Linear Body Measurements and Growth Performance Characteristics of Female Rabbits Fed Cocoa Bean Shell Meal - Based Diets

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(Corresponding Author)

M. I. Anya[1]
P.O. Ozung[2]
O. O. Kennedy Oko[3]
E. Idoko[4]

[1,2,3,4]*Department of Animal Science, Faculty of Agriculture, Forestry and Wildlife Resources Management University of Calabar, Calabar, Nigeria*
[1]*Email: izahanya@gmail.com Tel: + 2348053434989*
[2]*Email: pascalozung@yahoo.com Tel: +2348062246745*
[3]*Email: oluwatosin.kennedyoko@gmail.com Tel: +2348052299139*
[4]*Email: ozung.ogar203@gmail.com Tel: +2348115857833*

ABSTRACT

The Linear Body Measurements and Growth Performance Characteristics of 40 cross bred (New Zealand White X Chinchilla X Californian breeds) female rabbits weighing between 800 and 847g were determined in this study, which lasted 60 days. After weight equalization, eight (8) rabbits per treatment were randomly divided into five treatments designated as T_1, T_2, T_3, T_4 and T_5 containing 0, 5, 10, 15 and 20% cocoa bean shell meal, respectively using a Completely Randomized Design (CRD). Results showed that the linear body parameters (body length, tail length, heart girth, ear length, head to shoulder length, forelimb and hind limb lengths) were not significantly ($P > 0.05$) affected by dietary treatments. While the growth performance characteristics revealed significant ($P < 0.05$) differences between dietary treatments for the final weight, total weight gain and total feed intake, respectively. Results for the average daily weight gain, average daily feed intake and feed conversion ratio were statistically ($P > 0.05$) similar across dietary treatments. The results of this study suggest that hot – water treated cocoa bean shell meal can be included up to 20% in diets meant for female rabbits without deleterious effects on Linear Body Measurements and Growth Performance Characteristics.

Keywords: *Linear, Body, Growth, Rabbits, Cocoa bean shell.*

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1. INTRODUCTION

Feed supply has remained a major constraint in Animal Production due to the ever increasing cost of conventional feedstuffs occasioned by the competition between man and livestock for both grains and legumes [1]. This premise has necessitated the quest for alternative feed resources that are locally available and not competed for as feedstuffs by man, animals and industries. Prominent examples of such alternative feedstuffs are the agro – industrial by – products such as cocoa bean shell, cocoa pod husks, maize sievate and wheat offal. They are relatively cheap, easily accessible, widely distributed and non – edible by man.

Cocoa bean shell, a by – product of cocoa processing is about 10% of the bean with appreciable amount of vitamin D [2]. It has been estimated that about 10, 500 tonnes of cocoa bean shell are produced annually in Nigeria [3]. The current renewed interest in cocoa production will automatically increase the tonnage of cocoa bean shell in Nigeria; which is largely a waste product from chocolate industries. The rich nutritional potential of cocoa bean shell makes it worthy of consideration as an alternative feed ingredient in rabbit production. According to Aregheore [4] the crude protein, crude fibre and ash contents of cocoa bean shell are 16.00, 58.00 and 7.50% respectively, while the gross energy is 23.40MJ/Kg DM. However, the high crude fibre content and presence of anti – nutritional factors (theobromine and caffeine) are major limiting indicators affecting the utilization of cocoa bean shell in animal feeding trials. These anti – nutrients are active alkaloids that adversely affect growth rate and weight gain of animals [5]. The utilization of chemical treatment in the processing of cocoa bean shell to eliminate the toxic factors has shown some positive results, though with some associated hazards and high cost of procuring the chemicals, thereby discouraging its application in large scale animal production [6]. It is therefore rational to explore other strategies such as hot – water treatment of the cocoa bean shell so as to render it safe as an alternative feedstuff for animals [7, 8].

