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Performance of West African Dwarf (WAD) Goats Fed N-treated Source and Forage Supplemented Cassava Peels in Humid Cross River State, Nigeria

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Authors' contributions

This work was successful as a result of the contributive efforts of all the authors. Author GAK designed the experiment, carried out the growth trial and wrote the first draft of the work. Authors AAA and LNA supervised, thoroughly proof read and approved the final manuscripts. All authors read and approved the final manuscript.

Original Research article

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ABSTRACT

An investigation to ascertain the performance of West African Dwarf (WAD) goats fed N-treated source and forage supplemented cassava peels (CSP) in Cross River State, Nigeria was carried out. Cassava peels were treated and supplemented with materials rich in nitrogen: fertilizer grade urea [U] (T_1 – CSP + U), broiler litter (T_2 – CSP + BL), sweet potato (T_3 – CSP + SPF) and cassava (T_4 – CSP + CSF) forages in a Completely Randomized Design (CRD) for 90 days of the growth trial. Results revealed that the bucks in the cassava peel forage supplemented groups (T_3 and T_4) have better performance in terms of feed intake, weight gain, feed conversion ratio (FCR) and dry matter digestibility. This is due to the presence of fermentable and readily degradable proteins in the sweet potato and cassava forages. It is therefore recommended that basal crop by-product supplementation by small holder goat keepers should be geared towards the use of forages which is seen as a cheap and alternative supplement with crop by-products.

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Keywords: WAD Goats; performance; cassava peels; forage supplementation; N-source treatment.

1. INTRODUCTION

With the increase in the production levels of food crops in Nigeria, there are more residues and by-products (straws, haulms, stovers, cobs, vines, peels, brans, leaves, chaff, etc) left after crop harvest [1]. Similarly, crop by-products predominantly cassava peels are available in large quantities in the rural villages of Cross River State in Nigeria [2]. Hence, it is conceived that small ruminant animals, especially the West African Dwarf (WAD) goats owned by traditional resource-poor livestock keepers can obtain maximum productivity levels through these lignocellulosic materials [3].

These materials are characterized by low levels of protein, soluble carbohydrates and minerals [4]. They are poor quality materials, usually high in fiber, poorly degraded in the rumen, as well as low in nitrogen and minerals [5]. These characteristics will affect their utilization by ruminants through creating an unfavourable rumen environment, impeding microbial adhesion, affecting particle size reduction, passage rates of both particulate and liquid digester, as well as roughage degradation rate and volatile fatty acid (VFA) production [5].

There is therefore the need to upgrade the feeding value of fibrous crop by-products that are of paramount importance in the nutrition of the ruminants. This can be achieved by interfering with the protective effect of lignin on the availability of substrate to the rumen bacteria or to hydrolytic enzymes [6]. This process could be enhanced by using simple inexpensive treatments which could increase the breakdown of these fibrous crop by-products in the rumen.

Interestingly, it is understood that the quality of protein available for the ruminants to utilize poor quality feed stuffs is immaterial in their nutrition. What is paramount is the utilization of compounds rich in N-supplies in combination with these fibrous feed materials [5]. Increased N-supplies can improve the rumen environment (e.g., p^H, rumen NH_3 or rumen degradable protein) to ensure increased fermentation of the basal crop by-products by rumen micro-organisms [5]. Compounds with these properties are non-protein nitrogen (NPN) compounds such as urea. There is also the need to utilize highly nitrogenous forages and waste from the litter of poultry that are also rich in N-supplies [7]. These materials represent a potential source of crude protein for the ruminant animals and may serve as a rational means to recycle these waste nutrients back into animal feed. If this is achieved the double purpose of conserving animal protein and alleviating pollution within our environment would be served.

