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Rumen Degradation of Cassava Peel Meal Supplemented with Graded Levels of African Yambean by West African Dwarf Sheep in the Humid Zone of Nigeria

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Abstract

The effect of 0,10, 20 and 30% supplementation of cassava peel (*Manihot esculenta* Crantz) with African yambean (*Sphenostylis stenocarpa*-AYB) on rumen degradability of dry and organic matter (DM and OM) was investigated in a factorial experiment involving 4 treatments, 5 incubation periods, 3 animals and 2 nylon-bag samples per animal per incubation period. Three rumen-fistulated West African Dwarf ewes of 30 months of age and weighing an average of 31kg were used. Samples were incubated in the rumen for 6, 12, 24, 48 and 72 hours. DM and OM degradation increased significantly ($P< 0.05$) when the legume (AYB) fraction in the diets increased from 0 to 20%. Any further increase in the legume fraction up to 30% of the diet did not result in significant increases in DM and OM degradability. Also a significant ($P< 0.05$) increase in DM and OM degradability of all diets was recorded when incubation time in the rumen increased from 6 to 48 hours. Degradability of DM was 31% for cassava peel alone and 32, 38 and 39% respectively, for rations containing 10, 20 and 30% legume inclusion after 48 hours incubation. There was no significant ($P> 0.05$) increase in DM and OM degradability after 72 hours incubation time. The estimates of the immediate soluble fraction (a) and the rate of degradability (c) increased with increase in the level of AYB inclusion in the diets. As the level of AYB supplement increased, the lag time necessary for the microbial population to invade the feed also reduced appropriately. The study concludes that the inclusion of African yambean supplement in the diet of WAD sheep fed cassava peel meal up to 20% resulted in significant improvement in dry matter and organic matter degradation in the rumen.

Keywords: Rumen, degradability, organic matter, ewes

Introduction

In sub-Saharan Africa and most parts of the tropics, one of the major problems of ruminant production is the scarcity of forages all year round. The natural rangeland is the most important and the most widely available low-cost feeds for ruminants, after which crop residues and to a lesser extent, agro-industrial by-products. However, in some tropical pastures, even in

the wet season high yields are not necessarily matched by high nutritional composition, which compounds the feed deficit problem and leads to low animal productivity.

In Nigeria, about 95% of the entire ruminant population are in the hands of the nomadic pastoralist and smallholder rural farmers who are scattered across the country but very dominant in the Southern parts of Nigeria (Anya and Ayuk, 2011). These farmers are expected to increase their production to meet the demand for meat and milk in the country but have serious problems feeding these animals. Increased pressure on land, land tenure system coupled with rapid urbanization has forced people to farm near their homesteads and land hitherto used for pasture gets converted to arable crop cultivation. Given this scenario, during the cropping season, animals are kept in pens or tethered for most of the day and only allowed to graze later in the day, when they are less likely to travel outside the homestead and damage crops (Tuah *et al*, 1994). In the dry season, the quality of the sparsely scattered forages on the native rangeland is exceptionally poor. The resource poor smallholder farmers at this point have to rely on crop residues generated or gathered from their own farms as well as those of neighbours. The commonest crop residue fed to animals by farmers within this ecozone is cassava peel (CP), although peels of plantain, yam and cocoyam are also used.

Cassava is abundantly produced and processed in Nigeria. Nigeria is presently the largest producer of cassava in the world with an estimated production capacity of 50 million metric tonnes annually (FAO, 2008; Ogunjimi *et al*., 2010) and with an extraction rate of about 20% (Kossila, 1984), about 10 million metric tonnes of cassava peel are produced in Nigeria annually. However, this enormous feed resource is often discarded as waste, whereas it can conveniently support animal feeding in the face of scarcity and high cost of conventional feedstuffs.

Legumes may constitute an important feed resource providing fermentable nitrogen and of by-pass protein (Anya *et al.*, 2011). When fed to ruminants, legumes tend to increase the efficiency of the basal diet, which is usually a low nitrogen pasture or crop residue (Tchinda *et al.*, 1994; Anya *et al.*, 2011). AYB is classified as a minor grain legume when compared to conventional grain legume like soybean, cowpea, groundnut etc. because it is under-exploited (Saka *et al.*, 2004). However, this legume is often neglected in most Nigerian homes for consumption because of long cooking hours (fuel wastage) and tedious manual removal of the skin coat (Ezueh, 1984; Thomas *et al.*, 2005). This unconventional legume can be effectively utilized as supplement to low-nitrogen crop residues such as cassava peel.

