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Performance of Weaned Rabbits Fed Graded Dietary Levels of Composite Cassava Meal

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Target Audience: Ingredient processors, Feed millers, Rabbit farmers, Nutritionists, Animal Scientists.

Abstract

Thirty-six crossbred (New Zealand White x Chinchilla) weaned rabbits of both sexes averaging 1.03 kg in liveweight and aged 6 – 8 weeks were used in a completely randomized design experiment to evaluate the effect of graded levels of composite cassava meal (CCM) at 0%, 10%, 20% and 30% (designated as Treatments 1, 2, 3 and 4) on the growth performance, digestibility coefficient, nitrogen retention and economics of production of weaned rabbits for 84 days. There were no significant (P>0.05) differences among all the treatments in final live-weight (2.06 – 2.34 kg), daily weight gain (12.30 – 15.71 g), feed conversion ratio (2.58 – 3.19), and protein efficiency ratio (1.62 – 1.80). Average daily feed intakes of the 10% (Treatment 2, 39.70 g), 20% (Treatment 3, 40.51 g) and 30% (Treatment 4, 40.62 g) CCM-based diets were similar but significantly higher than that of the control (Treatment 1, 36.47 g). Crude fibre digestibility coefficients of 0% (56.43%), 10% (59.55%) and 20% (58.29%) CCM diets were higher than that of 30% (52.88%) CCM diet. Crude protein digestibility (Treatment 1 = 79.12%, Treatment 3 = 82.37%, Treatment 4 = 85.50%), nitrogen retention (Treatment 2 = 51.18%, Treatment 3 = 73.43%, Treatment 4 = 85.29%) and gross margin (Treatment 2 = ₦41.37, Treatment 3 = ₦38.42 and Treatment 4 = ₦35.93) increased as the CCM inclusion increased, while cost per kilogramme feed (Treatment 2 = ₦135.0, Treatment 3 = ₦173.5 and Treatment 4 = ₦220.6) and cost per unit weight gain (Treatment 2 = ₦132.0, Treatment 3 = ₦111.9 and Treatment 4 = ₦92.82) decreased as CCM inclusion increased.

Key words: Alternative feedstuff, micro livestock, weaned rabbit, nutrient utilization, profitability

Description of problem

The gap between the requirement and supply of animal protein in Nigeria is attributable to shortfall in animal production (1). This is occasioned by scarcity and high cost of inputs in animal production. This has resulted to escalated

cost due to high demand for the limited livestock products and to low level of animal protein consumption by average Nigerian. Rabbit production can be a panacea to animal protein deficit in the diets of Nigerians (2) because rabbit is prolific, has short gestation period (3), subsists on non-conventional feedstuff (4), and so can be raised on diets that are low in grain and high in roughage.

In many developing countries, feed cost represents over 70% of the total cost of producing livestock intensively (5, 6, 7). Cereal grains and legumes used in compounding feeds are liable to high and fluctuating costs and also in high demand for human consumption and industrial use. This has led to the search for alternative feedstuffs that have of high potential, easily available, cheap and rarely consumed or eaten by man as opposed to conventional ones (8). Farm wastes and by-products can serve as alternative feedstuffs (5). For instance, harvest and utilisation of cassava by human and industries result in accumulation of huge wastes in terms of its leaves, discarded stems, peels, sievetes, etc., and these constitute environmental hazards. Utilization of these by-products as composite cassava meal has been suggested by Ukachukwu (5).

This study, therefore, aims at evaluating the effect of composite cassava meal (CCM) on the growth performance, digestibility coefficient, nitrogen retention and economics of production of weaned rabbits.

Materials and methods

The study was conducted in the Rabbit Unit of Farming Systems Research Department of National Root Crops Research Institute, Umudike, Nigeria. Thirty-six crossbred (New Zealand White x Chinchilla) weaned rabbits of both sexes averaging 1.03 Kg in weight and aged 6 – 8 weeks were randomly allocated to 4 dietary treatments in a completely randomized design experiment of 12 rabbits per treatment, replicated into 3 with 4 rabbits per replicate. The rabbits were housed in experimental hutch made of wood and wire gauze with partitions at a rabbit per partition of 36cm x 36cm x 40cm. Each partition was supplied with aluminium drinkers and feeders which were cleaned daily.

