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Carcass and Nutrient Digestibility Trial of Growing Rabbits fed Cooked Bambara Nut Meal as Replacement for Groundnut Cake in a 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 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 experiment. In diets 1(control), 2, 3, 4 and 5 CBNM replaced GNC at 0%, 25%, 50%, 75% and 100%, respectively. The parameters determined were nutrients digestibility and carcass components. 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.There were no significant differences (P>0.05) among treatment groups in terms of nutrient digestibility except for Nitrogen-free extract (NFE). There were no significant difference (P>0.05) among treatment groups for all carcass parameters measured except for the dressed weight, dressing percentage; and racks expressed as percentage of slaughter weight. The retail cuts as percentage of slaughter weight differ significantly (P<0.05) for racks while the shoulder, loins and thighs did not differ (P>0.05) among treatment groups.*

Keywords**—Carcass, Cooked Bambara nut, Growing Rabbits and Nutrient Digestibility.**

I. INTRODUCTION

There is inadequate protein supply in the diet of most people living in developing countries including Nigeria as indicated by reports from different sources (Uko *et al*., 1999; Alade *et al*., 2001; Balogun *et al*., 2003; Ahamefule *et al*., 2005 and Igwebuike *et al*., 2005). The protein consumption of people in these countries is below the Food and Agriculture Organisation's (FAO, 1987) recommendation of 28g of animal protein/person/day. FAO (2000) also estimated that about 200 million people in Africa are undernourished at the dawn of the millennium. The protein inadequacy is related to high cost of conventionalfeed ingredients especially the protein sources.The high cost of ingredients isbasically attributed to competition between human and animals especially monogastrics which depend on cereal grains as their source of energy and pulses (legumes) such as groundnut and soyabeans as their protein sources. According to Alade *et al*. (2001) livestock feeds particularly for non-ruminants are costly in developing countries because of the competition between human and livestock for conventional ingredients.

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

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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, proteinsources 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 to other leguminous feed ingredients. Pfeffer *etal*. (2002) explained that bambara groundnut contained 27% crude protein, 60% nitrogen-free extract, 9% ether extract and gross energy of 19MJ/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 high cost of conventional feed ingredients as a result of competition between human and livestock brings about persistent shortfall of animal protein in the diets of most people living in developed countries, which invariably leads to undernourishment. The use of non-conventional feed such as bambara groundnut to feed fast-growing animals like rabbit should be given attention.The objective of this study is to evaluate the nutrient digestibility and carcass characteristics of growing rabbits fed varied levels of CBGM; anddetermine the proximate composition of Cooked Bambara Groundnut Meal (CBGM). The study will serve as a step towards improving the nutritional status and economic well-being of peasant farmers in Maiduguri. It will equallyprovide useful information about the effectiveness of using bambara groundnut (*Voandziea subterranea*) as an alternative to groundnut cake in the diets of growing rabbits.These information will be handy tools for students and researchers in the field of monogastric nutrition.The study evaluated the suitability of replacing GNC with CBGM as a protein source in the diets of growing rabbits. Parameters such as nutrient digestibility and carcass characteristics were evaluated.

II. MATERIALS AND METHODS

The feeding trial was conducted at the Ramat Polytechnic's Agricultural Science and Technology Animal Farm, in 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.

Sources of ingredients

Bambara groundnut (*Voandzeiasubterranea*) seeds were purchased from the Maiduguri Monday market. Other sources were Gamboru market, Muna Garage, Baga motor Park Market and other markets in Maiduguri, Nigeria. Likewise other ingredients were purchased or sourced locally.

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.

Experimental diets

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 that produced is nitrogenous and is calorie diets formulated to contain 18% crude protein and 3437 metabolizable energy (kcal/kg).

The parameters measured

The parameters measured were nutrient digestibility and carcass characteristics.

Nutrient digestibility

The nutrient digestibility trial was conducted at the end of the 6th week of the experiment. Three (3) rabbits were randomly selected for total faecal collection. These animals were allowed two days adaptation period which was followed by five (5) days of faecal collection. Faeces were collected by placing fine wire mesh trays under the cage cells. The amount of faeces voided daily was weighed and then dried at room temperature for 2-3 days. The air dried faeces were then oven-dried at 105^0 C for 24 hours to achieve constant weight. The dried samples were stored for chemical analysis. The chemical composition of the faecal samples was determined using the Association of Official Analytical Chemists (AOAC, 1980) procedures. The apparent nutrient digestibility was calculated according to the formula proposed by McDonald (1991) as:

$$\frac{\%\ \text{Nutrient in feed} \times \text{feed intake} - \text{nutrient in faeces} \times \text{faecal output}}{\%\ \text{nutrient in feed} \times \text{feed intake}} \times \frac{100}{1}$$