There is paucity of information as regards the performance on N-source treated (fertilizer grade urea and broiler litter) and forage supplemented cassava peels by West African Dwarf (WAD) goats owned by small holder goat farmers in the rural villages of Cross River State, Nigeria. The information on these performance parameters will help to provide alternative and cheap sources of feed stuffs that could help to sustain the livestock industry as well as increase the animal protein supplies that could meet the requirements of the rural populace and beyond.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the sheep and goats unit of the Teaching and Research farm of the University of Calabar, Calabar, Nigeria. Calabar is located at about latitude 4º58'N and longitude 8º17'E with an average annual temperature of 25 - 30ºC and annual rainfall of 1,830 mm [8].

2.2 Management of Experimental Animals

Sixteen weeks old weaner bucks of the West African Dwarf (WAD) type were dewormed and treated for possible attacks of ectoparasites. The goats were randomly assigned to each treatment group. Four replicates of 4 bucks per treatment group were housed singly in an open pen (3m x 4m) for the 90 days of the growth trial in a Completely Randomized Design (CRD). The animals were allowed to come out on a daily basis to exercise in an open palour (25m x 25m) within 7.30 – 9.00 am.

2.3 Feed / Feed Treatment and Management

The cassava peels were treated and supplemented with materials rich in nitrogen: fertilizer grade urea, broiler litter, sweet potato and cassava forages respectively. The broiler litters were obtained from the broiler production house of the University of Calabar commercial farm. It was sieved thoroughly to remove the wooden particles contained in them and thereafter sun dried prior to their use as treatment with the sundried basal cassava peels.

The cassava peel was treated by adding 4kg of urea to every 100 kg of the air dried cassava peels. The urea was dissolved in100 litres of water and sprayed over the cassava with the help of a watering can, while placed in a container. This was then covered with some plastic sheet and allowed for 21 days before using them to feed the animals [9]. An evidence of the reaction taking place is a change in colour of the cassava usually to bright yellow and of a strong smell of ammonia when the material is uncovered. The broiler litter was also treated with the cassava peels in similar manner as those of urea treatment above, while the fresh forages (cassava leaves and sweet potato leaves + vines) were provided at supplemental rates of 20% of the basal diet (cassava peels) on dry matter basis to avoid substitution effects [10]. The various treatment combinations were:

T_1 = Cassava peel + Fertilizer grade urea (T_1 – CSP + U)
T_2 = Cassava peel + Broiler litter (T_2 – CSP + BL)
T_3 = Cassava peel + Cassava forage (T_3 – CSP + CSF)
T_4 = Cassava peel + Sweet potato forage (T_4 – CSP + SPF)

The treated cassava peels and those supplemented were offered to the WAD goats at 3% of their body weights (dry matter basis). The feed, water and commercial mineral- salt licks (TANLICK®) were provided ad libitum*.* Daily feeds were offered to the animals in the morning and evening at 09:00 and 16:00 hour respectively.

2.4 Growth Trial

The growth trial involved the use of 16 weeks old weaner bucks with average initial weight of 6.76±0.03 kg of the West African Dwarf (WAD) goat. Four bucks were randomly assigned to each treatment group (T_1- T_3 and T_4, respectively). Four replicates of 1 buck per treatment were housed singly in an open pen (3m x 4m) for the 90 days of the growth trial in a Completely Randomized Design (CRD). The animals were allowed to exercise themselves within 7.00am – 8.30am in a 25m x 25m open parlor and retired by 9.00am and fed with the treated and supplemented cassava peels ad libitum in their individual pens. The animals had regular access to fresh clean water and commercial mineral-salt licks (TANLICK®). Feed offered and refused were recorded on a daily basis. Average weekly weight gains were computed.

2.5 Digestibility Trial

The digestibility trial lasted for 12 days (7 days of adjustment and 5 days of collection). Three (3) bucks were assigned per treatment (T_1-T_3 and T_4, respectively) into metabolic cages (2.5m x 1.5m x 4m) in a Completely Randomized Design (CRD). Daily feed offered and refusals were recorded. Representative samples of feed offered and refused were put into sample bags and kept in a Gallenkamp moisture extraction oven for 48 hours at 60ºC for dry matter (DM) determination. The difference in feed offered and refused per animal was recorded as voluntary feed intake on dry matter basis. At the end of the digestibility trial, daily samples of feed offered, feed refused and faeces, were bulked for the animals per treatment and a representative sample of the 5-day collection kept for chemical analysis.

