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Carcass Yield and Gastro - Intestinal Tract (GIT) Morphometry of Rabbits Exposed to Dietary Cocoa (*Theobroma cacao* L.) Pod Husk Meal

O.O.K. Oko[1], P.O. Ozung[1], M.I. Anya[1], E.A. Agiang[1]andI.E. Emem[2]
[1]Department of Animal Science, University of Calabar, Calabar; [2]Department of Animal Science, Akwa Ibom State University, ObioAkpa Campus
Corresponding author: P.O. Ozung; E-mail: pascalozung@yahoo.com; Tel: +2348062246745

Abstract
This study investigated the effect of different forms of dietary cocoa pod husk meal (CPHM) on the carcass yield and gastro – intestinal tract morphometry of growing rabbits. A total of 60 rabbits with mean body weight of 606.42±1.3 g were utilized across 12 experimental iso - caloric and isonitrogenous diets containing sundried (T_1, T_2, T_3, T_4); fermented (T_5, T_6, T_7, T_8) and hot – water treated (T_9, T_{10}, T_{11}, T_{12}) cocoa pod husk meal (CPHM) included at 0, 12.5, 25 and 37.5 percent levels respectively. The rabbits were subjected to 12 weeks feeding trial in a completely randomized design experiment. The rabbits were slaughtered at the end of the feeding trial and the carcass yield and GIT morphometry determined accordingly. The results showed that the live weight averaged between 1616.67 and 2483.33 g/rabbit, while the dressed weight ranged between 966.67 and 1500 g/rabbit with significant ($p < 0.05$) differences between treatments. The least values were recorded in rabbits fed the 37.5% level of CPHM inclusion. All primal cuts revealed no significant differences between dietary treatments. The GIT morphometry (relative weight and length of segments) recorded no significant ($p > 0.05$) effect that could be ascribed to diets. It could be concluded from this study that including sundried, fermented or hot – water treated CPHM up to 37.5% level will reduce the live weight, dressed weight and dressing percent of rabbits while GIT morphometry may be relatively unaffected. Hence, a lower level up to 25% fermented CPHM and levels <25% SCPHM and HCPHM are recommended for rabbits.

Keywords: Rabbit, carcass, intestine, morphometry, cocoa husk

Introduction

Animal production accounts for about 40 percent of the total gross value of global agricultural productivity and is likely to increase as the demand for livestock products is growing rapidly with increase in population and urbanization. The geometrical population growth in the world depicts more demand for meat and associated animal protein, which presently is in a deficit (Attah *et al.,* 2011). This dearth of animal protein is mainly due to poor animal productive performance, especially in developing countries. With the rapid exhaustion of limited animal products, increasing population and better life styles, it is now imperative to explore other aspects of livestock production to bridge the gap of protein intake from animal origin. Traditionally, ruminants and monogastrics are the main sources of domestic meat. However, rabbits and other micro livestock species are emerging in many developing countries like Nigeria as potential sources of animal protein. The inadequacy of animal protein coupled with stiff competition between man and animals for agricultural produce call for enhancing the diversification and productivity of livestock and this has culminated in resurgence of interest in rabbit production. Rabbit meat is healthy as it is low in cholesterol (50g/100g); fat (4g/100g); energy (124 Kcal/100g) but high in protein (22g/100g) (Aduku and Olukosi, 1990). The meat has complete amino acid profile compared with plant protein sources; it has good flavour, rich in nutrients as well as easily digestible. The renewed interest in rabbit production by researchers and farmers in Nigeria has necessitated research into alternative feed resources that are readily available, under - utilized agro by - products or agro - industrial wastes to substitute or supplement the highly demanded conventional cereals

One of the promising agro by - products that can be utilized in rabbit diet formulations is the cocoa pod husk. Cocoa pod husk meal (CPHM) can partially replace maize in animal diets with no adverse effects. Untreated CPHM has been added in the diets of growing swine up to 300g/Kg without deleterious signs. The practice of incorporating cocoa pod husk meal in various animal diets has been reported (Agyente - Badu and Oddoye, 2005). Cocoa pod husks contain 6 – 7% crude protein, 9 - 10 % total ash, 1 – 8 % ether extract and 23 – 33 % crude fibre. The metabolizable energy of cocoa pod husk is moderate and ranges between 2000 and 2100Kcal/Kg. However, the high crude fibre content hinders its effective utilization by monogastrics. This constraint calls for the processing of the cocoa pod husks by various methods (fermentation, hot – water treatment, urea, enzyme, fungal treatment and microbial detheobromination), so as to promote digestibility and biodegradability in animals.

This study was therefore designed to determine the effect of different forms of CPHM on the carcass yield and GIT morphometry of rabbits.