The test ingredient, composite cassava meal (CCM), was prepared in accordance with the recommendation of Ukachukwu (5) in which, cassava tubers were harvested, left for about 12 hours, followed by washing to remove sand. The unpeeled cassava tubers were chipped, bagged, and pressed for 24 hours. It was then released and sun-dried on concrete base for about 72 hours. Discard cassava stems (very old and tender parts) were also collected, chipped, dried and milled. Leaves with petioles were gathered, dried and milled. The three components were mixed in a ratio of 5:2:2, meaning 5 parts of cassava tubers mixed with 2 parts of stems and 2 parts of leaves. The resulting product was included into weaned rabbit diets (Table 1) at graded levels of 10% (Treatment 2), 20% (Treatment 3) and 30% (Treatment 4) in partial replacement of maize and wheat offal in the control diet (Treatment 1). Minor adjustments were made in GNC and palm oil to make the diets isonitrogenous (18% CP) and roughly isoenergetic (2650 - 2700 Kcal/Kg).

The rabbits were weighed individually at the beginning of the experiment and weekly thereafter. Feed and water were provided *ad libitum*. Data on average feed intake, average daily weight gain, feed conversion ratio and protein efficiency ratio were determined within 84-day feeding trial.

At the end of the feeding trial a rabbit per replicate was taken to metabolism cage, giving 4 rabbits in all. The first two days served to get the rabbits used to the new environment. Thereafter, the rabbits were starved for 12 hours prior to the experimental feeding to clear the gut of the previous meals, followed by 4 days feeding during which droppings and urine from the rabbits were collected. They were also starved for another 12 hours at the end of the feeding period to ensure total collection of faeces arising from the diet offered

Table 1: Percent composition of rabbit diets containing graded levels of composite cassava meal

	Treatment			
Parameter	1 (0%)	2 (10%)	3 (20%)	4 (30%)
Maize	48.32	41.00	33.80	26.46
CCM	0.00	10.00	20.00	30.00
Wheat offal	32.34	27.60	22.82	18.05
Groundnut cake	10.27	11.33	12.48	13.63
Fishmeal	4.85	4.85	4.85	4.85
Bone ash	3.00	3.00	3.00	3.00
Vit-Min Premix+	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50
Palm oil	0.47	1.47	2.20	3.26
Total	**100**	**100**	**100**	**100**
Calculated Analysis				
Crude Protein	18.01	17.98	17.96	17.94
ME, Kcal/kg	2702	2669	2666	2651
Crude fibre	4.62	6.37	8.12	9.88

+ Composition of 2.5kg (BioMix) Premix: Vit A (500,000 IU), Vit D3 (100,000 IU), Vit E (2,000 mg), Vit K3 (100 mg), Vit B1 (120 mg), Vit B2 (240 mg), Niacin (1,600 mg), Calcium pantothenate (400 mg), Biotin (3.3 mg), Vit B12 (1.0 mg), Folic acid (40 mg), Choline chloride (12,000 mg), Manganese (4,000 mg), Iron (2,000 mg), Zinc (1,800 mg), Copper (80 mg), Iodine (61 mg), Selenium (4 mg), Growth promoter (1,600 mg), Antioxidant (8,000 mg).

Faeces and urine were collected separately on a daily basis. The faeces were sun-dried for 5 days, weighed and put in a labelled bag and stored. Urine was also collected daily in a labelled container, with the record of the total weight and volume. An amount of 10% of each day's collection was stored in 10ml of 10% concentrated sulphuric acid to prevent nitrogen losses by evaporation of the ammonia and help keep the urine pH below 4. The urine was stored in a refrigerator until required for analysis. At the end of the drying period, faeces from each rabbit in each replicate were mixed, ground and samples taken for proximate analysis. Urine from rabbit in each replicate was also mixed together and samples taken for nitrogen determination.

Proximate composition of diets and faeces, and nitrogen in urine were determined according to the method of AOAC (9). Data obtained were subjected to analysis of variance (ANOVA) in a completely randomised design and differences among the treatment means were separated using Duncan's new multiple range test (10, 11).

Economics of production of weaned rabbits using composite cassava meal was performed at the end of the trial to assess the viability of the ingredient as an economical feedstuff, in accordance with the method of Ukachukwu and Anugwa (12).

