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Digestibility, nitrogen balance and blood profiles of West African Dwarf (WAD) goats fed with varying mixtures of grass-legume pellets

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***Target Audience:** Forage agronomists, Animal scientist, Feed millers, Extension workers*

Abstract

Unavailability of forage in required quality and quantity for all year round production of ruminant cannot be over-emphasized. Hence, need for improvement on available feed resource becomes an obligation. The study was conducted to evaluate digestibility, nitrogen balance and blood profiles of West African dwarf (WAD) goats fed with varying mixtures of grass-legume pellets. Fifteen (15) WAD goats (aged 6-7 months) were fed with varying mixtures of grass-legume pellets comprising (60% Megathyrsus maximus [6Mm]; 30% Megathyrsus maximus + 30% Lablab purpureus [3Mm3Lp]; 40% Megathyrsus maximus + 20% Lablab purpureus [4Mm2Lp]; 40% Megathyrsus maximus + 20% Stylosanthes hamata [4Mm2Sh] and 30% Megathyrsus maximus + 30% Stylosanthes hamata [3Mm3Sh]) with each containing 40% fixed ingredients (21%brewer's dried grain, 16% dried cassava peel, 2%local potash, 1%salt). The experimental design used is a Completely Randomized Design. Data obtained are crude protein (CP), crude fibre (CF), CP digestibility (CPd), CF digestibility (CFd), pack cell volume (PCV), white blood cell (WBC) and serum Alanine Aminotransferase (ALT), and subjected to one way ANOVA at 5% level of probability using SPSS. Pellets 4Mm2Lp and 3Mm3Sh had similar values for CP (17.10 and 17.32%), CPd (71.69 and 72.06%), CFd (65.85 and 66.67%), N retention (72.34 and 73.94%) while 3Mm3Sh had better improvement on PCV, WBC and ALT. Crude fibre was similar (p>0.05) for all the pellets except for 6Mm. It could be concluded that feeding 3Mm3Sh pellet to WAD goats improved their nutrient utilization, thus enhancing their performance all year round.

***Keywords:** Pellet, Megathyrsus maximus, Stylosanthes hamata, Lablab purpureus, WAD goat*

Description of Problem

Nutrition remains the bed rock of livestock production if the demand for animal protein by humans will be adequately met. The low productivity of livestock is partly a result of the poor nutritional status in terms of quality of feeds (1, 2), hence there is need for better feeding and management (3). Forage, a major feed resource for ruminant (4), are of adequate nutritive value but deteriorate and becomes scarce during the dry season. Hence, there is need to improve productivity of available pastures in order to enhance its utilization by ruminants. Agglomeration of locally available agro-industrial byproducts and farm waste of low-quality to form alternative forage based pellet becomes an option to explore. The use of these products will reduce the cost of animal production without a decrease in productivity (5). Such agro-industrial byproducts comprise cassava peels and brewers' dried grain. Cassava peels is a by-product of garri processing in Nigeria which contain 87.40% dry matter, 5.20% crude protein, 14% crude fibre, 1.40 - 5.80% ash

(6). Cassava peel is a good source of energy which when fortified with protein feedstuffs stimulates high performance in ruminants (7). Brewers' dried grains (BDG) are the solid residue left after the processing of germinated and dried cereal grains (malt) for the production of beer and other malt products. It is rich in protein; 27-33% DM (8) and fibre (ADF 17-26%) and energy, even up to 7.8 MJ/kg DM (9), which makes it suitable for ruminants. The use of "kan-un" as mineral source has been proved to be better than synthetic mineral premix. Aina and Oppong (10) reported that "Kan-un" is well utilized by goats as it contains virtually all the minerals required by small ruminants and, even higher than the quantities required by small ruminants (11). The availability of *Megathyrsus maximus* during the wet season in the southwestern Nigeria could be air-dried and use in combination with dried cassava peels and BDG to serve as ruminant feed during the dry season. Feed pelleting is a preservation method that fuses different feed components to a ration, thus improves palatability and intakes by ruminant (12). Pellets reduced dustiness and wastage of feed (13) as well as cost of feeding against the production output (14). It has been established that it enhances feed supply to West African Dwarf goat especially during the dry season (15). Therefore, this paper targeted at determining the digestibility, nitrogen balance and blood profiles of WAD goats fed with varying mixtures of grass-legume pellets.

