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The Productive Parameters and cost benefit Analysis of growing Rabbits Fed cooked Bambara groundnut meal in the semi- arid zone of Nigeria

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Abstract**—** *A ten-weeks feeding trial was conducted to determine the effect of replacing groundnut cake (GNC) with cooked Bambara nut meal (CBNM) on the performance of growing rabbits. Thirty mixed breed (New Zealand White X Dutch) of rabbits six to seven weeks of age with average initial body weight of 604.50 g were caged individually and allotted to five (5) dietary treatments. Each treatment had six (6) replications. The rabbits were given diets and clean drinking water ad libitum throughout the period of experimentation. In diets 1(control), 2, 3, 4 and 5 CBNM replaced GNC at 0%, 25%, 50%, 75% and 100%, respectively. The productive parameters measured include; feed intake, weight gain, feed conversion ratio. All data collected in the course of the experiment were subjected to analysis of variance (ANOVA) using the completely randomized design (Steel and Torrie, 1980) and where applicable Duncan's multiple range test, was used for mean separation, while analysis of economics of production was carried out based on the prevailing market prices of feed ingredients at the time of study. The cost per kilogram of each test diet, the cost of feeding rabbits on the test diets throughout the period of the experiment and the cost per kilogram of weight gained by the rabbits were used in assessing the economics of replacing different levels of groundnut cake with cooked Bambara nut meal. Daily feed intake was significantly (P<0.05) different among treatment groups with the control (0% CBNM) consuming more feed than those on different levels of CBNM. Daily feed intakes were 69.07 g, 59.51 g, 61.51 g, 60.53 g and 62.99 g for rabbits on the 0%, 25%, 50%, 75% and 100% CBNM levels, respectively. There were no significant difference (P>0.05) among treatments groups in weight gain, feed conversion ratio (FCR) and Use of CBNM as replacement for GNC resulted into a savings of at least ₦46.00 when 100% CBNM and up to ₦72.00 when 50% CBNM was used instead of GNC in growing rabbits' diets. It was concluded that CBNM can replace up to 50% of the GNC in the diets of growing rabbits for optimum economic benefit.*

Keywords**— Productive, Cost-benefit, Cooked Bambara Nut Meal and Growing Rabbits.**

I. INTRODUCTION

In order to overcome the problem of protein shortages, attention is now focused on the production of animals that are prolific and capable of using different sources of feeds that are less costly or which are underutilized (Balogun *et al*., 2003; Omoikhoje *et al*., 2005 and Igwebuike *et al*., 2005).Ahamefule *et al*. (2005) reported that in recent times a case has been made for rabbit production as a realistic approach to counter the animal protein deficit in the diet of Nigerians. According to Igwebuike *et al*. (2005) strategies advanced include the use of prolific animals and alternative non-conventional feed ingredients for feeding livestock. Rabbit production is one of such alternatives as the animal is highly prolific and is known to thrive on a variety of feed ingredients.

In the field of monogastric nutrition, protein sources such as groundnut cake and soyabean meal are costly. The Bambara groundnut (*Voandziea subterranea*) is being experimented as an alternative to the conventional leguminous protein sources which are vital in the feeding of monogastric animals (Omoikhoje *et al*., 2005). These authors reported that Bambara groundnut is an underutilized feed resource for livestock and it is indigenous to Africa. Therefore, it can be a useful alternative to groundnut cake and soyabean meal. This is because of its nutritional qualities which are comparable

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to other leguminous feed ingredients. Pfeffer *et al*. (2002) explained that Bambara groundnut contained 27% crude protein, 60% nitrogen-free extract, 9% ether extract and gross energy of 19 MJ/Kg DM. The crop is cultivated under a wide range of soil and climatic conditions. It is known to be cultivated in the semi-arid environment. Joseph *et al*. (1999) reported that Bambara groundnut seeds are virtually free from metabolic inhibitors and toxins, a common phenomenon in most legumes. However, Omoikhoje *et al*. (2005) have reported that it has trypsin inhibitors, which can be removed by heat treatment.