Total daily faecal output for the animals per treatment was collected using harness faecal collection bags and recorded. Samples of faeces were taken from the animals for each treatment and dried in the oven for 48hours at 60ºC to determine faecal dry matter. The remainder was bulked for the animals per treatment over the 5- day collection and stored in the deep freezer for faecal chemical analysis.

2.6 Chemical Analysis

The samples of oven-dried feed offered and feed refused were further dried at 105°C for about 6 hours to climatic residual moisture before being ground through 1mm screen for chemical analysis. About 1g samples were weighed into crucibles and placed in a muffle furnace at 500°C for 24 hours to determine ash content, while organic matter concentration was computed by difference [11]. The crude protein (CP) concentration (total nitrogen x 6.25) was determined according to the Micro-kjeldahl method, while crude fat (CF) was determined by extraction [11]. Similarly, neutral detergent fibres (NDF), acid detergent fibre (ADF) were determined according to prescribed standard procedures [12]. Metabolizable energy (ME) was estimated according to the model suggested by [13] as ME (MJ/kg DM) = 135 – 0.15*ADF%+ 0.14*CP% - 0.15*Ash%.

2.7 Statistical Analysis

Analysis of variance (ANOVA) using general linear model (GLM) procedures [14] for Completely Randomized Design (CRD) was used to determine the treatment effects in the growth and digestibility trials. Treatment means, was separated using the Duncan Multiple Range Test [15].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Basal Cassava Peel and Nitrogen Supply

The proximate composition of the basal cassava peel and nitrogen supply sources used as treatment and supplements for the study are presented in Table 1. Similarly, the proximate composition of the diets: urea and broiler litter treated cassava peels (T_1 and T_2 respectively) and cassava and sweet potato forage supplemented cassava peels (T_3 and T_4 respectively) are presented in Table 2. The dry matter (DM) contents of the feedstuffs were not significantly (P>0.05) different. However, the crude protein contents of the feedstuffs were significantly (P<0.05) different. The CP content ranged between 16.02 and 30.05% among the treatment groups with T_3 and T_1 having the lowest and highest values respectively. A trend in the increase of the CP contents of the diets were observed because of the complementary or contributive effects of the CP contents of the materials used for treating the cassava peel and/or used as a supplement Table 1. Thus the increase in the CP contents of T_1 and T_2 for instance, may be attributed to the higher CP contents of urea (28.84%) and broiler litter (26.50%) respectively. The use of these materials in this study is worthwhile since the use of conventional proteins may be a costly and wasteful venture amidst cheaper alternatives. For instance, the cost of nitrogen in the form of white fish meal is generally more than fifty times that of nitrogen from urea, and small amounts of urea can be added to diets for ruminants to supply at least a part of their nitrogen need [16]. In addition, it was observed that broiler litter consists of a mixture of a fibrous food with poultry excrement and it is possible that the ammonia which is produced as the excrement decays may actually increase the nutritive value of the fibrous part of the diet [16]. Therefore, these feedstuffs based on chemical analysis have been recommended to meet the minimum level of CP (12%) utilized for digestibility trials [17].

Table 1. Proximate composition of basal cassava peel and Nitrogen supply sources for experimental WAD goats

Nutrient (%)	Feed materials				
	Cassava peel	**Urea**	**Broiler litter**	**Cassava leaves****	**Sweet potato forage (Leaf+ vines)*****
Dry matter	93.77	ND	84.10	25.60	87.20
Nitrogen	ND	46.15	ND	ND	ND
Crude protein	6.23	28.84*	26.50	14.69	19.40
Ether extract	5.10	ND	2.80	8.39	3.25
Crude fibre	14.90	ND	9.30	15.63	18.50
Ash	11.77	ND	28.50	16.07	10.25
Nitrogen free extract	61.24	ND	32.90	45.22	48.60
Acid detergent fibre	32.85	ND	20.80	ND	30.50
Neutral detergent fibre	42.90	ND	39.30	ND	49.00
Metabolizable energy (MJ/Kg DM)	7.67	ND	9.81	ND	10.10