Materials and methods

Experimental site

The experiment was carried out at the Sheep and Goat Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso. The area is located at Latitude 8^0N, Longitude 4^0E with annual rainfall of 1270 to 2030 mm, which occurs in 7-10 months with a peak between July and September of the year. The temperature of the area ranges between 28^0C to 33^0C, with humidity of about 74% all year round except in January when the dry wind blows from the North (16).

Production procedure and treatments

Forages (*Megathyrsus maximus, Stylosanthes hamata* and *Lablab purpureum*) harvested at 8-week of age from already established paddocks, while cassava peels, brewer's dried grain (BDG) and salt were formulated into pellet according to the procedure of (15). Five forage based pellets were produced such that each comprises 60% of forage at varied mixtures: Pellet 1 = *Megathyrsus maximus* (60%); Pellet 2 = 30% *Megathyrsus maximus* + 30% *Lablab purpureus* (3Mm3Lp)*;* Pellet 3 = 40% *Megathyrsus maximus* + 30% *Lablab purpureus* (4Mm2Lp)*;* Pellet 4 = 40% *Megathyrsus maximus* + 20% *Stylosanthes hamata* (4Mm2Sh) and Pellet 5 = 30% *Megathyrsus maximus* + 30% *Stylosanthes hamata* (3Mm3Sh) with each containing 40% fixed ingredient (21% brewer's dried grain, 16% dried cassava peel, 2% local potash, 1% salt).

Management of animals and experimental design

Fifteen (15) growing West African Dwarf goats were subjected to digestibility trial on various mixtures of grass-legume pellets. The animals with initial live-weights of 7.57±0.11 were purchased from small ruminant markets in Ogbomoso and neck-tagged for proper identification. The goats were quarantined for a period of three weeks prior to the commencement of the study. During this period, Oxytetracycline and a multivitamin preparation were administered at the rate of 1ml per 10kg body weight through intramuscular route for prophylactic treatment. Ivermectin was also administered subcutaneously at the rate of 0.2ml per 10kg body weight against external and internal parasites. Animals were transferred to metabolic cage thoroughly washed with Morigad®. The digestibility trial lasted for 21 days in which the first 14 days were used as adaptation periods. There was nutrient digestibility and nitrogen balance data collection during the last period of 7 days. Pellet assigned randomly to the animals were served at 5% of their body weight at 8:30am. Fresh, clean water was made available *ad libitum* throughout the duration of the trial. During collection period, urine and faeces voided by each animal were collected every morning before serving the fresh ration. The experimental design was a completely randomized design (CRD) experiment

Data Collection

During digestibility study, 500g representative samples from the fed experimental pellets and 10% of daily faecal output by each animal were taken and dried in a forced-draught oven at 70^{o}C for 48h to determine the DM. The urine from each animal was collected in a bucket laced with 10ml of diluted H_2SO_4 to reduce ammonization. A 10% aliquot solution was taken daily and stored at -4^{o}C until needed for analysis.

Blood samples for haematological and serum studies were collected at the beginning and at the end of the trial via the jugular vein of each of the animals using sterilized needles and syringe. About 3ml was collected into plastic bottles, containing an anticoagulant (Ethylenediaminetetraacetic Acid (EDTA)), for haematological evaluation while the bottles voided of EDTA were used to collect blood samples for serum.

