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Nutrient Digestibility and Nitrogen Balance of Growing West African Dwarf (WAD) Goat Fed Nitrogen Supplemented Cassava Peel Meals

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Abstract: *A feeding trial was conducted to determine the nutrient digestibility and nitrogen balance of growing WAD goats fed nitrogen supplemented cassava peel meal. Forty growing West African Dwarf Goats (WAD) bucks aged 5 –7 months with an initial weight of 5.25kg ± 0.35 were used for the study. The goats were randomly assigned to five supplementary cassava peel meal diets namely; 100% urea treated cassava peels (CPU), 60% cassava peels + 40% cassava foliage (CSF), 60% cassava peels + 40% poultry manure (CPM), 60% cassava peels + 20% cassava foliage + 20% poultry manure (CPFM) in a completely randomized Design (CRD). Each diet group was replicated eight (8) times. Observed results revealed that nutrient digestibility and nitrogen balance parameters were significantly (p<0.05) influenced by supplemental nitrogen sources. Goats fed CPFU had higher value of 95.42% for dry matter digestibility, CPF had significant (P<0.05) higher organic matter digestibility (91.49%) and crude protein (CP) digestibility (94.22%) while CPFU had higher crude fibre digestibility of 91.64%. Nitrogen Free Extract (NFE) digestibility was observed with higher value (98.26%) for CPFM. Total digestibility nutrient was significantly higher (79.47%) in CPFU than other treatments. Results of nitrogen retention obtained indicated significant (p<0.05) difference of all parameters examined. Nitrogen intake and nitrogen recorded higher values in CPM and CPFM (19.06g/d and 17.29g/d respectively). The value of biological value obtained across the treatments were significantly (p<0.05) higher in CPU (99.86% than other treatments. It can be concluded that feeding of cassava peels with supplemental nitrogen to goats offers a potential results in the productive performance of small ruminants based on their nutrient digestibility and nitrogen retention qualities.*

Keywords: *Digestibility, Retention, Cassava Peel, Nitrogen balance, Cassava Peel Meal.*

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I. Introduction

Inadequate supply of animal protein in the diets of most people in developing country like Nigeria has been a major concern to Animal Scientists. The current level of consumption of meat and animal protein is low. The low level of animal protein consumption in Nigeria as reported by the Food and Agriculture Organization[1] revealed that the diet of an average Nigerian contains 20 percent less than the recommended requirement. The low nitrogen content of dry season fodder usually inflicts severe nutritional stress on ruminants. The dry season results in a rapid decline in the quantity and quality of forages leading to low forage intake and digestibility with resultant poor animal performances, supplementation has become the best alternative for better performance of animals[2]. It has been reported by[3] that poor quality roughages fed to ruminants without supplementation during the dry season caused considerable weight losses and eventual the death of animal. The prices of conventional sources of protein in livestock ration have risen exorbitantly[4] and this has necessitated the search for cheap alternative feed materials that can meet nutritional requirements of farm animals. These feed resources include cassava peels, cassava foliage and poultry manure, which are not in demands for human consumption and therefore cheap[5]. Nutrition is the most important factor limiting livestock production in Nigeria; its variations have an important influence on feed production. The extensive grasslands in the savanna zones of Nigeria constitute a most valuable feed resource for development of ruminant production systems. However, their use and outputs are constrained by quality, seasonality and management. Thus, ruminants suffer from scarcity in feed supply and pasture quality especially during the dry season when the natural vegetation is of poor nutritive value[6]. High variability in feed supply can cause reduced weight gain of ruminant animals especially in the dry season. Therefore, supplementing ruminant animals with easily accessible and cheap sources of nitrogen goes a long way in addressing feed quality shortage in ruminant enterprise. Protein supplementation is known to enhance utilization of poor quality feeds like crop residues as it maximizes roughage degradation and optimizes rumen microbial protein synthesis[7] thereby improving animal performance. However, most of the supplements used such as soya beans, cotton seed cake and groundnut cake are expensive and not readily available. One of the cheapest non protein nitrogen sources is urea; which is a cheap and good alternative source of protein[8]. Cassava peel, cassava foliage and poultry manure are readily available within the study area. The utilization and combination of cassava peel with non protein nitrogen sources by ruminants have been reported in literatures, there is paucity of information on nitrogen retention, digestibility and biological value. Therefore, concentrate supplements being fed to ruminants needs to be evaluated with respects to their utilization and protein quality in terms of biological value. The study evaluated nutrient digestibility and nitrogen balance of growing West African Dwarf goats fed nitrogen supplemented cassava peel meal.