Therefore, with the recent advocacy for increased protein in the diet of people living in developing countries through integrated livestock and crop production, rabbit production using under-utilized crops such as Bambara will be a step towards improving the nutritional and economic status of most peasant farmers, especially in the semi- arid zone of Nigeria. The objective of this study was therefore to investigate the effects of using cooked Bambara groundnut meal (CBGM) as a replacement for groundnut cake (GNC) on the productive parameters and to undertake the cost-benefit analysis of using the varied levels of CBGM in the diet of growing rabbits, in Maiduguri

II. MATERIALS AND METHODS

The feeding trial was conducted at the Teaching and Research Farm, department of Agricultural Technology, Ramat Polytechnic Maiduguri. Maiduguri is located within latitude 11^0 5' north and longitude 13^0 9' east (Encarta, 2007). It has an altitude of 354m above sea level (Alaku, 1983). The vegetative zone falls within the sahelian region of West Africa. The annual rainfall varies from 500-600mm with short duration of 3-4 months rainy season; long dry season of 7-8 months is prevalent. According to Ugherughe and Ekedolum (1986), the mean relative humidity ranges from 30%-50% around February to March, while maximum record of 90% is observed around August. Ambient temperatures are higher during the months of April to May and may reach up to 40^0 C and above (Alaku, 1983). According to Aliyu (2007), ambient temperature could be as low as 20^0C during the cold season while during the hot period, which is between February to June, it can reach 44^0 C.

Method of Processing Bambara groundnut seeds The Bambara groundnut seeds were subjected to cooking at boiling point (100^0C) for a period of one hour in an aluminum cooking pot containing water sufficient enough to cover the seeds using firewood as a source of fuel. After cooking for the period of one hour, the seeds were separated from the water and sun-dried for five days. This is to ensure complete reduction of moisture for ease of milling as corroborated by Omoikhoje *et al*. (2005) and Omoikhoje *et al*. (2006). The sun-dried seeds were then milled and used for the preparation of the experimental diets.

Experimental stock and management Thirty (30) mixed breed (New Zealand white X Dutch) of rabbits 6-7 weeks of age, were used for the feeding trial that lasted for the duration of ten (10) weeks, excluding one (1) week of adjustment period. The rabbits were weighed and randomly assigned to five (5) different dietary treatments, each treatment containing six (6) replicates. The rabbits were kept in separate cages made from wire with dimensions of 42cm x 42cm x 43cm (LX W X H). Cages were raised above the ground level for ease of cleaning. Metallic feeding trough and plastic drinkers were provided in each cage. Water and feed were provided *ad libitum* throughout the period of experiment. Five (5) experimental diets were prepared in which cooked Bambara groundnut meal (CBGM) replaced groundnut cake (GNC) as a source of protein at 0%, 25%, 50%, 75% and 100% levels in diets 1,2,3,4 and 5 respectively, as shown in Table 1. The parameters measured were daily feed intake, daily weight gain, feed conversion ratio, nutrient digestibility, carcass components, haematological characteristics and cost-benefit analysis.

Daily feed intake A known quantity (100g) of the experimental diets was fed to the animals in each treatment daily, the leftover of the feed was subtracted from the quantity given to determine daily feed intake of each rabbit. Daily weight gain was determined by weighing the animals at the onset of the experiment and weekly thereafter. The difference in weight at the end of each week gives the weight gained for that week and this is divided by seven to obtain the daily weight gain in grams.

Body weight gain/loss = final weight (g) - initial weight (g).

Feed conversion ratio was obtained by dividing the daily feed intake by the daily weight gain both expressed in grams.

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Daily feed intake (g)}}{\text{Daily weight gain (g)}}$$

The proximate chemical analysis of the cooked Bambara groundnut meal, groundnut cake, experimental diets and faecal samples were determined using the AOAC (1980) methods of analysis.