Legume supplements have a catalytic effect on feed utilization. They ensure a more efficient environment for digestion of cell-wall carbohydrates, perhaps by providing micronutrients such as peptides, amino acids, minerals and vitamins which increase fungal biomass and/or the rate of bacterial colonization of the fibre (Tchinda *et al.*, 1994). The potential of the diet to meet the requirements of the animal for amino acids, glycogenic precursors and long chain fatty acids depends on the pattern of fermentation and on dietary protein, lipids and starch that escape (by-pass) fermentation and are digested in the hindgut or intestines (Preston, 1986; Anya *et al.*, 2011). The extent to which the protein in a supplement escapes the rumen is partly a function of its rate of degradation in the rumen (Preston and Leng, 1978). The objective of this study was to access the effect of graded levels of African yambean (AYB) supplement fed

with cassava peel meal based diets on the degradability of dry and organic matter by West African Dwarf goats in the humid high rainforest zone of Nigeria.

Materials and Methods

Location of study

The experiment was carried out in the Sheep and Goat Unit of the Teaching and Research Farm, Faculty of Agriculture, University of Calabar, Calabar. Calabar is located on latitude $4^0$57'N and longitude $8^0$19'E of the equator. Annual temperature and rainfall ranges from 25^0 – 30^0C and from 1260 to 1280mm respectively. The relative humidity is between 70 – 90% and Calabar is 98 metres above sea level (NMA, 2018).

Animal management and processing of test ingredients

Three female West African Dwarf Sheep fitted with permanent rumen cannulas were used for the study. The animals were managed intensively and their average age and body weight were 36 months and 31±0.05kg respectively. The animals were fed four experimental rations consisting of oven-dried CP (cassava peel) only, or supplemented with AYB (African yambean *Sphenostylis stenocarpa* – Hochst. Ex A. Rich. Harms.) at 10, 20 and 30%.

Fresh CP and AYB were dried in a forced air laboratory oven at 60^0C for 48 hours, milled separately to pass through a 2mm screen sieve and mixed in the following CP/legume proportions, 100:0, 90:10, 80:20 and 70:30. Five grams of ratio (experimental diet) was placed in a special nylon bag (10 x 8cm with 20 micron porosity) and sealed. The composition of CP, AYB and their combinations incubated in the rumen are shown in Tables 1 and 2 respectively. The method of incubation in the rumen of the does was carried out as described by Orskov *et al.* (1980). Incubation of nylon bags in the rumen were for 6, 12, 24, 48 and 72 hours after which they were withdrawn and washed in cold water for 30 minutes and dried to constant weight at 60^0C in a forced air laboratory even and weighed. In the same way, six nylon bags containing samples of each ration were soaked in water for 30 minutes, washed and dried to constant weight.

The difference in weight of the DM in nylon bag before and after rumen incubation represents the material degraded in the rumen. Similarly, the difference in OM weight before and after incubation was equivalent to OM degraded in the rumen. The exponential equation of Orskov and McDonald (1979) was used to describe the degradation characteristics of each ration (experimental diets). Thus,

$p = a + b (I - e^{-ct})$
where a, b and c are constants

a = intercept or immediate soluble fraction

b = insoluble but potentially degradable material at time t

c = rate of degradation per hour

p = level of degradation at time T

e = natural logarithm

Chemical and Statistical analysis

Proximate components of cassava peel (CP), African yambean (AYB) and the experimental rations (diets) were carried out using standard methods (AOAC, 2000). There were four factors (4 rations or diets, 5 incubation intervals, 3 goats (does) and 2 nylon bags each per animal per incubation period). Thus, the experiment followed a 4×5×3×2 factorial design. Data obtained were analysed using the factorial procedures of SPSS (2006) Inc. 15.0 Evaluation version for windows for the analysis of variance. Significant mean levels were separated using Duncan Multiple Range Test as outlined in Obi (2002).

Results and Discussion

The degradation of dry matter of the respective rations (Table 3) increased significantly ($P< 0.05$) as a result of supplementation of CP with AYB. Total dry matter degraded increased from 30.65% in the diet containing CP only to 65.55% in the 30% AYB diet. These results are in the same pattern as the findings of Mosi and Butterworth (1983) and that of Tchninda *et al.* (1994) that the addition of 30% legume forage to a grass basal diet increased total dry matter digestibility from 40 to 60%. Legumes tend to increase the efficiency of the basal diet which is usually a low nitrogen pasture or crop residue. These results also support the fact that legumes have a catalytic effect which ensures a more efficient digestion of cell-wall carbohydrates. The diet with 0% supplementation was the least degraded 30.65% while diets supplemented with AYB were better and the diet with 30% supplementation was the best with 65.55% degradation of dry matter.

A comparison of DM degradation of the three diets containing legume supplement after 6, 12 and 24 hours incubation time indicated a significant difference ($P< 0.05$) between the rations containing 10 and 20% legume. However, there was no significant difference ($P> 0.05$) between those having 20 and 30% AYB supplement at 48 and 72 hours of incubation.