Results and discussion

Table 3 shows performance of growing rabbits fed diets containing the different levels of composite cassava meal (CCM). Significant differences ($P<0.05$) were observed for average daily feed intake among the treatment means. Treatment 4 (40.62g), 3 (40.51g) and 2 (39.70g) had similar ($P>0.05$) feed intakes which were significantly higher ($P<0.05$) than that of treatment 1 (36.47g). This shows that the rabbit's consumption increased as the level of inclusion of CCM increased. As CCM inclusion level increased dietary fibre level also increased (Table 2). This may have encouraged higher consumption of the diets with higher CCM inclusion. Since higher dietary fibre results in energy dilution of the diets, the rabbits had to consume more to meet their energy requirement. This agrees with the report of (13, 14) that growing rabbits adjusted their feed intake according to energy and crude fibre content of the feed given to them.

Table 2: Proximate composition of experimental diets containing graded levels of composite cassava meal

	Treatment			
Proximate component	1 (0%CCM)	2 (10%CCM)	3 (20%CCM)	4 (30%CCM)
Dry matte	92.74	93.56	93.60	93.64
Crude protein	20.08	20.73	21.70	22.53
Crude fibre	8.70	9.75	9.90	10.25
Ether extract	3.15	3.40	3.85	4.20
Nitrogen-free extract	54.56	52.83	51.25	49.01
Ash	6.25	6.85	6.90	7.65

There were no significant (P>0.05) differences among the treatments for mean initial live weight, mean final live weight, average daily weight gain (DWG), feed conversion ratio (FCR) and protein efficiency ratio (PER) (Table 3). However, there was a tendency to better performance as the CCM inclusion increased, though the improvement was not significant. This could be an apparent reflection of the feed consumption pattern or suggestion of caecotrophy activities due to presence of CCM. However, the presence of CCM did not significantly increase dietary crude fibre (Table 2), hence there was no disparity in the utilisation of the diets. Champe and Maurice (15) had reported that rabbits require a level of crude fibre of about 9% for normal growth and to encourage caecotrophy, which aids in the re-absorption of certain nutrients including essential amino acids and certain vitamins not previously utilized at first by rabbits (16, 17). Generally, the incorporation of dried cassava foliage into the CCM could have enhanced the utilization of root component of the CCM by the rabbits. The foliage contributed crude protein to balance the protein: energy ratio of diets. It also contributed crude fibre, minerals and vitamins. These may have enhanced utilization of both the cassava meal and the entire diet. This agrees with the suggestion of Akinfala *et al* (18) that incorporation of dried cassava foliage could enhance the metabolism and utilization of cassava roots. Furthermore, the rabbits were able to handle and tolerate the toxic and inhibitory substances (HCN) contained in the CCM-based diet. It is possible that the mode of action of the microbes in the alimentary system of the rabbits may have acted on the toxic and inhibitory substances in the CCM-based diet. The report of Fielding (19) agrees that rabbits posses special microbes in the alimentary system that can counteract the effect of toxic and inhibitory substances in their diets. Eriquenz and Ross (20) had earlier suggested incorporation of leaves and methionine as means of overcoming the adverse effect of HCN in cassava roots.

No significant differences (P>0.05) were observed for dry matter (DM), ether extract (EE) and nitrogen-free extract (NFE) among treatment means (Table 4). A range of DM digestibility coefficient was 78.18% (in the 10% CCM group) to 78.57% (in the 30% CCM group) with an average of 78.39%. Ether extract (EE) digestibility coefficients ranged from 85.72 (in the 30% CCM group) to 87.58 (in the 0% CCM group) with an average of 86.28%. NFE digestibility coefficients ranged from 80.45% (in the 30% CCM group) to 80.81% (in the10% CCM group) with an average of 80.58%.

Table 3: Performance of weaned rabbits fed graded levels of composite cassava meal-based diets

	Treatment				
Parameters	1 (0%)	2 (10%)	3 (20%)	4 (30%)	SEM
Mean initial weight, K g	1.03	1.04	1.03	1.02	0.01
Mean final weight, Kg	2.06	2.09	2.20	2.34	0.08
ADFI g	36.47^b	39.70^a	40.51^a	40.62^a	0.76*
ADWG g	12.30	12.50	13.93	15.71	0.92
Feed conversion ratio	3.06	3.19	2.91	2.58	0.19
Protein efficiency ratio	1.80	1.62	1.69	1.83	0.10

$^{a, b}$ = Figures followed by different superscripts are significantly different from each other at * P<0.05
ADWG =Average daily weight gain ADFI Average daily feed intake

The crude fibre digestibility coefficient of treatments 1 (56.43%), 2 (59.55%), and 3 (58.29%) were statistically the same (P>0.05) but significantly higher (P<0.05) than that of treatment 4 (52.88%). As the level of CCM increased in treatment 2, 3 and 4 the digestibility of crude fibre decreased. This could be attributed to the rapid passage of diet, since high fibre level encourages bowel movement (21).