Previous studies have shown that cocoa bean shell meal can be included up to 20% in poultry diets, 30 – 50% in diets meant for pigs and 50% in ruminant diets [9]. Industrially, cocoa bean shell serves as a raw material in soap manufacture in Ghana and Nigeria, since it contains 3 – 4% potassium (dry matter basis) [10]. Cocoa bean shell could also serve as a good source of organic manure for vegetable crops and wheat production, as it is a rich source of nutrients and minerals like potassium and phosphorus [11].

In view of the salient benefits that could be derived from rabbit production such as meat production, vis –a-vis more protein availability for man, prolificacy, short generation interval and ability to subsist on plant feed resources/ forages; it is has become imperative to explore its production using locally available feedstuffs like coco bean shell.

This study was designed to determine the effect of cocoa bean shell meal based – diets on the linear body measurements and growth performance characteristics of female rabbits.

2. MATERIALS AND METHODS

2.1. Location of Study

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, Department of Animal Science, University of Calabar, Calabar, Nigeria. Calabar is located at latitude 3^0N and longitude 7^0E with a land mass of 233.2 square miles (604Km^2), average annual rainfall of 1,830mm and average temperature of 24^0 - 30^0C as well as relative humidity ranging between 70 and 80% [12].

2.2. Experimental Animals, Housing and Management

A total of Fourty (40) weaned cross bred (New Zealand White X Chinchilla X Californian breeds) female Rabbits of 6 - 7 weeks old weighing between 800.00 and 847.00g were used in this Study. The Rabbits were purchased from the Rabbitry Unit of Teaching and Research Farm, Department of Animal Science, University of Calabar. Wooden hutches were used to house the Rabbits inside a well-ventilated building and before the arrival of the animals; the hutches were thoroughly washed and disinfected with saponated cresol and allowed to dry for seven (7) days. On arrival to the rabbitry, anti – stress vitalyte was administered via drinking water to the animals. Thereafter, the rabbits were dewormed using piperazine. They were further protected against microbial infection using a broad spectrum long acting antibiotic (Symoxyl). The rabbits were caged individually in clearly marked hutches and provided with a weighed amount of feed daily while clean drinking water was provided *ad – libitum*. The animals were allowed to adjust in rabbitry for two weeks and within this period; they were placed on the control diet before the actual commencement of the feeding trial which lasted Sixty (60) days.

2.3. Collection, Treating and Processing of Test Ingredient (Cocoa Bean Shell Meal)

The cocoa bean shells were collected from the Cocoa Research Institute of Nigeria (CRIN) sub – station at Ikom Local Government Area of Cross River State. The cocoa bean shells were treated using hot water as described by Adeyina, et al. [13] where the shells were added into hot water at the ratio of 1Kg: 4 litres of water maintained at 100^0C for 90 minutes with occasional stirring. Thereafter, the water was decanted and the cocoa bean shells were sundried for seven (7) days to a constant weight and stored in sack in a cool and dry place; until they were processed with the hammer mill to obtained Cocoa bean shell meal. The test ingredient (cocoa bean shell meal) was included in the respective diets containing corn and soybean as well as other basic ingredients used in the ration formulation.

2.4. Experimental Diets

Five (5) experimental diets were formulated containing cocoa bean shell meal (CBSM) at 0, 5, 10, 15 and 20% for dietary treatments T_1, T_2, T_3, T_4 and T_5, respectively. Dietary treatment (T_1) served as the control diet without CBSM. The gross composition of the experimental diets is presented in Table 1. The proximate analyses of the experimental diets and cocoa bean shell meal respectively were carried out based on the methods of AOAC [14].

2.5. Experimental Design

The rabbits were randomly assigned to the dietary treatments after weight equalization using a Completely Randomized Design (CRD), with eight (8) rabbits per treatment and each rabbit serving as a replicate.

2.6. Experimental Procedure

The linear body measurements (LBMs) were taken based on the anatomical reference points for physical body measurements of rabbits described by Yakubu and Ayoade [15]. The LBMs taken included:

Body Length: distance measured from the tip of the shoulder to the tail base.

Tail Length: Distance measured from the base of the tail to the tip.

Heart Girth: Measured as circumference as a point immediately behind the shoulder.

