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Effects of different levels of composite boiled sweet potato meal on performance and nutrient digestibility of growing rabbits

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***Target audience:** Nutritionists, Farmers and Policy makers*

Abstract

An experiment was conducted to evaluate the effects of different levels of composite boiled sweet potato meal (CBSPM) on performance, nutrient digestibility and economics of production of growing rabbits. Twenty four growing rabbits (New Zealand White x Chinchilla) averaging 1.14kg body weight were fed maize-based control diet (0%) and 10%, 20% and 30% replacement levels of maize with composite boiled sweet potato meal (CBSPM) and were designated Treatment 1, Treatment 2, Treatment 3 and Treatment 4 respectively. The experiment was arranged in a completely randomized design (CRD) replicated three (3) times with two (2) rabbits per replicate. The rabbits were fed ad-libitum throughout the period of the experiment. Data was collected on feed intake, weight gain and feed conversion ratio (FCR). There was significant difference (P<0.05) in feed intake as Treatment 4 had the highest feed intake while rabbits in Treatment 1 (control) had the lowest Feed intake. Treatment 4 also had significantly (p<0.05) higher final body weight, average daily weight gain and better feed conversion ratio followed by treatment 3 and 2 respectively. Weight gain increased as CBSPM increased in the diet. Forage meal mixture with the boiled sweet potato meal in the diets encouraged better digestibility of crude protein and Ether extract. Crude fibre digestibility reduced as CBSPM increased in the diet. Results for economics of production also shows that Treatment 4 had the lowest cost per kg feed, cost of total feed consumed per rabbit and cost per kg weight gain thus, gave the highest revenue and gross margin. It can be concluded that the test ingredients encouraged better performance of the rabbits with 30% replacement of maize with CBSPM recommended as the best as it gave better results in terms of growth, nutrient digestibility and economics of production of rabbits without adverse effects.

***Key words:** Rabbits, Composite Sweet Potato meal, nutrient digestibility, bio-economics*

Description of Problem

The tremendous increase in population and high demand of feedstuff, which causes rapid increase in the cost of feed, has led to the search for alternative low cost energy sources. In monogastric herbivores like rabbits, feedstuff represents 65% -70% of the total cost in an intensive production system (1). Limited supply of raw materials for the livestock feed industry has resulted in a continuous increase in the cost of livestock products. Energy source constitutes between 45 – 60% of finished feed (2). Maize is the commonly used source of energy in livestock feed. The increasing pressure on the use of maize by human population and livestock producers as well as the scarcity and cost of maize which, fluctuates with season makes the grain scarce and costly.

Sweet potato tuber is recognized as

cheaper carbohydrate source than grains. They have high caloric yield per hectare and low production cost (3). Sweet potato tubers are good energy sources while the leaves have substantial protein and vitamin contents; so both can be useful in rabbit feeding. This implies they can substantially substitute cereal grains in rabbit feed formulation. Maize and sweet potato have comparable metabolizable energy values of 14.5 and 14.8 (Kcal/g) respectively (4). The digestibility of sweet potato carbohydrate fraction is reported to be above 90% (5). However, the level of starch decreases with period of storage and instead the level of reducing sugars, total sugars and total dextrins increases (4). Sweet potatoes have also been reported to exhibit trypsin inhibitor activity ranging from 20 to 90% inhibition (4). However, (5) reported that trypsin inhibitor levels present in sweet potato tubers are low and should not be a cause for concern under practical situations. A study carried out by (6) recommended 27% and 30% levels of sweet potato in starter and finisher broiler diets respectively. However, Beckford and Bartlett (4) reported having replaced 50%-75% of maize in poultry feed with dried sweet potato flour without adverse effects on the growth of broilers. Currently, not much work has been done on the use of sweet potato as rabbit feed in south east Nigeria. Thus the objective of this study was to evaluate performance and nutrient digestibility of growing rabbits fed different levels of composite boiled sweet potato meal.