Table 4: Effect of Graded Levels of Composite Cassava Meal-based Diets on the Apparent Digestibility of Nutrients

	Treatment				
Parameters	1 (0%)	2 (10%)	3 (20%)	4 (30%)	SEM
Dry matter, %	78.44	78.18	78.37	78.57	0.26
Crude protein, %	80.85[c]	79.12[d]	82.37[b]	85.50[a]	0.44*
Crude fibre, %	56.43[a]	59.55[a]	58.29[a]	52.88[b]	0.99*
Ether extract, %	87.58	86.67	86.96	85.72	0.52
Nitrogen-free extract, %	80.61	80.81	80.46	80.45	0.53

[a, b, c, d] = Figures followed by different superscripts are significantly different from each other at * P<0.05

Crude protein (CP) digestibility coefficients of treatment 4 (85.5%) was higher than that of treatment 3 (82.37%), which was itself higher than that of the control (80.85%), and the control was in turn significantly higher than that of treatment 2 (79.12%). Treatment 2, 3 and 4 increased in CP digestibility coefficient as the level of CCM increased. This could be due to the microbial activity in the digestive system that may have increased as level of protein supplied by the CCM increased (22). The dietary protein level could have direct influence on the protein digestibility of the diet. Davidson and Spreadburg (23) had reported that there is a significant correlation between the protein content of the feed and the crude protein digestibility.

Nitrogen intake of treatments 4 (1.37g) and 3 (1.32g) were similar (P>0.05) but higher (P<0.05) than that of treatment 2 (1.23g) which was also higher (P<0.05) than that of treatment 1 (1.09g) (Table 5). Nitrogen intake increased as the level of CCM increased. This reveals that as CCM increased, consumption of protein also increased which is in agreement with the report of Tram and Preston (24) and Amaefule *et al* (25) that the differences in nitrogen intake could be attributed to crude protein content of diets.

Digested nitrogen and nitrogen retention for treatment 4 (0.88g and 0.75g) were significantly higher (P<0.05) than those of treatment 3 (0.76g and 0.56g) which was in turn higher (P<0.05) than those of treatments 2 (0.59g and 0.30g) and 1 (0.51g and 0.28g) that were themselves similar (P>0.05). As the level of CCM increased digested nitrogen also increased. Kidder and Manners (26) had reported that the digestibility of a particular protein will vary to some extent according to the level of feeding and other constituents of the diet. Nitrogen intake significantly (P<0.05) influenced digested nitrogen and nitrogen retention. It was observed that as digested nitrogen and nitrogen retention increased among the treatments the crude protein digestibility coefficient (Table 2) also increased.

Table 5: Nitrogen balance of weaned rabbits fed graded levels of composite cassava meal-based diet

	Treatments				
Parameters	1 (0%)	2 (10%)	3 (20%)	4 (30%)	SEM
Nitrogen intake, g	1.09[c]	1.23[b]	1.32[a]	1.37[a]	0.02*
Faecal nitrogen, g	0.57[b]	0.64[a]	0.56[b]	0.49[c]	0.02*
Urine nitrogen, g	0.23[b]	0.29[a]	0.20[b]	0.13[c]	0.02*
Digested nitrogen, g	0.51[c]	0.59[c]	0.76[b]	0.88[a]	0.04*
Nitrogen retention, g	0.28[c]	0.30[c]	0.56[b]	0.75[a]	0.05*
Retention as % of intake	25.47[b]	24.69[b]	42.24[a]	54.99[a]	4.37*
Retention as % of digested	51.88[b]	51.18[b]	73.43[ab]	85.29[a]	7.20*

[a, b, c] = Figures followed by different superscripts are significantly different from each other at * P<0.05

The increase observed in the digested nitrogen and nitrogen retention could be as a result of influence of digested crude protein. This in turn encouraged the growth performance and protein efficiency ratio of the rabbits in treatment 3 (Table 3).

Retention as percent of nitrogen intake and retention as percent of nitrogen digested for treatments 4 (54.99 and 85.29) and 3 (42.24 and 73.43) were similar (P>0.05) but higher (P<0.05) than treatments 2 (24.69 and 51.18) and 1 (25.47 and 51.88) which were themselves similar (P>0.05). Both increased numerically as the level of CCM increased.