Chemical analysis

Pellet samples from the various grass-legume mixtures were ground in a Wiley mill to pass through 1.0mm sieve screen. Thereafter, the following chemical analyses were carried out in the laboratory: Proximate composition was determined according to (17). Fibre fraction: Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were determined using the method of (18). Packed Cell Volume (PCV) was determined by the micro-haematocrit method as described by (19) and (20). Erythrocyte (RBC) was counted using the improved Neubauer haemocyto meter (20). Haemoglobin concentration (Hb) and Leucocytes counts (WBC) were determined as described by (21). Serum Aspartate Aminotransferase and serum Alanine Aminotransferase were analyzed using Spectrophotometric linked reaction method (22).

Statistical Analysis

All observed data were subjected to one way analysis of variance (ANOVA) using the (23). The significant treatment means were separated by Duncan Multiple Range Test (DMRT) of the same package while the significant difference between initial and final blood sample were determined by student's t-test.

Results

The chemical compositions (%) of the experimental pellets made from varying mixtures of grass-legume forage were as presented in Table 1. There were significant ($p<0.05$) variations across the treatments except for dry matter (DM) and ash content. Highest crude protein (CP) was obtained for 3Mm3Sh (17.32%) and 4Mm2Lp (17.10%) while other treatments were lower and as well similar ($p>0.05$) to one another. Crude fiber (CF), Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were insignificant (p>0.05) across the treatments except for 6Mm. Highest CF (29.77%), NDF (58.81%) and ADF (45.46%) were determined for 6Mm. There was significant influence of the fed varying mixtures of grass-legume pellets (Table 2) on the nutrient digestibility coefficient (%) of WAD goats. Animals on 4Mm2Lp and 3Mm3Sh had comparable trend for digestibility coefficient (%) while 3Mm3Lp and 4Mm2Sh were also similar except for ash, crude fibre (CF) and acid detergent fibre (ADF) digestibility. Animals on 6Mm had the least digestibility coefficient (%) although the Ash, CF and NDF digestibility were comparable for 6Mm (60.00, 60.32 and 60.71%) and 3Mm3Lp (50.04, 51.22 and 61.90%).

Table 1: Chemical composition (%) of the experimental pellets made from varying mixtures of grass-legume forage

Parameters	6Mm	3Mm3Lp	4Mm2Lp	4Mm2Sh	3Mm3Sh	SEM(±)
Dry Matter	93.13	93.22	94.10	93.05	94.04	1.12
Crude Protein	16.62^{b}	16.84^{b}	17.10^{a}	16.93^{b}	17.32^{a}	1.04
Ash	7.13	7.36	7.40	7.34	7.43	0.25
Crude fibre	29.77^{a}	20.32^{b}	20.84^{b}	21.16^{b}	21.32^{b}	2.15
NDF	58.81^{a}	51.31^{b}	50.97^{b}	51.45^{b}	51.66^{b}	1.23
ADF	45.46^{a}	42.14^{b}	41.26^{b}	42.33^{b}	42.51^{b}	1.43

$^{a,b,c:}$ Means carrying different superscript in each row are significantly different (p<0.05); SEM: standard error of mean; 6MMm: 60% *Megathyrsus maximus*; 3MMm3Lp: 30% *Megathyrsus maximus* + 30% *L. purpureus*; 4MMm2Lp: 40% *Megathyrsus maximus* + 20% *L. purpureus*; 4MMm2Sh: 40% *Megathyrsus maximus* + 20% *S. hamata*; 3MMm3Sh: 30% *Megathyrsus maximus* + 30% *S. hamata.*

Table 2: Nutrient digestibility coefficient (%) of West African Dwarf (WAD) goats fed varying mixtures of grass-legume pellets