II. Materials and Methods

The study was carried out at the Sheep and Goat Unit of the Teaching and Research Farm of Kogi State University, Anyigba in accordance with the Institution's animal research ethical committee guideline. Anyigba lies between latitude 7°5'N and 7°21'E of the equator and longitude 7°11'N and 7°32'E of the Greenwich meridian, with an altitude of about 420m above sea level. The zone is characterized by 6-7 months of average annual rainfall of about 1600mm and the daily temperature ranges between 25°C and 35°C [9]. Fresh cassava peels, free from stumps were collected and grated before being subjected to hydraulic press for dewatering. The dewatered peels were then pulverized and sieved to obtain the coarse mash, which was then sun-dried for 2-3days before being loaded into bags for feeding animals[10]. Cassava foliage was harvested fresh and sundried until the leaves became brittle for milling. Poultry manure was obtained from poultry farms having battery cage system, and sundried for 5-7 days, to enable easy milling and mixing. Four kilograms (4kg) of urea fertilizer was dissolved in 100litres of water and then used to treat 100kg of cassava peels by spraying[10]. The product was then pressed together to eliminate air while in the container. The product in the container was then covered with plastic sheet and ensiled for 21 days before being used for diet formulation[11]. Five supplementary experimental diets (Table 1) were compounded namely; CPU (100% urea treated cassava peel), CPF (60% untreated cassava peel +40% cassava foliage), CPM (60% untreated cassava peel+40% poultry manure), CPFU (60% untreated cassava peel+20% cassava foliage+20% treated cassava peel) and CPFM (60% untreated cassava peel+20% cassava foliage+20% poultry manure)[10].

A total of forty (40) West African Dwarf bucks of about 5-7 months, with initial weight of 5.25kg ± 0.35 were obtained from goat producers within Anyigba Town. The goats were treated against ecto-parasites and endo-parasites, besides vaccination against peste des petits ruminants (PPR).The goats were randomly assigned to the five treatments in a Completely Randomized Design (CRD), and each treatment was replicated eight times. Two representative animals were transferred into metabolic cage fitted for separate urine and feacal sample collection after a feeding trial which lasted for 60 days. A 7 day adjustment period was allowed for the goats before data collection commenced. All goats in each treatment were served feed and water *ad libitum.* Sample collection was carried out for seven days. Feacal samples were weighed daily on replicate basis and sundried prior to laboratory analysis. While 5ml H_2S0_4 was added to the urine sample bottles to prevent volatilization of nitrogen. Urine samples were kept in refrigerator prior to laboratory analysis. Feed samples were also analyzed for their proximate composition[12]. Nutrient digestibility and biological value were determined using the following formulae[13].

$$\text{Digestibility} = \frac{\text{Nutrient intake} - \text{nutrients in feaces}}{\text{Nutrient intake}} \times \frac{100}{1}$$

$$\text{The Biological Value} = \frac{\text{Nitrogen Intake} - (\text{Urinary Nitrogen} + \text{Feacal Nitrogen})}{\text{Nitrogen Intake} - \text{Feacal Nitrogen}} \times \frac{100}{1}$$

Data collected were subjected to Analysis of Variance (ANOVA) and differences between treatment means were separated by Duncan's New Multiple Range Test using Computer Statistical Software Package – Statistical Package for Social Sciences (SPSS) version 20.

Table 1: Feed Composition of Nitrogen Supplemented Cassava Peal Meal

Ingredients	CPU	CPF	CPM	CPUF	CPFM
Urea Treated Cassava Peel	100	-	-	20	-
Untreated Cassava Peel	-	60	60	60	60
Poultry Manure	-	-	40	-	20
Cassava Foliage	-	40	-	20	20
Total	100	100	100	100	100

Source:[10]

III. Results

Nutrient composition of experimental diets is shown in Table 2. The dry matter content of the diets ranged from 83.23% to 85.60%. Organic matter (OM) content ranged between 77.86% and 80.53% while the crude protein values varied from 9.95% to 11.89%. The crude fibre content of the diets ranged from 9.68% to 10.95%. Value of ether extract obtained ranged from 2.99% to 3.25% while ash content obtained ranged from 4.85% to 5.77%. Nitrogen free extract varied from 52.59% to 56.02%. Fibre fractions, which are acid detergent fibre and neutral detergent fibre ranged from 15.90% to 31.85% and 29.22% to 50.01% respectively while hemicellulose ranged from 11.42%-18.16%.