In this study, differences in nitrogen intake resulted in significant differences in digested nitrogen, nitrogen retention, and retention as percent of nitrogen intake and digested, suggesting that differences in nitrogen intake were biologically important. The results also show that nitrogen utilization and growth of weaned rabbits are affected by level of incorporation of CCM in the diet.

There were significant differences (P<0.05) among treatments in all measured parameters of economics of production except revenue (Table 6). Relative cost/kg feed for treatment 4 (67.10%), 3 (71.75%) and 2 (77.25%) were smaller than the control (100%) by 32.9%, 28.25% and 22.75% respectively. This could be as a result of the cost and quantity of each ingredient used in compounding the diets especially CCM in relation to maize and wheat offal which it replaced. The level of inclusion of CCM in the diets significantly (P<0.05) minimized the cost per kg feed in the treatments. This is in agreement with the observation of Ukachukwu (8) that most of the alternative feedstuffs are still much cheaper than the conventional ones, and their use will, therefore, minimize cost input in feed formulation. Cost (₦) of total feed consumed per rabbit followed the same trend as that of cost per kg feed. Treatment 1 (₦164) was significantly higher (P<0.05) than treatments 2 (₦138), 3 (₦130.70), and 4 (₦122.60). However, treatment 2 was similar (P>0.05) to treatment 3 but higher (P<0.05) than treatment 4, while there were no significant differences (P>0.05) among treatments 3 and 4. These differences derive from the cost per kg of the various feeds consumed by the rabbits. Though the experimental diets (treatments 2 and 3) were equally consumed, the differences in price of each, occasioned by the levels of CCM, reflected in the cost of total feed consumed.

Table 6: Effect of Graded Levels of Composite Cassava Meal-Based Diet on Economics of Production

	Treatments				
Parameters	1 (0%)	2 (10%)	3 (20%)	4 (30%)	SEM
Cost/kg feed (₦)	53.55	41.37	38.42	35.93	
Relative cost/kg feed (%)	100	77.25	71.75	67.10	
Cost of total feed consumed/ rabbit (₦)	164.0[a]	138.0[b]	130.7[bc]	122.6[c]	3.19
Cost/kg weight gain (₦)	163.7[a]	132.0[ab]	111.9[bc]	92.8[c]	9.93
Revenue (₦)	268.67	273.00	304.20	343.20	20.12
Gross margin (₦)	104.6[c]	135.0[bc]	173.5[ab]	220.6[a]	17.20

a, b, c = Figures followed by different superscripts are significantly different from each other at * P<0.05

Cost per kg weight gain (₦) for treatment 1 (₦163.70) was the same (P>0.05) but significantly higher (P<0.05) than those of treatments 3 (₦111.90) and 4 (₦92.82) that were themselves similar (P>0.05). Cost per kg weight gain (₦) for treatment 1 was the similar (P>0.05) to that of 2 (₦132.00). Also, treatments 2 and 3 were not different (P>0.05) from each other. The cost observed in treatment 2, 3 and 4 reduced numerically as CCM increased. This could be as a result of higher incorporation of CCM in the diet and the ability of the rabbits to convert the feed to flesh. This agrees with the report of Ukachukwu and Anugwa (12) that least-cost feed formulation seeks to achieve cost input minimization and output maximization.

Revenues (₦) were not significantly different (P>0.05) among the treatments. Gross margins for treatments 4 (₦220.6) and 3 (₦173.50) were similar (P>0.05) but higher (P<0.05) than treatments 2 (₦135) and 1 (₦104.6) which were similar (P>0.05). However, treatments 2 and 3 were themselves also similar (P>0.05). Generally, gross margin increased numerically as CCM incorporation increased in the diets.

The results made economic sense which is very important in view of the high cost feed in the total operating cost and its effect on profitability in rabbit production. Gross margin results show that using CCM in formulation of feed for rabbit production has effect of raising net-returns. This will result in cost reduction since incorporation of CCM up to 30% level in the diet could still yield profit more than the control. This will result in the reduction of price of rabbit meat and product to affordable price. Its utilization will also curtail the competition between man and animal for available food.

Conclusion and application

1 From the foregoing, it could be concluded that 30% inclusion of CCM in the ration of weaned rabbit gave the overall best result in growth performance indices and economic gains compared to the lower inclusion levels.

2 It is therefore recommended that 30% level of CCM inclusion in weaned rabbit feed formulation be used for higher productivity.

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