Carcass yield and gastro - intestinal tract morphometry of rabbits exposed to dietary cocoa (*Theobroma cacao* L.) pod husk meal

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Abstract

In this study, the effect of different forms of dietary cocoa pod husk meal (CPHM) on the carcass yield and gastro-intestinal tract (GIT) morphometry of growing rabbits was investigated. A total of 60 rabbits with mean body weight of 606.42±1.3g were utilized across 12 experimental iso – caloric (2,592.04 Kcal/kg ME) and iso - nitrogenous (16.52% CP) diets containing sundried (T₁, T₂, T₃, T₄); fermented (T₅, T₆, T₇, T₈) and hot – water treated (T₉, T₁₀, T₁₁, T₁₂) 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 (CRD) experiment. The rabbits were slaughtered at the end of the feeding trial and the carcass yield and GIT morphometry were determined. The results showed that the average live weight was between 1616.67 ± 44.10 and 2483.33 ± 16.67 g/rabbit, while the dressed weight was between 966.67 ± 18.12 and 1500 ± 28.87 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 effect that could be ascribed to diets. The study concluded 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% are recommended for sundried CPHM and hot- water treated CPHM are recommended for growing rabbits.

Keywords: Carcass, cocoa husk, intestine, morphometry, rabbit

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. 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 (cattle, sheep and goats) and monogastrics (poultry and swine) 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 (Ozung, 2016). The inadequacy of animal protein coupled with stiff competition between man and animals for agricultural produce call for enhancing the diversification and

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productivity of livestock and this has culminated in resurgence of interest in rabbit production in the tropics. Rabbit meat is healthy as it is low in cholesterol (50g/100g); fat (4g/100g); energy (124Kcal/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 (Ozung *et al.*, 2017).

One of the promising agricultural by - products that could be utilized in rabbit diet formulations is the cocoa pod husk (Ozung, 2016). Cocoa pod husk meal (CPHM) can partially replace maize in animal diets with no adverse effects on performance characteristics. Untreated CPHM has been added in the diets of growing swine up to 300 g/Kg without deleterious signs. The practice of incorporating cocoa pod husk meal in various animal diets has been extensively reported (Agyente - Badu and Oddoye, 2005; Alexander *et al.*, 2008; Adeyina *et al.*, 2010; Adamafio, 2013; Ozung *et al.*, 2017). The raw cocoa pod husk meal (CPHM) contains 6 – 7% crude protein, 9 – 10 % total ash, 1 – 8 % ether extract and 23 – 33 % crude fibre (Donkor *et al.*, 1991). According to Ozung (2016), the sundried CPHM contains 9.37% CP, 8.83% ether extract and 9.30% ash; the fermented CPHM has 7.70% CP, 9.52% ether extract and 10.80% ash while the hot –water treated CPHM has 8.94% CP, 11.68% ether extract and 10.85% ash, respectively. 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 differently treated forms of CPHM on the carcass yield and GIT morphometry of growing rabbits.

Materials and methods

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, 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°C for 15 minutes which was later drained, shade dried and stored for later use. Twelve (12) experimental iso - caloric (2,592.04 Kcal/kg ME) and iso –

nitrogenous (16.52% CP) 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 T₁, T₂, T₃, and T₄ (SCPHM), T₅, T₆, T₇, T₈ (FCPHM) and T₉, T₁₀, T₁₁, T₁₂ (HCPHM), respectively in the experimental diets. Sixty weaned mixed breed rabbits between five and six weeks old of both sexes (24 bucks and 36 does), (mean initial body weight of 606.42±1.3g) were used. 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 completely randomized design (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 *intoto* 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 and expressed in terms of percent live weight to obtain relative weight values. Data obtained in this study was subjected to one – way Analysis of Variance (ANOVA) using GenStat Release 10.3DE. Significant means were separated using the Least Significance Difference (LSD) option (Steel and Torrie, 1980).

Results

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 ($P > 0.05$) difference between dietary treatments. The GIT morphometry is summarised in Table 2. All GIT segments (weight and length) recorded no significant ($P > 0.05$) effect of dietary treatments.