*ND = Not determined; *CP = N x 6.25; **Values adopted from Oyenuga, (1978); ***Values adopted from Olurunnisomo et al. (2005); ME (MJ/kgDM) = 13.5 – 0.15*ADF% + 0.14* CP% - 0.15*Ash% (MAFF, 1984)*

Table 2. Proximate composition of forage supplemented and treated cassava peel diets for experimental WAD goats

Nutrients (%)	Feed materials					
	T_1 (CSP+U)	T_2 (CSP+BL)	T_3 (CSP+CSF)	T_4 (CSP+SPF)	Mean	±SEM
Dry matter	89.07[NS]	89.77[NS]	86.24[NS]	88.65[NS]	88.43	2.90
Crude protein	30.05[a]	25.00[b]	16.02[d]	18.04[c]	22.28	1.95
Ether extract	6.04[c]	10.05[b]	14.00[a]	13.00[a]	10.77	1.17
Crude fibre	15.05 [NS]	17.00 [NS]	19.55 [NS]	20.06 [NS]	17.92	1.38
Ash	16.00 [NS]	16.05 [NS]	20.04 [NS]	18.01 [NS]	17.53	1.49
Nitrogen free extract	32.86[a]	31.90[a]	30.39[b]	30.89[b]	31.51	1.06
Acid detergent fibre	16.00[d]	26.00[c]	32.00[b]	34.00[a]	27.00	1.96
Neutral detergent fibre	30.06d	40.0[c]	50.05[b]	56.00[a]	44.03	3.05
Metabolizable energy(MJ/kgD)	12.00[a]	10.55[b]	7.94[c]	7.95[c]	9.61	0.58

*[NS] Not significantly different (P> 0.05); [a,b,c,d]Means bearing different superscripts along the same row are significantly different (P < 0.05) ; **ME (MJ/kgDM) = 13.5 – 0.15*ADF% + 0.14* CP% - 0.15*Ash% (MAFF, 1984) ; T_1(CSP+U)= Cassava peel + urea;T_2 (CSP + BL)= Cassava peel + broiler litter; T_3 (CSP + CSF)= Cassava peel + cassava forage; T_4 (CSP + SPF) = Cassava peel + sweet potato forage*

There was a significant (*P*<0.05) difference in the ether extract (EE) contents of the feedstuffs. The EE contents of the feedstuffs were in the increasing order of 6.04, 10.05, 13.00 and 14.00%, for T_1, T_2, T_4 and T_3. The EE contents in T_3 and T_4 were higher as compared to T_1 and T_2. The higher EE contents of the feedstuffs T_3 and T_4 may be attributed to the relative content of oil contained in the forages of cassava and sweet potato [18].

The crude fibre (CF) contents of the feedstuffs were not significantly (*P*>0.05) different. The CF contents of the feedstuffs were in the increasing order of 15.05, 17.00, 19.55 and 20.06% for T_1, T_2, T_3 and T_4. Although significant difference did not occur among the feedstuffs in CF contents, T_4, T_3 and T_2 recorded higher CF contents. These higher values may be attributed to the lignin contents contributed by the leaves/vines of the cassava and sweet potato as well as those of wood chips which are a component of the broiler litter [19].

The ash contents of the feedstuffs were not significantly different (*P*>0.05).The ash contents of the feedstuffs were in the increasing order of 16.00, 16.05, 18.01 and 20.04% for T_1-T_3. Although significant differences did not occur among the feedstuffs in ash contents, T_3 and T_4 recorded higher ash contents. These feedstuffs are higher in ash contents because of the contributive effects of the leaves of cassava and sweet potato that have been reported to be a valuable source of ash [18].