Carcass parameters /slaughter procedure

At the end of the experiment three (3) rabbits from each treatment were selected for slaughter. The rabbits were selected based on the average weight of each treatment group. The rabbits were fasted overnight (12 hours) before slaughtering; this was done to reduce the risk of contamination of the carcass during dressing. Before slaughtering, the rabbits were weighed in the morning. This measurement is important in determining the dressing percentage (Fielding, 1991). The rabbits were slaughtered by transverse cutting of the trachea, oesophagus, large carotid arteries and jugular veins to ensure maximum bleeding (Mann, 1960).The dressed carcass is the part of the rabbit left after the removal of the head, feet, skin, kidneys and visceral organs. The dressed carcass were later divided into retail cuts (shoulder/forelegs, hind legs, rack and loins) as described by Blasco *et al*. (1993). The head, feet, skin, heart, liver, kidneys and lungs were weighed and expressed as percentage of slaughter weight. The weight of dressed carcass was expressed as a percentage of the live weight to obtain the dressing percentage.

$$\text{Dressing percentage (\%)} = \frac{\text{carcass weight (g)}}{\text{Live weight (g)}} \times \frac{100}{1}$$

Chemical analysis

The proximate chemical analysis of the faecal samples were determined using the AOAC (1980) methods of analysis.

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 nutrient digestibility of rabbits fed various levels of CBGM was presented in Table 9. The result of this study showed that there were significant differences ($P<0.05$) among treatments for digestibility ofdry matter and crude protein, crude fibre, ether extract, ash as well as that of nitrogen-free extract. The digestibility for CP has ranges of 80.27% to 85.33% with the control having highest value. The EE digestibility were 72.25% to 80.67% for different treatment groups with rabbits on 25%CBGM diet having highest value while lowest value was recorded in the group receiving 75%CBGM.The digestibility for ash ranges from 71.31% to 79.26%. Nitrogen free-extract digestibility ranges from 65.52% to 67.93% with significantdifference ($P<0.05$) among treatment groups. Despite the slightly higher digestibility of the control group (0%CBGM) the digestibility of nutrients recorded in this experiment showed that the nutrients in CBGM are highly digestible especially with heat treatment which was reported to bring about increased digestibility and protein utilization (Okah *etal.*, 2006) and this could be responsible for the appreciable growth observed in the rabbits investigated since higher digestibility of nutrients makes them available for the animals to utilize.

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Carcass measurements

The carcass measurements are summarized in Table 2.Therewereno significant difference (P>0.05) among treatment groups for all carcass parameters measured except for the dressed weight, dressing percentage; and racks expressed as percentage of slaughter weight. The final live weight for the treatment groups ranged from 1375.00 g to 1456.66 g with the control having highest value, though not significantly different (P>0.05). The values obtained were higher than 960.10 g to 1041.60g reported by Joseph *et al*.(1999). Slaughter weights of 1243.33 g to 1390 g were obtained in this experiment and these were lower than 1695.00 g to 2050.00 g reported by Onifade and Tewe (1993) for growing rabbits. The dressed weight of 711.67 g to 756.67 g was recorded for the treatment groups with T_2group having significantly (P<0.05) higher dressed weight than other treatment groups. These values were higher than 288.70 g to 501.60 g reported by Joseph *et al*. (1999) since dressed weight is a reflection of the slaughter weight of the rabbits. The dressing percentage obtained were 53.10% to 56.79% with the control having significantly (P<0.05) lower value of 53.10%. This shows that inclusion of CBGM has positive influence on the carcass yield of the rabbits as reflected by the dressing percentage. Although the increase in dressing percentage did not followed a regular pattern, the treatment group T_2 (25%CBGM) has 56.79%, followed by T_5, T_3 and T_4 with 55.59%, 53.76% and 53.75% respectively. The dressing percentage obtained here compared favourably with the range (50-56%) reported by Fielding (1991) as normal for growing rabbits.

The weight of organs/body components expressed as percentage of slaughter weight indicated that there were no significant difference (P>0.05) among the various treatment groups. The values for head, skin, feet, heart, liver, lungs, stomach (with content), small intestine (with content), large intestine (with content), caecum, kidneys and kidney fats as percentage of slaughter weight were similar in all the treatments. The values for retail cuts expressed as percentage of slaughter weight shown in Table 12 indicated that there were no significant difference (P>0.05) among treatment groups in respect of theshoulder, loin and thigh. The weight of racks showed that there were significant differences (P>0.05) among treatment groups. The control group has lowest rack weight compared to other treatment groups. The range 5.54% to 6.36% was obtained for the rack which is slightly lower than 6.50% to 7.80% reported by Joseph *et al*. (1999) who fed toastedBambara nut to weaner rabbits. The low rack weight in the control group (0% CBGM and the 75% CBGM) may be linked to the low dressing percentage of the groups.