Table 2: Nutrient Composition of Nitrogen Supplemented Cassava Peel Meals (%)

Nutrients	CPU	CPF	CPM	CPUF	CPFM
Dry matter	85.60	83.23	83.63	84.40	85.38
Organic Matter	80.05	77.98	77.86	79.25	80.53
Crude Protein	9.95	11.89	11.09	10.70	10.89
Crude Fibre	10.95	10.25	10.62	10.15	9.68
Ether Extract	3.13	3.25	3.25	3.20	2.99
Ash	5.55	5.25	5.77	5.15	4.85
Nitrogen Free Extract	56.02	52.59	52.63	55.20	51.00
Neutral Detergent Fibre	29.22	39.95	50.01	29.00	39.73
Acid Detergent Fibre	17.80	26.05	31.85	15.90	25.23
Hemicellulose	11.42	13.90	18.16	11.42	14.50

CPU= Cassava peels + 4% urea graded fertilizer, CPF= Cassava peels + cassava foliage CPM= Cassava peels + poultry manure (CPM), CPUF = Cassava peels + 4% urea graded fertilizer + cassava foliage CPFM = Cassava peels + Cassava foliage + poultry manure (CPFM), NDF= Neutral detergent fibre, ADF= Acid detergent fibre, ADL= Acid detergent Lignin.

Nutrient digestibility of WAD goats fed nitrogen supplemented cassava peels meals is presented in Table 3. Nutrient digestibility significantly (P<0.05) varied with the dietary treatments. Dry matter digestibility varied between 93.85% and 95.34% with CPF and CPFM having similarvalues. However, CPFU had the highest value (95.42). Organic matter digestibility significantly (P<0.05) varied among the treatments with CPF having higher value (91.49%). Digestible crude protein varied (P<0.05) with supplementary feeding. CPM had lower (89.00%) value while the value of CPF and CPFU were comparably similar. Crude fibre digestibility was higher (P<0.05) in CPFU (90.65%) but lower (85.24%) in CPM. Ether extract digestibility ranged from 83.05% to 90.00% with CPU having higher value. The observed value for nitrogen free extract (NFE) digestibility indicated that CPFM had the highest NFE digestibility value. The total digestible nutrient was higher in CPFU and CPF (79.47%) while CPFM recorded the lowest value (77.05%).

Table 3: Nutrient Digestibility of WAD Goats Fed Nitrogen Supplemented Cassava Peel Meals (%)

Parameters	CPU	CPF	CPM	CPFU	CPFM	SEM
Dry Matter	95.34^{b}	94.75^{c}	93.85^{d}	95.42^{a}	94.76^{d}	0.11
Organic Matter	89.98^{c}	91.49^{a}	90.89^{b}	91.35^{a}	91.20^{a}	0.99
Crude Protein	92.96^{b}	94.22^{a}	89.00^{d}	94.00^{a}	91.66^{c}	0.40
Crude Fibre	90.65^{d}	87.32^{c}	85.24^{e}	91.64^{a}	86.95^{d}	0.49
Ether Extract	90.00^{a}	87.52^{c}	88.78^{b}	85.93^{d}	83.05^{d}	0.59
Nitrogen Free Extract	97.33^{e}	94.42^{d}	97.77^{b}	97.67^{b}	98.26^{a}	0.67
Total Digestible Nutrient	78.27^{b}	79.47^{a}	76.95^{c}	79.47^{a}	77.05^{c}	0.39

abcde - Means in the same row with different superscript are significant different (P< 0.05) SEM- Standard Error of Mean, CPU= cassava peels + 4% urea graded fertilizer CFU= cassava peels = cassava foliage, CPM= cassava peels + poultry manure, CPFU= cassava peels + 4% urea graded fertilizer + cassava foliage CPFM = cassava peels + cassava foliage + poultry manure.