Determination of trypsin inhibitors This involved the weighing of 0.2 g of the samples into a screw cap centrifuge tube, 1 ml of 0.1 M phosphate buffer was

added and the contents shaken at room temperature for one hour on a UDY shaker. The suspension obtained was centrifuged at 5000 rpm for 5 minutes and filtered through Whatman No.42 filter paper. The volume of each was adjusted to 2 ml with phosphate buffer. The test tubes were placed in a water bath and maintained at 37º C. Six milliliters of 5% TCA solution was added to one of the tubes which serves as a blank. Two (2) ml of casein solution was added to all the tubes which were previously kept at 37º C. These were incubated for 20 minutes. The reaction was stopped after 20 minutes by adding 6 ml of TCA solution to the experimental tubes and the tubes were shaken. The reaction was then allowed to proceed for 1hour at room temperature. The mixture was filtered through Whatman No. 42 filter paper.

Absorbance of the filtrate from sample and trypsin standard solutions were read at 280 nm and the trypsin inhibitors in mg g^{-1} was calculated using the formula of Kakade *et al*. (1969)

$$\text{T.I mg } g^{-1} = \frac{\text{A standard} - \text{A sample x Dilution factor}}{0.1 \text{ g x sample wt. in g } 1000 \text{ x sample size}}$$

Economic analysis The economic analysis was carried out based on the prevailing market prices of feed ingredients at the time of study. The cost per kilogram of each test diet, the cost of feeding rabbits on the test diets throughout the period of experiment and the cost per kilogram of weight gained by the rabbits were used in assessing the economics of replacing different levels of groundnut cake with cooked Bambara groundnut meal.

Statistical analysis All data collected in the course of the experiment were subjected to analysis of variance (ANOVA) using the randomized complete block design (Steel and Torrie, 1980) and where applicable, Duncan's multiple range test (Duncan, 1955) was used for mean separation

III. RESULTS AND DISCUSSION

The proximate chemical composition of the experimental diets, CBGM and GNC were presented on Table 2. The performance characteristics of rabbits fed varied levels of CBGM are shown in Table 8. The mean daily feed intake per rabbit was significantly different ($P < 0.05$) for the treatments. The control group (0% CBGM) consumed more feed than those on different levels of CBGM. There was no significant difference ($P > 0.05$) between treatments in weight gain and it is within the range of 10 to 20 g reported by Cheeke (1987) for growing rabbits in tropical environments. Similarly final weight gain also showed no significant difference ($P>0.05$) among treatment groups. The final weight in this study is above the 1267.00- 1295.00 g/rabbit reported by Igwebuike *et al*. (1995) for growing rabbits of similar age fed graded levels of sorghum waste. The feed conversion ratio (FCR) were not significantly ($P>0.05$) different among treatments. FCR obtained in this study was slightly inferior to the 4.13- 3.93 reported by Ehebha *et al*. (2008) who fed graded levels of cooked Bambara groundnut to growing rabbits. The performance of the rabbit in this experiment indicated that CBGM contains essential nutrients that can support adequate growth of rabbits at various levels of inclusion in their diets.

The cost-benefit analysis of the rabbits on the various treatment diets was presented in Table 4. The results indicated that at the end of this study final weight was obtained for the different treatment groups, with no significant difference ($P>0.05$) among the treatment groups. The control treatment (0%CBGM) consumed more feed and recorded the highest total feed cost of (₦50.33/kg feed) but gained weight similar to other groups on Bambara nut-based diets. That means more expenses was incurred in the control than in treatment groups. The cost/Kg weight gain was also highest in the control compared to other groups which implied that the control gain similar weight with other groups at a higher price/ Kg gain. Treatment T_2 (25%CBGM) diet consumed lowest feed and gain weight similar to other treatment groups. The cost/Kg weight gain for the study was lowest**.** Treatment T_3 (50%CBGM) has lowest value of ₦55.48 cost/Kg gain with a slightly higher total weight gain 799.20 g than other treatments while the control T_1 (0%CBGM) recorded highest cost/Kg gain of ₦65.36. At the end of the study it was observed that all treatments gained similar weight, but there was variation in quantity of feed consumed which was responsible for differences in cost/Kg gain. The percentage reduction in cost/Kg gain between treatment groups were as follows; T_1 and T_2 14.43%, T_1 and T_3 15.17%, T_1 and T_4 10.10% and T_1 and T_5 9.85%. Therefore, the use of CBGM as replacement for GNC resulted into a savings of at least ₦6.44 when 100% CBGM and up to ₦9.88 when 50% CBGM is used instead of GNC in feeding growing rabbits. Furthermore, the profit margin obtained ranged from ₦305.07 to ₦335.06 with treatment T_3 having highest profit margin compared to the control and other groups. The percentage profit margin ranged from 1.63 to 9.83 as shown in the Table 4.