Materials and Methods

The experiment was carried out at the Rabbitary unit of the National Root Crops Research Institute, Umudike, south east Nigeria. Matured sweet potato tubers were harvested, washed, chipped, boiled inside water at 100^{o}C for 30 minutes using a metal pot, after the water was decanted the boiled chips were sundried for four weeks during dry season and then milled. The matured leaves were harvested, chopped, sundried two weeks and then milled. The milled tubers and leaves were mixed in the ratio of 3:2 (composite boiled sweet potato meal (CBSPM)) and the proximate composition analysed using the procedure of (7). The gross energy was determined using Adiabatic Bomb Calorimeter.

Twenty four (24) cross breed of New Zealand white x Chinchilla growing rabbits with average weight1.14kg were randomly allotted to four treatment groups of six (6) rabbits each. Each treatment group was replicated thrice with two (2) rabbits per replicate. The groups were randomly assigned to four (4) iso-caloric and iso-nitrogenous diets in a completely randomized design (CRD) experiment, Four (4) experimental diets were formulated such that Treatment 1 (control) contained 0% composite boiled sweet potato meal, Treatment 2 contained 10% composite boiled sweet potato meal (CBSPM), Treatment 3 contained 20% composite boiled sweet potato meal (CBSPM) and Treatment 4 contained 30% composite boiled sweet potato meal (CBSPM).Other ingredients were added to meet the needs of growing rabbits for proteins, vitamins and minerals.

All experimental rabbits were given feed and water *ad-libitum*. Records of average final weight gain, average daily weight gain, average daily feed intake and feed conversion ratio were taken. The experimental diets were fed for 12 weeks.

Economic analysis of production

Cost analysis was carried out at the end of the trial period to assess the viability of using the test ingredient according to the procedure given by (8) and modified by (9).

These parameters were calculated as follows:

Cost/kg feed = Total cost of producing 100kg of feed /100.

Cost of feed consumed (₦) = Cost/kg of feed × total feed consumed.
Cost/kg weight gain = Cost/kg of feed × feed conversion ratio.
Revenue = Price of 1kg meat × mean weight gain.
Gross margin = Revenue – Cost of production

Digestibility Trial

At the end of the experiment, a rabbit from each replicate was taken to metabolic cage and the first 2 days were used as acclimatization period. Thereafter, the rabbits were starved for 12 hours prior to the experimental feeding to clear the gut of the previous meals. This was followed by 7 days of feeding *ad-libitum* during which their faeces 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. Faeces and urine were collected separately on a daily basis. The faeces were sun-dried to a constant weight and put in a labeled bag and stored for proximate analysis. The dried faeces were mixed, grounded and sent for proximate analysis. Urine was also collected daily in a labeled 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 ammonia and help keep the urine pH below 4. The urine was stored in a refrigerator until required for analysis at the end of 7 days collection period.

The feeds and faeces were analyzed for their proximate composition according to (7). The data collected were subjected to analysis of variance (ANOVA) and means separated where there were significant differences by Duncan multiple range-test as outlined by (10). Data analysis was done using the computer package SPSS.

Table 1: Proximate analysis of composite boiled sweet potato meal

PROXIMATE (%)	CBSPM
Crude Protein	8.79
Crude Fibre	5.10
Ether Extract	7.55
Nitrogen Free Extract	67.25
Ash	11.32
Gross Energy(Kcal/g)	3.27

Results and Discussion

The growth performance of the rabbits fed the experimental diets is presented in table 4. There were significant differences ($p<0.05$) among the treatment groups in their daily feed intake. Significantly ($p<0.05$) treatment 4 were more consumed than Treatments 3, 2 and 1. The level of consumption among the treatments significantly increased ($p<0.05$) as the level of composite boiled sweet potato meal increased in the diet. This indicates that treatment 4 is more palatable than other treatments. It could also mean the energy decreased as the levels of the composite meal increased in the diet. This agrees with the report of Raharjo (11) that sweet potato and its foliage is palatable to rabbits. The total average feed intake of the rabbits in treatment 4, 3 and 2 were significantly higher ($p<0.05$) than those of the control diet. This may be compensatory feeding which agrees with the report of (12) that the leaves included in the ration provided additional crude fibre which diluted energy of the feed consumed by rabbits fed composite boiled sweet potato meal (CSPM).