Discussion

Carcass yield

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 an enhanced 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 had 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

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

Parameter	Sundried CPHM				Fermented CPHM				Hot –water treated CPHM				S.E.M
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	T ₁₂	
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 ^c	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 (% 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,d} means on the same row with different superscripts are significantly different ($P < 0.05$)

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

Parameter	Sundried CPHM			Fermented CPHM			Hot –water treated CPHM		
	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	0.06	0.01
Stomach	0.87	1.10	1.17	1.10	0.93	1.08	1.11	1.22	0.04
Small intestine	0.97	1.52	1.98	2.09	1.23	1.20	1.47	1.28	0.09
Colon	0.55	1.15	1.12	0.87	1.00	1.09	1.35	0.92	0.08
Caecum	0.75	1.49	1.32	1.25	0.87	1.17	1.37	0.98	0.07
Appendix	0.25	0.29	0.31	0.27	0.27	0.22	0.19	0.33	0.01
Total GIT	3.54	5.65	5.69	5.64	4.35	5.08	5.49	4.79	0.18
Linear measurements of GIT (cm):									
Oesophagus	12.50	12.87	11.50	7.00	10.00	12.83	10.33	9.17	0.51
Stomach	8.50	10.33	11.50	9.17	8.33	9.33	9.83	8.63	0.27
Small intestine	128.67	267.67	231.00	244.33	204.74	218.00	234.67	226.33	9.98
Colon length	63.74	72.33	98.50	72.41	85.33	86.00	87.67	99.33	4.45
Caecum length	47.37	60.00	45.50	27.37	30.38	36.00	35.67	29.00	2.87
Appendix length	9.00	10.83	11.83	8.98	9.67	9.00	9.17	9.23	0.26
Total GIT length	269.77	434.03	409.83	369.27	348.45	374.33	384.00	375.07	12.98

All parameters are expressed in relative weight basis, except lengths

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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. Even though relative weight values in this study showed statistically similar effects ($P>0.05$), the weight for shoulder maintained a gradual increase while other cut up parts fluctuated across dietary treatments. This means that cocoa pod husk meal based diets have the ability of depositing tissue with the fermented group being the method of choice; since it recorded fairly higher values compared to the two other methods. The non-significant effect of dietary treatments on the major/cut up parts has also indicated that the inclusion of differently processed forms of cocoa pod husk meal in the diet had no negative effect on the carcass quality. Similar findings have also been made by other workers who fed pigeon pea seed meal and gala waste meal, respectively to rabbits (Amaefule *et al.*, 2004; Adejobi, 2011).

Gastro – intestinal tract (GIT) morphometry

The gastro – intestinal tract morphometry of rabbits (weight and length of GIT segments expressed in percent live weight basis) fed cocoa pod husk meal based diets (Table 2) were similar. All segments of the GIT (weight and length) did not follow a regular pattern that could be attributed to the diets. This means that the anti – nutrient (theobromine) content in the raw, 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 to those earlier reported by Ozung *et al.* (2011) for rabbits fed cassava peel meal as replacement for maize. However, the weight and length of the small intestine showed gradual increase in values in the raw CPHM group, when compared to the fermented and hot – water treated groups without definite trends. The observation associated with the raw CPHM may be attributed to the increased fibre in the diets which might have exerted a positive tissue formation in the linings of the small intestine to withstand digestive dysfunction due to theobromine toxicity. The hot – water treated CPHM group showed gradual and steady decline in the total GIT length with increasing levels of inclusion compared to the raw and fermented CPHM groups without definite trends. This observation could be attributed to the effect of residual theobromine on the total GIT length. This is because the high levels of cocoa pod husk meal and associated theobromine in animal diets could affect the proper functioning of the alimentary canal causing sloughing – off effect of the walls of the GIT (leading to reduction in length) and possible liquid faeces in animals (Meffeja *et al.*, 2006).

Conclusion and recommendation

The study showed that cocoa pod husk meal could be included in differently processed forms in animal diets; however, the sundried CPHM should be used with caution as it has more residual theobromine. The best form of cocoa pod husk meal 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 growing rabbits, so as not to impair the carcass yield and GIT morphometry.

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