Materials and Methods

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, Department of Animal Science, University of Calabar, Calabar, Cross River State, Nigeria. Freshly broken composite cocoa pod husks (derived from CRINc1 – 8, WACRI 11 Hybrids and F3 - Amazon) were obtained from the fermentation units of the Cocoa Research Institute of Nigeria (CRIN) sub - station at Ajassor, Ikom LGA of Cross River State. The broken pods were washed and sun - dried to constant weight, bulked and milled with hammer mill to produce Cocoa Pod Husk Meal (CPHM). The resultant meal was shared into three (3) portions: The sun dried CPHM (SCPHM), Fermented CPHM (FCPHM) and Hot water - treated CPHM (HCPHM), respectively. CPHM for the fermented treatment was thoroughly mixed with 60 percent water, relative to its weight and bagged in an air tight polythene bag. This was allowed to stand for three (3) days under room temperature, thereafter, it was opened and shade dried for five (5) days; before being packed and stored in a cool dry place until it was used. The final portion was treated with hot water that was boiled to 100^{0}C for 15 minutes which was later drained, shade dried and stored for later use. Twelve (12) experimental isocaloric and isonitrogenous diets were formulated in line with the nutrient needs of rabbits.

Each processed form of CPHM was included at 0, 12.5, 25 and 37.5% levels for T_1, T_2, T_3, and T_4 (SCPHM), T_5, T_6, T_7, T_8 (FCPHM) and T_9, T_{10}, T_{11}, T_{12} (HCPHM), respectively in the experimental diets. Sixty (60) weaned mixed breed rabbits between 5 and 6 weeks old of both sexes (24 bucks and 36 does), (average initial body weight of 606.42±1.3g) were used in this study. The experimental animals were accommodated individually in wooden hutches (with wire mesh floor) measuring 65 × 65 × 65 cm (L × H× W) and raised 25 cm from the ground and placed in a standard rabbitry with half walls to allow for cross ventilation. Five rabbits per treatment were randomly distributed to the test diets using a simple CRD. At the end of the 60 days feeding trial, evisceration and singeing were done. The Gastro – Intestinal Tract (GIT) and its segments were obtained and weighed with a precision electronic balance and their linear measurements determined with a measuring tape. The length of the caecum was taken from the *ileo-caeco-colic* junction to the point where the appendix begins. The weights of cut – up parts of the carcass were obtained.

Data obtained in this study were subjected to one – way Analysis of Variance (ANOVA) using GenStat Release 10.3DE. Significant means were separated using Least Significance Difference (LSD) option.

Results and Discussion

The result of carcass yield of rabbits fed diets containing CPHM is presented in Table 1. The live and dressed weight values of rabbits recorded significant differences ($p<0.05$) between dietary treatments. The control diets recorded the highest values and the least values were obtained in the 37.5% inclusion level across treatments. The dressing percent ranged between 59.79 and 63.64% with no significant difference. The major cuts/parts of the rabbit carcass (expressed in terms of percent live weight) did not record any significant difference between dietary treatments. The GIT morphometry is summarised in Table 2. All GIT segments (weight and length) recorded no significant effect of dietary treatments.

Table 1: Carcass yield of rabbits fed cocoa pod husk meal based- diets

Parameter	SCPHM				FCPHM				HCPHM				
	T_1 0%	T_2 12.50%	T_3 25.00%	T_4 37.50%	T_5 0%	T_6 12.50%	T_7 25.00%	T_8 37.50%	T_9 0%	T_{10} 12.50%	T_{11} 25.00%	T_{12} 37.50%	S.E.M
Live weight (g)	2483.33^a	2016.67^b	2083.33^b	1950.00^b	2383.33^a	2116.67^b	2150.00^b	1683.33^c	1900.00^b	1933.33^b	1700.00^c	1616.67^c	176.09
Dressed weight (g)	1500.00^a	1283.33^c	1283.33^c	1216.67^c	1483.33^a	1333.33^b	1300.00^c	1033.33^d	1183.33^c	1183.33^c	1016.67^d	966.67^e	106.95
Dressing percent (%)	60.40	63.64	61.60	62.39	62.24	62.99	60.47	61.39	62.28	61.21	59.80	59.79	1.13
Relative weight of major parts/cuts (% live weight):													
Head	7.50	8.57	8.59	8.86	7.55	8.62	8.99	8.69	9.16	10.54	9.48	9.19	0.23
Neck	3.72	4.59	4.38	3.25	3.99	4.25	3.23	4.85	3.65	3.63	4.11	4.04	1.74
Shoulder	2.16	2.69	3.18	3.94	3.72	3.72	4.18	5.15	4.50	3.72	3.50	3.03	0.23
Fore limbs	4.41	4.90	4.05	4.25	4.29	4.57	4.56	3.94	4.18	3.25	4.00	4.30	0.12
Rack	10.74	10.34	6.60	8.61	6.98	8.17	9.10	14.84	13.06	9.85	12.97	11.81	0.74
Back cut	16.19	19.93	23.85	14.56	19.31	18.83	16.29	28.97	26.50	19.47	14.87	11.04	1.50
Loin	5.72	5.84	5.21	5.41	4.13	4.80	4.11	4.51	3.49	3.27	2.88	2.39	0.33
Thigh/hind limbs	13.61	14.02	16.65	13.83	12.30	13.74	13.22	16.69	13.73	13.32	15.71	12.59	0.42

$^{a,b,c…e}$ means on the same row with different superscripts are significantly different ($p< 0.05$)