Ear Length: Measured from the base of the ear to the tip.

Head to Shoulder Length: Measured from the tip of nose to the end of shoulder.

Length of Forelimb: Measured from tip of fore toe nail to the shoulder.

Length of Hind limb: Measured from the tip of the toe nail to the hock.

In order to obtain feed intake, the rabbits were fed in the morning hours between 7:00 and 7:30 am. Each rabbit was offered a weight amount of feed daily and supplemented with a known quantity of wilted *Aspilia africana* leaves in the evening. The quantity of feed offered was increased weekly in response to growth changes in the rabbits. Fresh and clean drinking water was provided *ad –libitum* on a daily basis. Left over feed was collected daily into clearly labelled envelopes and weighed with a precision electronic scale (Kero model). The feed intake was calculated by deducting the left over feed from the quantity served the previous day. To obtain body weight changes, the rabbits were weighed individually at the beginning of the study and weekly thereafter. Body weight changes were determined by difference. A top loader weighing scale was used in weighing the rabbits; while the feed conversion ratio was calculated as the ratio of feed intake to weight gain.

2.7. Statistical Analysis

All results obtained in this study were subjected to one – way Analysis of Variance (ANOVA) for CRD, while significant means were separated using the New Duncan Multiple Range Test [16].

3. RESULTS

3.1. Proximate Composition (Determined Analysis) of Experimental Diets and Test Ingredient (Cocoa Bean Shell Meal)

The results of the proximate composition of experimental diets and cocoa bean shell meal are presented in Table 2. Dietary treatments with 0,5,10, 15 and 20% inclusion levels of CBSM recorded crude protein contents of 18.64, 20.11, 21.86, 21.88 and 22.24%, respectively; while the test ingredient (cocoa bean shell meal) had 16.00% as crude protein content. The ether extract contents were 4.50, 3.84, 6.40, 4.80 and 5.25% as well as 19.62% respectively for dietary treatments with 0, 5, 10, 15 and 20% CBSM inclusion levels as well cocoa bean shell meal. The crude fibre content in the dietary treatments recorded a gradual increase in values as the levels of cocoa bean shell meal increased across all the treatments. The values were 11.25, 12.41, 12.64, 15.30 and 15.86% for diets with 0, 5, 10, 15 and 20% inclusion levels of CBSM, respectively; while the cocoa bean shell meal recorded a high crude fibre content of 46.60%. The ash content of the experimental diets recorded 9.00, 10.00, 8.00, 10.00 and 7.00% for diets with 0, 5, 10, 15 and 20% inclusion levels of CBSM, respectively; as well as the test ingredient (CBSM) recording 7.50% as ash content. The NFE content of the dietary treatments ranged between 46.36 and 56.61% while that of the CBSM was 11.48%.

3.2. Linear Body Measurements and Growth Performance Characteristics

The Linear Body Measurements of female rabbits fed cocoa bean shell meal based – diets are presented in Table 3. The results showed that the dietary treatments recorded no significant ($P > 0.05$) effect on the all the linear body parameters with most of them showing fluctuating trends. The growth performance characteristics are presented in Table 4. The dietary treatments recorded significant ($P < 0.05$) effect on the final weight, total weight gain and total feed intake, respectively. The results for average daily weight gain, average daily feed intake and feed conversion ratio did not show any significant difference between dietary treatments. All growth parameters in this study recorded fluctuating trends across dietary treatments.

4. DISCUSSION

4.1. Proximate Composition (Determined Analysis) of Experimental Diets and Test Ingredient (Cocoa Bean Shell Meal)

The crude protein content of the experimental diets in this study ranged from 18.62 to 22.24%, which falls within the range of 17.97 to 22.33% reported by Aregheore [4] for rabbits. The values for ether extract (3.84 - 6.40%) and crude fibre (11.25 – 15.86%) are comparable to the values 3.77 – 6.82% for ether extract and 16.98 – 22.35% for crude fibre as earlier reported by Bouafou, et al. [17]. The crude fibre content increases positively across dietary treatments as the levels of cocoa bean shell meal increased.