The Nitrogen free extract (NFE) contents of the feedstuffs were significantly different (*P*<0.05). The NFE content ranged between 30.39 – 32.86% for T_3 and T_1. The acid detergent fibre (ADF) and the neutral detergent fibre (NDF) were significantly different (*P*<0.05). The ADF contents in the feedstuff were in the increasing order of 16.00, 26.00, 30.39 and 34.00% in T_1-T_4 respectively. Similarly, the NDF contents in the feedstuffs were in the increasing order of 30.06, 40.00, 50.05 and 56.00% in T_1-T_4 respectively.

The calculated metabolizable energy (ME) of the feedstuffs was significantly different (*P*<0.05). The ME content of the feedstuffs varied from as low as 7.94 MJ/kgDM to as high as 12.00 MJ/kgDM in T_3 and T_1 respectively. The feedstuffs that possess the higher CF content recorded the lowest values of ME [19]. However, the ME of the feedstuffs was within the recommended levels (6 - 13MJ/kgDM) for maintenance and production for goats [20].

3.2 Feed Intake

Table 3 shows the result of the performance of WAD bucks fed cassava peels treated with urea (T_1) and broiler litter (T_2) and cassava peels supplemented with cassava forage (T_3) and sweet potato forage (T_4). Results from the study revealed that there were significant ($P<0.05$) differences in the dry matter feed intake among the WAD bucks in the utilization of the different diets. However, the intake of T_3 and T_4 by the bucks were not significantly ($P>0.05$) different. The dry matter intake of the feedstuffs varied from as high as 276.07 g/day to as low as 104.27 g/day for T_3 and T_1 respectively in the WAD bucks. The bucks in the cassava peel forage supplemented groups (T_3 and T_4) were observed to have a higher feed intake as compared to their cassava peel urea (T_1) and broiler litter (T_2) treatment groups. The increase in feed intake may be attributed to the catalytic effects of the forages used as supplements [6]. In addition, the forages may have fermentable proteins and readily degradable walls as are peculiar with legume forages which would increase the substrates available to cellulolytic microbes with a consequent increase in the population of these microorganisms [21]. Therefore, conditions that enhance the activities of these rumen microorganisms are liable to increase food intake [20].

Table 3. Performance of the West African Dwarf (WAD) bucks fed treated and forage supplemented cassava peels

Parameters	Feed materials					
	T_1 (CSP+U)	T_2 (CSP+BL)	T_3 (CSP+CSF)	T_4 (CSP+SPF)	Mean	±SEM
Average Initial weight (kg)	6.76^{NS}	6.76^{NS}	6.76^{NS}	6.76^{NS}	6.76	0.025
Average final weight (kg)	7.25^{NS}	7.29^{NS}	7.63^{NS}	7.58^{NS}	7.43	0.77
Average Total weight gain (g)	490.00^{d}	533.50^{c}	870.00^{a}	823.50^{b}	679.25	31.35
Average weight gain (g/day)	5.44^{d}	5.93^{c}	9.67^{a}	9.15^{b}	7.55	0.38
Feed DM intake (g/day)	104.27^{b}	107.82^{b}	276.07^{a}	265.45^{a}	188.40	32.39
FCR (intake/Gain)	19.17^{d}	18.18^{c}	28.55^{b}	29.01^{a}	23.73	0.26
Dry matter digestibility (%)	53.13^{c}	51.53^{bc}	64.93^{a}	63.20^{a}	58.20	8.34

^{NS} Not significantly different (P> 0.05); ^{a,b,c,d} Means bearing different superscripts along the same row are significantly different (P< 0.05 ; T_1(CSP+U)= Cassava peel + urea;T_2 (CSP + BL) = Cassava peel + broiler litter; T_3 (CSP + CSF)= Cassava peel + cassava forage;T_4 (CSP + SPF) = Cassava + sweet potato forage