Parameters	6Mm	3Mm3Lp	4Mm2Lp	4Mm2Sh	3Mm3Sh	SEM (±)
Dry Matter	66.67^{c}	70.59^{b}	74.41^{a}	70.97^{b}	75.08^{a}	2.48
Crude Protein	64.65^{c}	68.57^{b}	71.69^{a}	68.95^{b}	72.06^{a}	2.16
Ash	60.00^{c}	60.32^{c}	64.33^{a}	62.54^{b}	65.00^{a}	1.02
Crude Fibre	50.04^{c}	51.22^{c}	65.85^{a}	53.85^{b}	66.67^{a}	1.34
NDF	64.29^{c}	67.21^{b}	70.12^{a}	67.87^{b}	71.77^{a}	1.55
ADF	60.71^{c}	61.90^{c}	67.58^{a}	64.94^{b}	68.00^{a}	1.78

$^{a,b,c,d:}$ Means carrying different superscript in each row are significantly different (p<0.05); SEM: standard error of mean; 6Mm: 60% *Megathyrsus maximus*; 3Mm3Lp: 30% *Megathyrsus maximus* + 30% *L. purpureus*; 4Mm2Lp: 40% *Megathyrsus maximus* + 20% *L. purpureus*; 4Mm2Sh: 40% *Megathyrsus maximus* + 20% *S. hamata*; 3Mm3Sh: 30% *Megathyrsus maximus* + 30% *S. hamata*.

Table 3 reveals the nitrogen balance and utilization by West African Dwarf goat fed on varied grass-legume mixture pellets. There were significant (p<0.05) differences among the treatments except for urinary output. Higher (p<0.05) Nitrogen intake (6.14g/day) was recorded for animals on 3Mm3Sh, though similar to 4Mm2sh (5.17g/day) and 3Mm3Lp (5.72g/day) while the least (p<0.05) was observed for 6Mm (4.74g/day). Faecal N and total N output had similar trend. Animals on all the treatments had insignificant (p>0.05) higher N output except for 4Mm2Lp (1.29 and 1.43g/day). However, N absorbed (%), N retention (g/day) and N retention (%) had comparable trend, and similar (p>0.05) obtained values except for animals on 6Mm.

The initial and final blood of West African Dwarf goat fed on varied grass-legume mixture pellets (Table 4) had similar ($p>0.05$) values for hematological and serum indices except for 3Mm3Sh. Higher PCV (34.83%), Hb (12.15g/l), RBC ($20.12x\ 10^6/mm^3$) were recorded for final blood samples of animals fed 3Mm3Sh but lower WBC ($10.11\ x\ 10^3/mm^3$) and ALT (17.03iµ/l). Except for animals on 3Mm3Lp, other treatments had higher ($p<0.05$) PCV percentage at final.

Table 3: Nitrogen balance and utilization by West African Dwarf (WAD) goats fed on pellets from varied grass-legume mixture

Parameters	6Mm	3Mm3Lp	4Mm2Lp	4Mm2Sh	3Mm3Sh	SEM (±)
Nitrogen Intake (g/day)	4.74[c]	5.72[ab]	5.17[b]	5.69[ab]	6.14[a]	0.55
Nitrogen Output (g/day)						
Faecal	1.51[a]	1.60[a]	1.29[b]	1.52[a]	1.46[a]	0.13
Urinary	0.15	0.12	0.14	0.13	0.14	0.02
Total	1.66[a]	1.72[a]	1.43[b]	1.65[a]	1.60[a]	0.12
Nitrogen Absorbed (%)	68.14[b]	72.03[ab]	75.05[a]	73.29[ab]	76.22[a]	2.48
Nitrogen Retention (g/day)	3.08[b]	4.00[ab]	3.74[ab]	4.04[ab]	4.54[a]	0.46
Nitrogen Retention (%)	64.98[b]	69.93[ab]	72.34[a]	71.00[ab]	73.94[a]	1.47

[a,b,c,d:] Means carrying different superscript in each row are significantly different ($p<0.05$); SEM: standard error of mean; 6Mm: 60% *Megathyrsus maximus*; 3Mm3Lp: 30% *Megathyrsus maximus* + 30% *L. purpureus*; 4Mm2Lp: 40% *Megathyrsus maximus* + 20% *L. purpureus*; 4Mm2Sh: 40% *Megathyrsus maximus* + 20% *S. hamata*; 3Mm3Sh: 30% *Megathyrsus maximus* + 30% *S. hamata*.