IV. CONCLUSION AND RECOMMENDATIONS

The continued increase in the demand for animal protein in the diet of people living in developing countries calls for an increase in production of fast-growing and prolific animals such as rabbit using non-conventional feed ingredients like bambara groundnut.

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 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 and nutrient digestibility. Although CBGM can replace 100% of the GNC in the rabbit's diets, the inclusion of up to 50% of CBGM in the diet of growing rabbits as replacement for GNC gave optimum economic benefits. The use of CBGM in the feeding of growing rabbits is a simple and cheaper method of overcoming the adverse effects of the anti-nutritional factors.

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. However, to obtain more information, it is recommended that investigations be extended to cover other age groups and classes of rabbits such as fattening, pregnant and lactating rabbits.

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Table 1: Nutrient digestibility of rabbits fed varied levels of cooked bambara nut 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	3	3	3	3	3	-
Dry matter (DM) %	63.32^{ab}	62.70^{ab}	61.49^{ab}	59.49^{c}	64.17^{a}	0.3652*
Crude protein (CP)%	85.33^{a}	80.27^{e}	81.33^{d}	81.71^{c}	85.18^{b}	0.5774*
Crude fibre (CF) %	47.79^{b}	47.41^{c}	46.44^{d}	42.38^{e}	49.69^{a}	0.3361*
Ether extract (EE) %	78.35^{abc}	80.67^{a}	78.91^{ab}	72.25^{e}	72.98^{d}	0.3665*
Ash %	79.26^{a}	76.16^{ab}	71.45^{c}	67.71^{e}	71.31^{d}	0.3661*
Nitrogen-free extract %	66.92^{ab}	67.46^{b}	67.93^{a}	65.52^{c}	66.12^{c}	0.3624*

SEM= standard error of means
NS= not significant (P> 0.05)
* Significant difference (P<0.05)
a, b, c. mean in the same row bearing different superscripts differ significantly.

Table 2: Carcass measurement of rabbits fed varied levels of cooked bambara groundnut meal(CBGM)

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	3	3	3	3	3	-
Final live weight (g)	1456.66	1425.00	1375.00	1346.00	1398.33	38.8350^{NS}
Slaughter weight (g)	1390.00	1333.33	1323.33	1243.33	1311.70	45.1680 ^{NS}
Dressed weight (g)	738.33^{b}	756.67^{a}	711.67^{ab}	668.00^{ab}	728.33^{b}	26.0830*
Dressing percentage (%)	53.10^{c}	56.79^{a}	53.76^{ab}	53.75^{ab}	55.59^{b}	1.0972 *
Weight of organs/body componentsas percentage of slaughter weight						
Head	9.45	9.89	9.31	9.20	10.25	0.4233 ^{NS}
Skin (wet)	8.77	8.35	8.55	8.77	9.23	0.5500 ^{NS}
Feet	2.33	2.67	2.16	2.35	1.63	0.2366^{NS}
Heart	0.26	0.29	0.32	0.27	0.75	0.2220 ^{NS}
Liver	2.77	2.28	2.76	2.54	2.63	0.1326 ^{NS}
Lungs	0.70	0.79	0.70	0.81	0.73	0.1211 ^{NS}
Stomach(with content)	3.89	3.63	3.20	3.77	3.38	0.4543 ^{NS}
Small intestine ,,	3.25	3.02	2.96	3.00	2.33	0.2575^{NS}
Large intestine ,,	1.66	1.49	2.12	1.70	1.12	0.3715 ^{NS}
Caecum ,,	7.05	4.29	5.81	6.55	5.11	0.7819 ^{NS}
Kidneys	0.63	0.59	0.71	0.64	0.63	0.1615 ^{NS}
Kidney fat	0.86	0.94	0.93	1.39	0.70	0.2723 ^{NS}
Retail cuts as percentage of slaughter weight						
Shoulder/forelegs	15.42	17.53	14.79	15.97	15.97	0.4465^{NS}
Racks	5.54^{b}	6.13^{ab}	6.55^{a}	5.49^{b}	6.36^{a}	0.2378*
Loins	10.73	9.80	10.34	10.85	8.62	0.6299^{NS}
Thighs/hind legs	21.30	23.06	21.39	21.75	22.81	0.8339^{NS}

SEM = standard error of means
NS= not significant (P>0.05)
* = significant difference (P<0.05)
a, b, c… means in the same row bearing different superscripts differ significantly (P<0.05).

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