3.3 Weight Gains

The results of the performance of the WAD bucks fed cassava peels treated with urea (T_1) and broiler litter (T_2) and cassava peels supplemented with cassava forage (T_3) and sweet potato forage (T_4) are presented in Table 3. The initial weights of the WAD bucks allotted to the different feed treatment groups were not significantly ($P>0.05$) different. Similarly, the final total weight and the weight gains were also not significantly ($P>0.05$) different. However, the final weight in order of superiority for the WAD bucks were 7.63kg, 7.58kg, 7.29kg and 7.25kg for T_3, T_4, T_2 and T_1 respectively. The average total weight gain and the average daily weight gain of WAD bucks for the treatment groups were significantly (P<0.05) different. The average total weight gain values in the WAD bucks varied from as high as 870.00g to as low as 490.00g for T_3 and T_1 respectively. The average daily weight gain values for the WAD bucks varied from as high as 9.67g/day to as low as 5.44g/day forT_3 and T_1 respectively. The marked variation in weight gain by WAD bucks fed the different feedstuffs may be attributed to the various levels of metabolizable energy in the crop by-products [22]. Although the metabolizable energy of T_3 was lower than those of T_1 they were within the range 6 – 13 MJ/kg DM necessary for optimal productivity [20]. The superior weight gains exhibited by WAD goats fed T_3 may also be attributed to the level of voluntary intake of the diets. This is in agreement with the reports by [23] that if the voluntary intake of feed by the animals is too low, rate of production will be depressed. This factor has thus, been described as one of the factors for productivity in small ruminants [24].

3.4 Feed Conversion Ratio (FCR)

The results in Table 3 revealed that there were significant (P < 0.05) differences in the FCR among the WAD bucks fed cassava peels treated with urea (T_1) and broiler litter (T_2) and cassava peels supplemented with cassava forage (T_3) and sweet potato forage (T_4). The FCR of the WAD bucks were in the increased from 18.18 to 19.17 through 28.55 and 29.01 for T_2, T_1, T_3 and T_4 respectively. The WAD bucks fed the cassava peels supplemented with forages (T_3 and T_4) utilized feed for body weight gain poorly (P < 0.05) when compared with the cassava peel treated with urea (T_1) and broiler litter (T_2). Thus, the cassava peels supplemented with forage groups recorded a higher body weight gain. However, the efficiency at which the WAD bucks converted feeds for body weight gains in this present study was contrary to the average value (11.96) obtained by [25]. The disparity in FCRs may be attributed to the difference in the initial body weights of the animals utilized.

3.5 Dry Matter Digestibility

The results in Table 3 revealed that there were significant differences (P< 0.05) in the dry matter digestibility among the WAD bucks fed cassava peels treated with urea (T_1) and broiler litter (T_2) and cassava peels supplemented with cassava forage (T_3) and sweet potato forage (T_4). The dry matter digestibilities of the feedstuffs were in the increasing values of 64.93%, 63.20%, 53.13% and 51.53% for T_3, T4, T_1 and T_2 respectively. Although animals fed T_3 possessed the highest digestibility value (64.93%), they were not statistically different from those of T_4 (63.20%). The high digestibility value recorded by WAD goats fed T_3 could be related to the high feed intake values recorded for the feedstuff by the WAD bucks. A regular trend in the relationship between feed intake and feed digestibility was observed in this study. The digestibility of feed among the WAD bucks fed the different diets increased with increasing levels of feed intake. This is in agreement with the reports of [16], who established a positive relationship between the digestibility of foods and their intake.

4. CONCLUSION AND RECOMMENDATION

The bucks in the cassava peel forage supplemented groups (T_3 and T_4) were observed to have better performance in terms of feed intake, weight gain, feed conversion ratio (FCR) and dry matter digestibility. This is attributed to the catalytic effects of the forages used as supplements due to the presence of fermentable and readily degradable proteins which would increase the substrates available to cellulolytic microbes with a consequent increase in the population of these microorganisms that are liable to increase food intake, feed utilization, digestibility and subsequent weight gain. It is therefore recommended that basal crop by-product supplementation by small holder goat keepers should be geared towards the use of forages which is seen as a cheap and alternative supplement with crop by-products.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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