Table 4: Haematological parameters and serum indices of West African Dwarf (WAD) goats fed with varying mixtures of grass-legume pellets

		6Mm	3Mm3Lp	4Mm2Lp	4Mm2Sh	3Mm3Sh
PCV (%)	Initial	30.50±0.29[b]	29.02±0.11	30.50±0.29[b]	30.00±0.41[b]	30.00±0.93[b]
	Final	32.05±0.37[a]	32.15±0.14[b]	32.15±0.29[a]	33.25±0.34[a]	34.83±0.51[a]
HB (g/l)	Initial	10.10±1.02	9.80±0.23	9.60±0.26	10.80±1.14	9.6±0.39[b]
	Final	9.63±0.16	10.48±0.29	10.10±0.23	10.28±0.13	12.15±0.41[a]
WBC	Initial	11.15±1.03	9.52±1.20	10.89±0.33	11.24±0.46	12.8±0.27[a]
($x10^3/mm^3$)	Final	11.00±0.28	9.15±0.01	11.01±0.12	11.65±0.18	10.11±0.33[b]
RBC	Initial	20.04±1.16	19.98±2.45	19.60±0.78	18.73±0.50	18.43±1.02[b]
($x10^6/mm^3$)	Final	20.43±0.22	20.35±1.42	20.17±0.41	19.91±0.37	20.12±1.04[a]
Total	Initial	6.38±1.41	5.65±1.01	4.30±5.03	6.73±3.66	6.02±1.87
Protein (g/dl)	Final	6.5.7±0.36	5.85±1.06	4.70±5.58	7.15±3.06	6.30±1.76
AST (iµ/l)	Initial	56.25±2.61	26.00±0.53	22.75±2.02	38.50±1.92	34.75±2.56
	Final	55.50±1.79	26.78±0.21	24.00±2.06	40.75±1.89	35.25±1.64
ALT (iµ/l)	Initial	15.25±1.37	22.25±0.70	17.50±0.47	15.00±0.65	19.00±0.32[a]
	Final	16.00±1.45	23.50±1.42	17.25±0.29	14.25±1.81	17.03±0.66[b]

[a,b:] Means carrying different superscript in each row are significantly different ($p<0.05$); SEM: standard error of mean; 6Mm: 60% *Megathyrsus maximus*; 3Mm3Lp: 30% *Megathyrsus maximus* + 30% *L. purpureus*; 4Mm2Lp: 40% *Megathyrsus maximus* + 20% *L. purpureus*; 4Mm2Sh: 40% *Megathyrsus maximus* + 20% *S. hamata*; 3Mm3Sh: 30% *Megathyrsus maximus* + 30% *S. hamata*.

Discussion

The average dry matter (DM) content of the pellets in this study was higher than the values reported (12, 13, 24). The difference between this study and others could be traced to the forage types, season, age at harvest and other included feed ingredients. .The disparity in crude protein (CP) content of the pellets across the treatments could be attributed to the grass-legume inclusion levels, handling and processing as reported by 15. The increasing rate of CP in this study agreed with the report by (13) that an increase in CP of forage based pellets is a function of legume inclusion level. The observed CP values were also higher than the recommended minimum requirement (7%) for ruminants in the tropics (9, 25) and 7.00% - 8.00% recommended for the efficient functioning of rumen microorganisms (26, 27). They also exceeded the range of 11.00 to 13.00% known to be capable of supplying adequate protein for maintenance and moderate growth in goats (9). Therefore, this forage pellets would be an adequate feed resource for ruminants at all time. The NDF and ADF contents of the pellets in this study were within the range of rated for most tropical forages (<45% for high quality, 45 – 65.5% for medium quality and >65% for poor quality roughages) (28, 29). The reduction in fibre fractions for the pellets will increase feed intake and, high level of digestibility (26, 30). This suggests that the forage based pellets a good nutritive feed for ruminants. The reduction in the fibre fractions has been reported to increase digestibility (24).