The carcass characteristics revealed significant effect ($p<0.05$) of dietary treatments on the live weight and dressed weight (Table 1). The dressed weight recorded a significantly steady declining trend in the sun dried, fermented and hot – water treated CPHM as the inclusion levels increased. The findings showed that the highest level of CPHM (37.5%) inclusion adversely affected the dressed weight compared with the values in the control diet. This implies that theobromine has a negative influence on the dressed weight of rabbits. However, the dressed weight values in this study were similar to the values reported by Akinmutimi and Obioha (2010) and higher than the values reported by Ozung *et al*. (2011). These differences in values could be attributed to age differences in the rabbits, differences in processing methods and different feeding materials utilized in the separate studies. The average dressing percentage recorded in this study ranges from 59.79 to 63.64 % across dietary treatments. These values were similar to the range of 60.48 – 62.39 % reported by Ozung *et al*. (2011) and fairly higher than the range of 57.26 – 58.81% earlier reported by Akinmutimi and Obioha (2010). The observed differences in dressing percentage occurred because the heads were removed from the carcasses in this study. This is because the head, skin and feet of rabbit carcass contribute about 10, 11 and 3 percent, respectively to the dressing percentage (Aduku and Olukosi, 1990). The relative weight values of the major cut up parts were fairly lower than the values reported by Akinmutimi and Obioha (2010) for the shoulder, rack, back cut, loin and thigh.

The GIT morphometry of rabbits fed cocoa pod husk meal based diets (Table 2) did not record any significant effect of dietary treatments. This means that the anti – nutrient (theobromine) content in the sundried, fermented and hot – water treated CPHM were within tolerable levels for effective digestion in rabbits. In this study, weight and length of GIT segments like the oesophagus, stomach, small intestine, colon, caecum and appendix recorded values that were comparable with those earlier reported by Ozung *et al*. (2011) for rabbits fed cassava peel meal as replacement for maize. The HCPHM group showed gradual and steady decline in the total GIT length with increasing levels of inclusion compared with the SCPHM and FCPHM groups without definite trends. This observation could be attributed to the effect of residual theobromine on the total GIT length. This is because high levels of cocoa pod husk meal and associated theobromine in animal diets could affect the smooth functioning of the alimentary canal causing sloughing – off effect of the walls of the GIT in animals (Meffeja *et al*., 2006).

Table 2: Gastro - intestinal tract (GIT) morphometry of rabbits fed cocoa pod husk meal based- diets

Parameter	SCPHM				FCPHM				HCPHM				
	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	S.E.M
Relative weight of empty GIT segments (% live wt.):													
Oesophagus	0.15	0.09	0.10	0.05	0.06	0.09	0.07	0.07	0.06	0.06	0.06	0.08	0.01
Stomach	0.87	1.10	1.17	1.10	0.93	1.08	1.11	0.79	0.78	1.00	1.22	1.02	0.04
Small intestine	0.97	1.52	1.98	2.09	1.23	1.20	1.47	1.51	1.29	1.36	1.28	1.25	0.09
Colon	0.55	1.15	1.12	0.87	1.00	1.09	1.35	1.19	1.81	1.27	0.92	0.96	0.08
Caecum	0.75	1.49	1.32	1.25	0.87	1.17	1.37	1.29	1.20	0.79	0.98	1.27	0.07
Appendix	0.25	0.29	0.31	0.27	0.27	0.22	0.19	0.30	0.25	0.23	0.33	0.32	0.01
Total GIT	3.54	5.65	5.69	5.64	4.35	5.08	5.49	5.15	4.87	4.72	4.79	4.95	0.18
Linear measurements of GIT (cm):													
Oesophagus	12.50	12.87	11.50	7.00	10.00	12.83	10.33	9.67	9.67	10.00	9.17	9.17	0.51
Stomach	8.50	10.33	11.50	9.17	8.33	9.33	9.83	8.67	9.50	8.50	9.33	8.63	0.27
Small intestine	128.67	267.67	231.00	244.33	204.74	218.00	234.67	210.00	224.67	226.33	229.33	185.33	9.98
Colon length	63.74	72.33	98.50	72.41	85.33	86.00	87.67	96.67	103.33	99.33	86.33	53.67	4.45
Caecum length	47.37	60.00	45.50	27.37	30.38	36.00	35.67	29.00	34.33	28.17	31.67	28.67	2.87
Appendix length	9.00	10.83	11.83	8.98	9.67	9.00	9.17	9.33	9.50	10.00	9.23	8.67	0.26
Total GIT length	269.77	434.03	409.83	369.27	348.45	374.33	384.00	363.33	391.00	382.33	375.07	297.47	12.98

All parameters are expressed in relative weight basis, except lengths

Conclusion and recommendation

It is the conclusion of this study that cocoa pod husk meal could be included in animal diets; however the sundried CPHM should be used with caution. The best form was the fermented CPHM followed by the hot – water treated form. It is therefore recommended that farmers can include up to 25% FCPHM and lower levels for SCPHM and HCPHM in diets meant for rabbits, so as not to impair the carcass yield and GIT morphometry.

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