rabbit fed T3 diets were significantly ($P<0.05$) better than these rabbits fed T4 (3.75) and T5 (3.79) diets, but similar ($P>0.05$) to those fed T1 (3.48) and T2 (3.58) diets.
3. There was a reduction in the cost per kg diet, total feed cost, total cost of production and feed cost as percent of total cost of production, due to replacement of maize with CR-FCM in diet.
4. Profit was made from all treatment and was maximized when rabbits were fed T3 diet while less profit was made from production of rabbits fed T4 diet.

   It is therefore, recommended that cassava root-forage composite meal can replace maize in rabbit diets, and to maximize returns, cassava root-*Moringa* leave composite meal should be preferred.

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Table 1: Composition of Experimental Diets (%)

Ingredients	**Dietary Treatments**				
	T1	**T2**	**T3**	**T4**	**T5**
Maize	38.66	-	-	-	-
Cassava Composite Meal	-	37.34	37.42	37.38	37.34
Full-Fat Soyabean	32.59	32.91	32.83	32.87	32.91
Rice offal	25.00	25.00	25.00	25.00	25.00
Bone ash	3.00	3.00	3.00	3.00	3.00
Palm oil	-	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
Vitamin-mineral premix*	0.25	0.25	0.25	0.25	0.25
	100.00	**100.00**	**100.00**	**100.00**	**100.00**
Proximate Analysis					
Digestible Energy (Kcal/kg)	2778.84	2463.79	2694.63	2576.53	2711.37
Crude Protein (%)	17.32	17.37	17.23	16.03	17.35
Crude Fibre (%)	13.10	15.85	14.36	15.23	17.48
Calcium (%)	1.25	1.50	1.62	1.61	1.92
Phosphorus (%)	1.14	1.12	1.12	1.12	1.11
Lysine (%)	1.10	1.03	2.57	2.70	3.07
Methionine (%)	0.32	0.81	0.84	0.87	0.85
Feed cost(₦/kg)	108.60	77.26	77.24	77.24	77.26

**Contains Vit. A 4000000IU; Vit. D. 800000IU; Vit. E 40000mg; Vit. K3 800mg; Vit. B1 1000mg; Vit. B2 6000mg; Vit.B6 5000mg; Vit.B12 25mg; Niacin 6000mg; Pantothenic acid 20000mg; Folic acid 200mg; Biotin 8mg; Manganese 300000mg; Iron 80000mg; Zinc 20000mg; Cobalt 80mg; Iodine 400mg; Selenium 40mg; Choline 800000mg.*

Table 2: Performance of Growing Rabbits Fed Cassava Root-Forage Composite Meal in Diets

	Dietary Treatments					
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**
Initial weight (g)	529.13	583.00	573.88	575.50	577.25	14.15
Final weight (g)	1860.00^{a}	1827.63^{a}	1867.25^{a}	1545.88^{b}	1687.75^{ab}	36.34
Daily weight gain (g)	22.64^{a}	22.23^{a}	23.10^{a}	17.33^{b}	19.83^{ab}	0.59
Daily feed intake (g)	77.52^{a}	79.54^{a}	73.92^{ab}	65.27^{b}	73.92^{ab}	1.68
Feed Conversion Ratio	3.48^{ab}	3.58^{ab}	3.22^{b}	3.75^{a}	3.79^{a}	0.06

^{abc}Means followed by the same superscript in horizontal rows are not significantly different (P>0.05) from one another; SEM = Standard Error of Mean.

Table 3: Economics of Performance of Growing Rabbits Fed Cassava Root-Forage Composite Meal in Diets

Parameters	Dietary Treatments					
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**
Initial weight (g)	529.13	583.00	573.88	575.50	577.25	14.15
Total weight gain (g)	1267.88^{a}	1245.00^{a}	1293.38^{a}	970.38^{b}	1110.50^{ab}	33.15
Total feed intake	4341.25^{a}	4454.25^{a}	4139.75^{ab}	3655.25^{b}	4139.75^{ab}	94.33
Cost /kg diet (₦)	108.60	77.26	77.24	77.26	77.24	NA
Cost saving (₦)		31.34	31.36	31.34	31.36	NA
Total feed cost (₦)	471.46	344.13	319.75	282.33	319.83	NA
Cost saving (₦)		73.33	97.71	135.13	97.63	NA
Cost/kg weight gain (₦)	377.46	276.51	253.62	289.56	292.49	NA
Cost saving (₦)		100.95	123.84	87.90	84.97	NA
Total cost of production (₦)	971.46	844.14	819.75	782.33	819.84	NA
Cost saving (₦)		127.32	151.71	189.13	151.62	NA
Feed cost (%TCP)	48.53	40.77	39.01	36.09	39.01	NA
Revenue (₦)	1267.86	1245.00	1293.78	970.38	1110.50	NA
Gross margin (₦)	0.77	0.68	0.63	0.81	0.74	NA
Cost/benefit ratio	0.52	0.47	0.44	0.55	0.51	NA

^{ab}Means followed by the same superscript in horizontal rows are not significantly different (P>0.05) from one another; SEM = Standard Error of Mean. Cost of weaned rabbits = ₦500.00/rabbit. Cost/kg live weight = ₦1,000.00.