There were significant differences ($p<0.05$) among the treatment groups in their daily gain and final weight thus, rabbits in treatment 4 had the highest ($p<0.05$) daily gain and body weight followed by rabbits in treatments 3 and 2 respectively while those of control diet (treatment 1) had the lowest value. (13) also obtained higher average daily weight gain with concentrate mixed feeding.

Table 2: Gross composition of experimental diets (%)

	Treatments			
Ingredients	**1(0%** CBSPM)	**2(10% CBSPM)**	**3(20% CBSPM)**	**4(30% CBSPM)**
Maize	53.00	47.70	42.40	37.10
CBSPM	0.00	5.30	10.60	15.90
Wheat Offal	28.75	28.75	28.75	28.75
Groundnut Meal	14.50	14.50	14.50	14.50
Bone Meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
Vitamin Mineral Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated values				
ME Kcal/kg	2723	2713	2703	2692
Crude protein	16.71	17.02	17.33	17.65
Crude fibre	4.52	4.95	5.32	5.80

CBSPM: Composite boiled sweet potato meal, ME: Metabolisable energy, Kcal: kilocalorie,
**1kg of premix contains: vitamins A (5,000,000 I.U), VitaminD3 (1,000,000 I.U), Vitamin E (16,000mg), Vitamin K3 (800mg), Vitamin B1 (1,200mg), Vitamin B2 (22,000mg), Niacin (22,000mg), Calcium pantothanate (4,600mg), Vitamin B6 (2,000mg), Vitamin B12 (10mg), Folic acid (400mg), Biotin (32mg), Choline chloride (260,000mg), Manganese (948,000mg), iron (40,000mg), Zinc (32,000mg), Copper (3,400mg), Iodine (600mg), Cobalt (120mg), Selenium (48mg), Anti-oxidant (48,000mg).*

Table 3: Proximate composition of experimental diets

	Treatments			
Proximate (%)	**1(0% CBSPM)**	**2(10% CBSPM)**	**3(20% CBSPM)**	**4(30% CBSPM)**
Dry matter	93.16	92.54	91.30	90.60
Crude protein	16.62	18.20	18.37	18.76
Crude fibre	7.94	8.43	8.62	8.70
Ether extract	5.40	4.20	3.94	3.70
Nitrogen free extract	7.10	7.45	8.74	9.24
Ash	56.10	54.27	51.63	50.20

Table 4: Performance of growing rabbits fed graded levels of composite boiled sweet potato meal (CBSPM)

	Treatments				
Parameters	1(0%) CBSPM	2(10%) CBSPM	3(20%) CBSPM	4(30%) CBSPM	SEM
Mean initial live weight (kg)	1.14	1.14	1.15	1.13	0.01
Mean final live weight (kg)	1.73^{d}	1.80^{c}	1.85^{b}	1.97^{a}	0.03
Average Daily feed intake(g)	14.05^{d}	15.79^{c}	16.74^{b}	20.00^{a}	0.16
Average daily weight gain (g)	45.00^{d}	50.00^{c}	51.67^{b}	54.33^{a}	0.24
Feed conversion ratio	3.29^{a}	3.15^{b}	3.09^{c}	2.75^{d}	0.36

a,bc, Means on the same row with different superscripts differs significantly ($p<0.05$) .

The performance of the rabbits in treatment 4 maybe because the sweet potato leaf meal had higher content of crude protein and crude fibre. There were also significant differences {$p<0.05$} in the feed conversion ratios of the treatment groups. Treatment 4 had superior {$p<0.05$} feed conversion ratio followed by treatment 3 and 2 respectively, while treatment 1 {control} had the poorest feed conversion ratio.