IV. CONCLUSION AND RECOMMENDATIONS

In this study cooked Bambara groundnut meal was found to be suitable for the feeding of growing rabbits at different levels of inclusions, from 25% to 100% as a

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replacement for groundnut cake, a conventional plant protein source. Rabbits fed varied levels of CBGM have shown good performance in terms of weight gain, feed efficiency etc. From this experiment it can be concluded that cooked Bambara groundnut meal (CBGM) can replace groundnut cake (GNC) at different levels of inclusions but 50% CBGM diets should be used for optimum economic benefit.

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Table 1: Composition and calculated analysis of the experimental diets

Ingredients (%)	Levels of GNC replaced by CBGM				
	T_1 (0)	T_2 (25)	T_3 (50)	T_4(75)	T_5 (100)
Maize grains	45.00	45.00	45.00	45.00	45.00
Wheat offal	17.00	17.00	17.00	17.00	17.00
Groundnut cake (GNC)	18.35	13.76	9.18	4.59	0.00
Cooked Bambara groundnut meal (CBGM)	0.00	4.59	9.18	13.76	18.35
Groundnut haulms	13.00	13.00	13.00	13.00	13.00
Fish meal	4.00	4.00	4.00	4.00	4.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Common salt (NaCl)	0.50	0.50	0.50	0.50	0.50
Premix*	0.15	0.15	0.15	0.15	0.15
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis					
Dry matter (DM)	95.66	95.61	95.68	95.64	95.63
Crude Protein (CP)	19.25	18.54	17.76	17.15	16.44
Crude Fibre (CF)	6.04	5.90	5.76	5.62	5.48
Ether Extract (EE)	5.19	5.88	6.56	7.24	7.93
Ash	4.59	4.51	4.42	4.33	4.24
Nitrogen free-extract (NFE)	64.93	65.17	65.50	65.66	65.91
Metabolizable energy (Kcal/Kg)	3437.66	3476.81	3513.73	3551.92	3590.42

*Premix: Bio-mix supplying the following vitamins/minerals per kg: vit. A 5,000 IU; vit.D_3 800,000 IU; vit E 12,000 mg; vit K 1,500mg; vit B_1 1,000mg; vit B_2 200mg; vit B_6 1,500mg; Niacin 12,000mg; pantothenic acid, 20.00mg; Biotin 10.00mg; vit B_{12} 300.00 mg, folic acid 15,000 mg; choline chloride 60,000 mg; manganese 10,000 mg; Iron 15,000 mg; Zinc 800 mg; Copper 400 mg; Iodine 80 mg; Cobalt 40 mg; and Selenium 8,000 mg.