4.2. Linear Body Measurements (LBMs)

The rabbits fed cocoa bean shell meal based diets did not record any significant ($P > 0.05$) difference in all linear body parameters considered in this study. The results for body length across dietary treatments ranges between 31.86 and 33.60cm; which are slightly higher than 25.46 and 28.92cm earlier reported by Henry, et al. [18] who fed *Citrus sinensis* pulp based – diets to rabbits. The slight differences may be attributed to the effects of breed and different test ingredients used in the separate studies. The results for tail length (8.06 – 8.57cm) and heart girth (20.28 – 22.25cm) are comparable to the values of 6.56 – 8.48cm and 19.21 – 22.66cm respectively, reported by Henry, et al. [18] in their earlier study. Results obtained in this study for ear length (9.37 – 9.62cm) are comparable to the values of 8.43 – 9.54cm reported by Henry, et al. [18] for rabbits. The marginal difference in values could be attributable to dietary effect due to varied test ingredients used in these studies. The length of head to shoulder (12.27 – 12.59cm) followed the same trend for ear length recorded in this study; while the fore limb length values (12.73 – 13.55cm) agrees with the values 13.34 – 14.73cm reported by Henry, et al. [18] and higher than the values 12.98 – 13.00cm reported by Yakubu and Ayoade [15]. The results suggest the possible absence of toxic effect of residual theobromine on the linear body parameters of rabbits.

4.3. Growth Performance Characteristics

The results for the average final weight gain, total weight gain and total feed intake of rabbits fed cocoa bean shell meal based – diets recorded significant ($P < 0.05$) differences between dietary treatments. The highest value of final weight gain (1755.00g) was recorded in dietary treatment with 5.00% CBSM inclusion compared to the control diet as well as other dietary treatments. However, the range of values for final weight gain (1620.00 – 1755.00g) obtained in this study is fairly higher than the range of values (1005.00 – 1141.30g) reported by Adeyina, et al. [13] who also utilized hot – water treated CBSM in their earlier study. The difference may be due to the age differences of rabbits and prevailing environmental conditions in the separate studies. The values for average total weight gain (772.50 – 885.00g) for rabbits in this study were comparable to values (750.00 – 850.80g) reported by Adeyina, et al. [13]. The total feed intake (3718.37 – 4528.00g) values were higher than the values of 2714.90 – 3084.50g reported by Oluokun [19] who fed growing rabbits with treated and untreated cowpea husks. Other growth performance characteristics such as average daily weight gain, daily feed intake and feed conversion ratio did not record significant ($P > 0.05$) differences between dietary treatments; implying that hot – water treated cocoa bean shell meal did not adversely affect the growth characteristics of rabbits.

5. CONCLUSION

Results obtained in this study have shown that hot – water treated cocoa bean shell meal based – diets have no deleterious effects on the linear body parameters and growth performance characteristics of rabbits.

6. RECOMMENDATION

Based on the findings in this study, it is therefore recommended that farmers can include up to 20% hot – water treated cocoa bean shell meal in corn – soybean diets for rabbits without fear of compromising linear body parameters and growth performance characteristics.

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Table-1. Gross Composition of Experimental Diets (% Dry Matter basis)

	Dietary treatments				
	T_1	T_2	T_3	T_4	T_5
Ingredients	Levels of Cocoa Bean Shell Meal (CBSM) inclusion				
	0%	5%	10%	15%	20%
Maize	50.00	45.00	40.00	35.00	30.00
CBSM	0.00	5.00	10.00	15.00	20.00
SBM	10.00	10.00	10.00	10.00	10.00
PKC	8.00	12.00	12.00	12.00	12.00
W. Offal	17.00	12.00	12.00	12.00	12.00
Rice bran	5.00	5.00	5.00	5.00	5.00
Crayfish dust	6.00	7.00	7.00	7.00	7.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
% CP	16.56	17.65	17.70	17.75	17.80
% CF	7.00	9.67	10.95	13.75	16.55
ME (Kcal/Kg)	2,700.90	2,694.80	2,640.30	2,585.80	2,531.30