Table 5 shows apparent digestibility coefficients of feed nutrients. Significant differences {$p<0.05$} were observed in all the component nutrients except nitrogen-free extract. The treatments that had levels of composite boiled sweet potato meal (CBSPM) included in their diets had the best apparent digestibility coefficients for crude protein and ether extract. Treatment 4 had the best ($p<0.05$) apparent digestibility coefficient for crude protein and ether extract, while treatment 1 {control} had the poorest {$p<0.05$} apparent digestibility coefficient for crude protein and ether extract.

The better {$p<0.05$} apparent digestibility coefficients observed among rabbits fed the experimental diets {composite boiled sweet potato meal} could be due to the method of processing of feedstuff used (14, 15). According to (16) and (17), the ability of rabbits to efficiently digest the protein in forages is associated with caecal fermentation and cecotrophy.

The observed non-significant difference ($P>0.05$) in the nitrogen-free extract (NFE) digestibility of the treatment groups agrees with the report of (18).

Table 5: Apparent digestibility values of growing rabbits fed graded levels of composite boiled sweet potato meal (%)

	Treatments				
Parameters	1(0%CBSPM)	2(10%CBSPM)	3(20%CBSPM)	4(30%CBSPM)	SEM
Dry matter	78.04	79.70	79.94	80.53	0.03
Crude protein	82.61^{c}	86.39^{b}	86.29^{b}	88.68^{a}	0.05
Crude fibre	74.09^{c}	76.33^{a}	72.16^{b}	72.00^{b}	0.04
Ether extract	82.57^{b}	81.78^{c}	89.10^{a}	90.03^{a}	0.08
Nitrogen-free extract	79.07	80.67	79.88	79.94	0.02

a,b,c, Means on the same row with different superscripts are significantly different ($p<0.05$)

Table 6 shows the bio-economics of production of rabbits fed graded levels of composite boiled sweet potato meal (CBSPM). There were significant differences ($p<0.05$) observed for all parameters considered in bio-economics of production. Treatment 4 had the lowest ($p<0.05$) cost per kg feed followed by treatments 3 and 2 respectively.

Table 6: Bio-Economics of production of rabbits fed graded levels of composite boiled sweet potato meal (CBSPM)

	Treatments				
Parameters (₦)	1(0%CBSPM)	2(10% CBSPM)	3(20% CBSPM)	4(30% CBSPM)	SEM
Cost/kg feed	61.81[a]	56.70[b]	49.75[c]	44.76[d]	
Cost of total feed consumed/rabbit	116.82[a]	119.07[b]	107.96[c]	102.15[d]	0.13
Cost/kg weight gain	203.56[a]	179.36[b]	153.56[c]	123.24[d]	0.27
Revenue	206.50[d]	232.17[c]	246.17[b]	294.00[a]	0.35
Gross margin	89.68[d]	113.10[c]	138.21[b]	191.85[a]	0.20

a,b,c, Means on the same row with different superscripts are significantly different ($p<0.05$)

Treatment 1 (control) which is a maize-based diet had the highest cost per kg feed. This indicates that maize is a high cost conventional feed cost, while composite boiled sweet potato meal (CBSPM) is a low cost alternative feed ingredient. For cost of total feed consumed per rabbit, treatment 4 was significantly lower ($p<0.05$) than treatments 3 and 1 respectively while treatment 2 had the highest ($p<0.05$) value. There was also significant difference ($p<0.05$) among treatments for cost per kg weight gain. This followed the same trend with the values of the average daily weight gain. As the level of composite boiled sweet potato meal (CBSPM) increased in the diet, the value of the cost per kg weight gain reduced. This shows that composite boiled sweet potato meal is a low cost feed ingredient that also enhanced the animals' growth performance. Treatment 4 gave the highest ($p<0.05$) revenue and gross margin followed by treatments 3 and 2 respectively. Treatment 1 gave the lowest revenue and gross margin as well as highest cost per kg feed and cost per kg weight gain.

Conclusion and Applications

1. Composite boiled sweet potato meal (CBSPM) appears to be a better alternative feedstuff that can conveniently replace maize optimally at 30% level of inclusion in rabbit feeding without any adverse effect on the rabbits.
2. Result showed that feeding rabbits with CBSPM enhanced growth performance, nutrient digestibility and reduced cost of production.

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