The high digestibility values obtained for most nutrients suggest that the diets were highly degraded in the rumen. (31) reported that the extent of degradation by rumen microflora has important implications for both intake and digestibility. However, for any feedstuff or ration to be considered as ruminant feed, it should have a dry matter digestibility coefficient of 40-50% (32). Hence, the higher digestibility coefficient of pellets observed in this study suggests improved degradation thus increased intake and utilization by the fed animals. The observed trend of CP digestibility coefficient (%) of animals fed the forage based pellets agreed with the suggestions (33, 34) that protein digestibility decreased with decreasing levels of dietary protein. Crude fibre, NDF and ADF digestibility in this study project the ability of fed animals, to digest cell wall fractions and process structural carbohydrates, to obtain nutritional benefit from them (35). The apparent significant variations across the treatments for fibre digestibility could be linked to CP contents of the forage pellets as also observed by (36) for legume hay supplement with graded levels of *Ficus thonningii* on Washera lambs. If the protein-rich feeds are fed to animals, there will be an increased population of the microorganism which increases the rate of fermentation of the crude fibre component (11). Therefore, this could be determinant factor behind high digestibility coefficient observed for animals fed on 4Mm2Lp and 3Mm3Sh.

Nitrogen balance has been described as a good indicator of the protein value of a diet when the amino acid supply is balanced with the energy supply (37). The variations in N - intake might be attributed to the crude protein contents of the diets , bio- avalability of the protein due to combination effects of ingredients, and protein intake of the animals as reported by (38). The faecal N output (g/day) of WAD goats was an indication that there could be traces of undigested CP as well as reflection of N – intake level (39). Also, the urinary N – output could probably be due to a reflection of nitrogen in the rumen which depends on the quantity and solubility of the diets. It was reported (40) that the N in the urine might be the one escaped from the rumen as ammonia gas and converted to urea. No significant difference was observed for urinary nitrogen across the treatments in this study. The positive N - balance observed demonstrated that the pellets were well utilized and efficiently used as fermentable nitrogen sources for microbial growth in the rumen of the fed animals (30, 39, 41). The significant differences observed could be averred to the proportion of ingested protein, which is a reflection of CP in the fed forage based pellets. The more nitrogen consumed and digested, the more the nitrogen retained and vice versa (42). Hence, the highest nitrogen retention observed for animals fed 4Mm2Lp and 3Mm3Sh could be associated with high protein content and well utilization by the animals (43).

The examination of blood gives the opportunity to investigate the presence of several metabolites and other body constituents of animals which plays vital roles in the physiological, nutritional and pathological status of an organism (44, 45). The blood parameters observed in this study fell within the range of recommended values by (46) that reported PVC (25.6–36.8%), Hb (9.20-14.20g/dl), WBC (3.70-14.00x10^3mm^3), RBC (14.90-20.30 x10^6mm^3), total protein (5.90-7.80g/dl), AST (12.0-122.00iμ/l) and ALT (0.50-47.00iμ/l). The slight increase in values observed for PCV, an index of toxicity level of the blood, confirmed the nutritional adequacy (47) and absence of toxicity in the forage based pellets. The significance differences observed for blood parameters of WAD goats fed 3Mm3Sh may likely reckon with well utilization of its nutritional components. High dietary protein (48), dietary contents of the fed feed (49) and adaptation (50) had been reported to influence the blood profile of the farm animals.

Conclusion and Application

1. Based on the findings from this study, varied mixtures of grass-legume pellets improved the chemical compositions, digestibility, nitrogen balance and utilization while Pellet from 30% *Megathyrsus maximus* + 30% *Stylosanthes hamata* (3Mm3Sh) had better influence on blood profile of fed WAD goats. Therefore, feeding 3Mm3Sh on WAD goats is recommended for better utilization, thus productivity will be enhanced.

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