Table 4 depicts nitrogen utilization of WAD goats fed nitrogen supplemented cassava peel meals. Nitrogen utilization obtained significantly (P<0.05) differed among the dietary treatments. Nitrogen intake and feacal nitrogen values were significantly (P<0.05) different with CPM having significant higher values. Urinary nitrogen showed highest value for CPFM (0.40g/day) than other treatments. Retained nitrogen was significantly (P<0.05) higher in CPM than other dietary treatments while biological value was higher in CPU (99.86%) than other treatments.

Table 4: Nitrogen Utilisation of WAD Goats Fed Nitrogen supplemented Cassava Peel Meals

Nitrogen Balance	Treatments					SEM
	CPU	CPF	CPM	CPFU	CPFM	
Nitrogen Intake (g/day)	16.04^{b}	13.61^{c}	19.06^{a}	13.54^{c}	15.84^{b}	0.34
Faecal Nitrogen (g/day)	1.59^{e}	1.71^{d}	1.74^{c}	1.77^{b}	1.90^{a}	0.23
Urinary Nitrogen(g/day)	0.02^{e}	0.04^{d}	0.10^{c}	0.29^{b}	0.40^{a}	0.53
Nitrogen Retained(day)	14.16^{c}	11.31^{d}	17.29^{a}	11.73^{d}	16.58^{b}	0.56
Nitrogen Retained (%)	88.25^{b}	83.10^{d}	90.70^{a}	86.59^{c}	90.40^{a}	0.64
Nitrogen Retained BW $^{0.75}$	7.30^{c}	6.17^{e}	8.48^{a}	6.34^{d}	8.21^{b}	0.22
Biological Value BV (%)	99.86^{a}	99.66^{a}	99.42^{a}	97.54^{b}	97.13^{b}	0.10

a,b, c, d = means with different superscript on the same row are significantly different.(P<0.05). SEM- Standard Error of Mean, CPU= cassava peels + 4% urea graded fertilizer, CFU= cassava peels = cassava foliage CPM= cassava peels + poultry manure, CPFU=cassava peels + 4% urea graded fertilizer + cassava foliage, CPFM = cassava peels + cassava foliage + poultry manure.

IV. Discussion

Observed values for dry matter contents ranged between 83.23% and 85.60% are within 83.13% - 88.21% reported by[14] for molasses urea multi-nutrients blocks. Ash content of 4.82% and 5.77% are lower than 8.89% - 11.00% reported by[15] for cassava peels supplemented with selected tree forages and legumes. The values obtained for organic matter are lower than 92.52% to 93.70% reported by[16] for urea treated cassava peels but comparable to the values reported by[17] for diets containing cassava peels. Crude protein (CP) values ranged from 9.95%.-11.89%.The values are lower than 20.56% - 21.61% reported by[15] but comparable to 8.94% to 10.50% reported by[16] for grazing WAD goats fed with urea treated cassava peels. The crude protein content of the diets were generally higher than 8%, below which[18] observed that feeds will not provide the required levels of ammonia for optimum rumen microbial activity. Values above 8% for crude protein obtained in this study may be attributed to the supplemental nitrogen used in this study. Values of Crude fibre (CF) obtained were lower than the values reported by[19] for cassava peels – cassava leaf meals fed to West African Dwarf bucks. Ether extract (EE) values were lower than 3.02 and 6.84 reported by[20]. Nitrogen free extract NFE) values which ranged from 52.56% to 56.01% are higher than the values reported by[19]. Observed fibre fraction levels obtained in this study are lower than the safe upper limit of 60% reported by[21], for guaranteed forage intake by ruminant. The values of the fiber fractions obtained in this study are lower than the values reported by[22]. The fibre fractions show that the diets have the potentials to support intestinal movement and proper rumen function. This implies that the fibre fractions of the diet would enhance fermentation in the fore stomach of the animals. Fasae[23] opined that excess fibre fractions especially NDF reduces the rate of fermentation and reduce feed intake, but moderate fibre leads to rapid rumen fermentation and potential acidosis. The nutrient composition values observed for the dietary supplements in this study are comparable to those reported by[17]. Thus confirming the potentials of these supplements as sources of supplemental nitrogen to crop residues which possess nutrient levels that for improving rumen microbial activities. Therefore, these supplements have the potentials to generate a high level of ammonia in the rumen and promote an efficient digestion process[24].