Premix used: Advit Super with the following composition per Kg:
Vitamin A: 10,000,000 IU; Vitamin B_{12}: 0.15g; Vitamin K_3: 2.50g; Calcium pantothenate: 12.50g; Biotin: 0.05g; Folic acid: 1.00g; Chloride: 2500g; Cobalt: 0.40g; Copper: 8.00g; Iron: 32g; Iodine: 80g; Manganese: 64g; Zinc: 40g; Spiromycin: 5g; DL – Methionine: 50g; L- Lysine: 120G, Selenium: 0.16g.
Key:
CBSM: Cocoa bean shell meal; SBM: Soybean meal; PKC: Palm kernel cake; W.Offal: Wheat offal;
CP: Crude protein; CF: Crude fibre and ME: Metabolisable energy

Table-2. Proximate Composition of Experimental Diets & CBSM (Test ingredient)(% Dry Matter basis)

	Dietary treatments					
	T_1	T_2	T_3	T_4	T_5	
Parameter	Levels of Cocoa Bean Shell Meal inclusion					
	0%	5%	10%	15%	20%	CBSM
CP	18.64	20.11	21.86	21.88	22.24	16.00
EE	4.50	3.84	6.40	4.80	5.25	19.52
CF	11.25	12.41	12.64	15.30	15.86	46.60
Ash	9.00	10.00	8.00	10.00	7.00	7.50
NFE	56.61	46.36	48.90	51.98	50.35	11.48

CP: Crude protein; EE: Ether extract; CF: Crude fibre; NFE: Nitrogen free extracts
CBSM: Cocoa Bean Shell Meal

Table-3. Linear Body Measurements of Female Rabbits fed CBSM based – Diets

	Dietary treatments					
	T_1	T_2	T_3	T_4	T_5	
Parameter	Levels of Cocoa Bean Shell Meal (CBSM) inclusion					
(cm)	0%	5%	10%	15%	20%	SEM
Body Length	33.60	32.59	31.89	32.95	31.86	0.33
Tail Length	8.06	7.89	8.47	8.57	8.33	0.13
Heart girth	20.28	21.49	20.42	20.55	22.25	0.38
Ear Length	9.37	9.45	9.62	9.47	9.42	0.04
HSL	12.42	12.27	12.43	12.44	12.59	0.05
FLL	13.03	12.73	13.73	13.40	13.55	0.08
HLL	20.20	20.65	20.74	20.97	19.83	0.21

HSL: Head – to – Shoulder Length
FLL: Fore limb Length
HLL: Hind limb Length
SEM: Standard Error of Means

Table-4. Growth Performance Characteristics of Female Rabbits fed CBSM based – Diets

	Dietary treatments					
	T_1	T_2	T_3	T_4	T_5	
Parameter	Levels of Cocoa Bean Shell Meal (CBSM) inclusion					
	0%	5%	10%	15%	20%	SEM
Initial wt. (g)	820.00	847.00	820.00	800.00	800.00	8.79
Final wt.(g)	1700.00	1755.00	1620.00	1685.00	1680.63	21.94
TWG (g)	880.00[a]	772.50[b]	800.00[b]	885.00[a]	880.66[a]	24.18
ADG (g)	14.66	12.87	13.33	14.75	14.60	0.40
TFI (g)	3973.82[a]	3732.97[b]	3718.37[b]	4528.00[a]	4044.09[a]	149.38
ADFI (g)	66.23	62.22	61.97	75.47	67.40	2.49
FCR	4.51	4.83	4.65	5.12	4.62	0.11
Mortality (No.)	1.00	0.00	0.00	1.00	0.00	

[a, b] Means on the same row with different superscripts are significantly different ($P < 0.05$)
SEM: Standard Error of Means
TWG: Total Weight Gain
ADG: Average Daily Weight Gain
TFI: Total Feed Intake
ADFI: Average Daily Feed Intake
FCR: Feed Conversion Ratio