Table2: Proximate composition of cooked Bambara groundnut meal (CBGM) groundnut cake (GNC) and the experimental diets

Nutrients (%)	Levels of GNC replaced by CBGM							
	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	CBGM	GNC	RBG
Dry matter	90.56	90.57	90.60	90.63	90.61	93.80	95.90	92.70
Crude protein(CP)	16.79	15.53	14.37	13.37	12.31	22.14	47.60	21.31
Crude fibre (CF)	9.48	10.62	10.76	10.90	11.05	9.83	3.71	6.78
Ether extract (EE)	5.19	5.88	5.89	6.05	6.20	8.13	2.73	7.50
Ash	5.40	5.60	5.00	5.80	5.31	3.60	4.90	3.34
Nitrogen-free extract (NFE)	53.70	51.71	52.21	51.17	51.38	47.10	36.96	60.21
Trypsin inhibitor activity (TIA) %	-	0.14	0.29	0.43	0.58	3.14	-	7.15
Metabolizable energy* (Kcal/Kg)	2,947	2,886	2,862	2,801	2,771	3,149	3,294	3,533

*ME (Kcal/Kg) calculated according to the formula of Pauzenga (1985) ME = 37 X % CP + 81 X %EE + 35.5 X %NFE.

RBG= Raw Bambara groundnut.

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Table 3: Performance of rabbits fed varied levels of cooked Bambara groundnut meal (CBGM) as replacement for groundnut cake (GNC)

	Levels of GNC replaced by CBGM					
	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Number of rabbits	6	6	6	6	6	-
Mean initial weight(g/rabbit)	606.67	602.50	600.00	606.67	606.67	81.112^{NS}
Mean final weight(g/rabbit)	1373.30	1385.00	1399.20	1354.20	1374.20	69.575^{NS}
Mean daily feed intake(g/rabbit)	69.07^{a}	59.51^{b}	61.51^{b}	60.53^{b}	62.99^{b}	1.3405*
Mean weight gain(g/rabbit)	10.66	11.18	11.41	10.68	10.96	0.7559^{NS}
Feed conversion ratio(FCR)	6.48	5.32	5.39	5.67	5.90	2.4011^{NS}
Mortality (%)	0	0	0	0	0	--

SEM = standard error of means

NS = not significant (P> 0.05)

* Significant difference (P< 0.05)

a, b = means in the same row bearing different superscript differ significantly (P<0.05).

GNC= groundnut cake

CBGM= cooked Bambara groundnut meal.

Table 4: Cost-benefit analysis of feeding varied levels of cooked Bambara groundnut meal (CBGM) to growing rabbits as replacement for groundnut cake (GNC)

	Levels of GNC replaced by CBGM				
	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Cost price/ rabbit (₦)*	540.00	540.00	540.00	540.00	540.00
Initial weight (g/rabbit)	606.67	602.50	600.00	606.67	606.67
Final weight(g/rabbit)	1373.00	1385.00	1399.20	1354.20	1374.20
Total weight gain(g/rabbit)	766.33	782.50	799.20	747.53	76.53
Total weight gain(Kg/rabbit)	0.77	0.78	0.81	0.75	0.77
Total feed intake(g/rabbit)	690.74	595.12	615.09	605.32	629.86
Total feed intake(Kg/rabbit)	0.69	0.60	0.62	0.61	0.63
Cost/kg feed (₦/Kg)	72.94	72.71	72.48	72.25	72.02
Total feed cost (₦)	50.33	43.63	44.94	44.07	45.37
Cost of Production (₦)	590.33	583.63	584.94	584.07	585.37
Selling price/rabbit (₦)	895.40	905.07	920.00	900.05	895.40
Profit margin/rabbit (₦)	305.07	321.44	335.06	513.98	310.03
Cost /Kg gain (₦/Kg)	65.36	55.93	55.48	58.76	58.92
Percent reduction in Cost /Kg gain (₦/Kg)	-	14.43	15.17	10.10	9.85
Percent marginal gain in relation to the control	-	5.10	9.83	3.58	1.63

Cost per kilogram of the various ingredients used in compounding the experimental diets; maize grains ₦73.55, GNC ₦100.00, CBGM ₦95.00, Wheat offal ₦46.00, Groundnut haulms ₦70.00, Fish meal ₦103.44, Bone meal ₦60.00, Premix ₦600.00 and Salt ₦30.00.(price of ingredients as at June 2009).

The percentages in parenthesis represent the levels of GNC replaced by CBGM in the diets.

***** ₦1.00 ≡ $0.0067