Digestibility values for dietary dry matter (DM), organic matter(OM), crude protein(CP), crude fibre(CF), ether extract(EE) and nitrogen free extract(NFE) were generally high and significantly(P<0.05) differed among the treatment. The nutrient digestibility values obtained in this study are higher than the values reported by[23] who fed WAD sheep with varying levels of cassava leaves and peels. This might be as a result of the difference in the feed composition as well as the type of the animals used. The high nutrient digestibility obtained in this study might also be due to the nature of diet, palatability protein level and energy content of the supplements. This is in consonance with the findings of[25] who opined that increased protein supplementation tended to improve intake by increasing nitrogen supply to the rumen microbes. This may increase microbial population and also improves the rate of digesta. Therefore, high dry matter digestibility (DMD) may indicate high palatability and acceptability of the diet. Gabriel[20] had posited that high nutrient digestibility by goats indicated that the diets were palatable. However, the results obtained in this study are higher than those reported by[20] the workers obtained a range of 60.98-83.05% for DMD, 50.28% - 71.97% for digestible crude protein (DCP) with WAD goats fed cassava peels with urea-molasses block(UMMB) supplements.

The higher digestibility values might suggest the positive effects of supplementation on the growing goats grazing poor quality forage. More so, the dietary fibre in the supplements could be said to have no hindering effect on nutrient intake or their utilization. It can also be reported that the rumen bacteria were able to rapidly hydrolyze cellulose from the dietary supplements in this study there- by converting the end products to volatile fatty acids which form important part of ruminant energy intake. The values obtained in this study are higher than those reported by[22] who fed WAD goats with graded levels of dried cassava leaves. They are also higher than those reported by[26] for ruminant animals fed pelletized and unpelletized cassava based diets. The value of nitrogen intake obtained in this study fell between 13.54 and 19.06 (g/day). The values obtained in this study are higher than 1.95 -7.75(g/day) reported by[20], and 5.04-7.98(g/day) obtained by[27] for Yankasa rams fed *moringa oleifera*, *Glirricedia sepium* and *Leucana luecocephala* ensiled with molasses as additive. The higher values might be due to the inclusion levels of poultry manure. Poultry manure has been reported to be high in nitrogen, which ruminants can utilize as an energy source[28]. The faecal nitrogen value obtained in the study is significantly ($p<0.05$) higher among the treatments and it is in contrast with the value obtained by[29] but lower to 5.18-5.64(g/day) reported by[30] for sheep fed *Prosopis julifora* pods and *Cenchrus* grass. The urinary nitrogen is significantly higher among the treatments with CPFM having the higher value. This might be due to the presence of poultry manure and cassava foliage combination in the diet. Also, the value range obtained in this study is lower to 2.29-3.62(g/day) reported by[29]for WAD goats fed elephant grass- different proportions of plantain peels and mango peels. Nitrogen retained (balance) is similar to value the reported by[30]. Percentage nitrogen retained value ranged from 83.10 and 90.40. These values are higher than 34.92- 43.08% reported by[29]. The higher nitrogen retained (balance) in this study is in harmony with the report of[31] who used poultry manure as source of dietary crude protein to replace cottonseed cake and groundnut cake in ruminant diets. Abdel- Baset and Abbas[32] also attributed high retention or nitrogen balance to uric acid present in poultry manure and its efficient utilization by rumen microbes for protein production. The biological value (BV) was higher in CPU (99.86%) than other treatment groups. This may be attributed to the due to the presences of ammonia nitrogen in the supplemented ration for that particular dietary group. The biological value obtained in this study was higher than 59.65% reported by[33] with WAD goats and BV value of 98 % reported by[34] Red Sokoto goats. The positive nitrogen retention (balance) values observed in this study may indicate that the diets were adequate in their supply of nitrogen to the rumen.

V. Conclusion

This study revealed that better nutrients digestibility and nitrogen utilization could be obtained by supplementing non protein nitrogen sources in the diets of goats. The results of nitrogen utilization and biological value revealed that dietary treatments gave better protein quality with CPM and CPU. Therefore, supplementing cassava peels with non protein nitrogen sources in the diet of small ruminants especially goat can improve intake, digestibility and protein quality of goat diet. It is suggested that the use of supplemental nitrogen sources such as urea, cassava foliage and poultry manure should be given adequate consideration in ruminant production so as to achieve better productive performance especially goats in the tropics.

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