OM degradation of all diets is presented in Table 4. After 12, 24, 48 and 72 hours rumen incubation of these diets, diets with AYB supplement had significantly ($P< 0.05$) higher OM degradation that CP alone. OM degradation attained a maximum increased value of 15% especially in the diet containing 30% AYB supplement. Similar results were reported by Tchinda *et al.* (1994) when supplements of perennial peanut were fed with elephant grass to West African Dwarf Sheep. Dixon *et al.* (1979) also reported similar finding in his studies with *Leucaena leucocephala* supplements on cattle. These results are an indication of increased microbial synthesis due to supplementation.

There was no significant difference (P> 0.05) between the OM degradation of the diet containing 0% supplement and the one containing 10% AYB after 6 hours of rumen incubation. Similarly, there was also no significant (P> 0.05) improvement in OM disappearance in the rumen when the level of AYB supplement in the diet was raised from 20 to 30%. Improvements in OM degradation were significant and very evident after 24 and 48 hours incubation time of feed samples in the rumen. However, extending the incubation time to 72 hours did not result in any significant increase in OM degradation or had no effect on OM degradation.

Another observation in this study was that estimated maximum potential degradable OM in the diets increased with increase in the level of AYB supplement in the diets. After 72 hours of rumen incubation, only 31% of maximum degradable amount of CP organic matter in the diet with 0% supplement had disappeared whereas other treatments with AYB supplements, more than 66% had been completely degraded.

In this study, supplementation of CP with graded level of AYB resulted in an increase in the rate of DM and OM degradation in the rumen of WAD sheep. DM increased from 0.0201 to 0.0388% per hour as the level of AYB in the ration increased while OM increased from 0.0105 to 0.0301% per hour. Another very clear and outstanding observation was that with a rise in the AYB supplementation in the diets, there was a reduction in the lag time necessary for the attack of the feed by the microbial population.

Conclusion

It is concluded in this study that the inclusion of African yambean (AYB) supplement in the diet of WAD sheep fed Cassava peel meal (CPM) up to a level of 20% will result in significant improvement in dry matter (DM) and organic matter (OM) degradation in the rumen.

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Table 1: Composition (%) of dried CP and AYB used in formulating rations incubated in the rumen

Proximate components	CP	AYB
Dry matter (DM)	90.10	88.50
Organic matter (OM)	84.01	84.31
Crude protein	3.22	22.10
Crude fibre	14.73	5.92
Ash	5.57	5.28

Table 2: Composition of experimental diets (rations) in the rumen of sheep

Proximate components	CP: AYB ratio			
Dry matter (DM)	90.10	90.07	90.04	90.02
Organic matter (OM)	84.01	84.31	84.41	84.46
Crude protein	3.22	10.96	11.36	11.44
Crude fibre	14.73	10.31	11.05	12.47
Ash	5.57	9.12	8.62	8.49

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Table 3: Effect of level of supplementation on dry matter loss in the rumen of sheep (g/100gDM)

Treatment: AYB Supplementation rate	Washing loss (g/100gDM)	Incubation Period (hours)										
		6	12	24	48	72	A	b	c	Residual Mean Sq.	a+b	Time lag
0%	8.20	2.15	3.99	10.80	30.05	31.45	2.09	42.35	0.0201	19.70	44.44	5.70
10%	8.80	7.10	9.35	21.20	37.61	40.50	5.61	53.15	0.351	10.41	58.76	3.51
20%	9.10	14.21	16.21	26.35	38.41	41.75	13.45	43.60	0.0380	4.05	57.05	0.00
30%	11.20	14.64	22.88	24.10	39.09	41.10	18.26	39.55	0.0388	10.05	57.81	0.00

NOTE: a, b and c are constants in the equation $P = a+b\ (1 - e^{-ct})$ where P is the level of degradation at time t; a is the intercept or immediate soluble fraction; b is the insoluble but potentially degradable fraction at time t; c is the rate of degradation per hour while a+b is the maximum degradable fraction (asymptote).

Table 4: Effect of level of supplementation on organic-matter loss in the rumen of sheep (g/100gDM)

Treatment: AYB Supplementation rate	Washing loss (g/100gDM)	Incubation Period (hours)										
		6	12	24	48	72	A	b	c	Residual Mean Sq.	a+b	Time lag
0%	9.55	3.65	5.40	12.75	35.21	36.65	3.41	60.60	0.0105	26.81	64.01	5.66
10%	10.45	8.20	10.81	24.60	43.20	47.31	5.85	62.20	0.340	11.85	68.05	3.22
20%	11.30	14.75	19.65	29.72	43.88	47.81	16.73	49.55	0.0387	1.99	66.28	0.00
30%	12.85	14.60	22.15	28.68	46.63	47.99	18.01	49.40	0.0301	10.41	67.41	0.00

NOTE: a, b and c are constants in the equation $P = a+b\ (1 - e^{-ct})$ where P is the level of degradation at time t; a is the intercept or immediately soluble fraction; b is the insoluble but potentially degradable fraction at time t; c is the rate of degradation per hour while a+b is the maximum degradable fraction (asymptote).

