Intake, Digestibility and Nitrogen Balance of Ensiled Signal Grass fed to West African Dwarf Sheep

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Abstract

Pasture scarcity and limited availability of year round feed resources during the prolonged dry season is a hindrance to ruminant production in Nigeria. Silage production is very essential in order to salvage the situation. This experiment was designed to investigate the nitrogen balance and apparent nutrient digestibility of West African Dwarf sheep fed Brachiaria decumbens ensiled with grain by-products using a completely randomized design. B.decumbens was ensiled with grain residues to produce four treatments consisting of the following: TR1 (80% B.decumbens + 20% white maize by-product), TR2 (80% B.decumbens + 20% yellow maize by-product), TR3 (80% B.decumbens + 20% guinea corn by-product), TR4 (100% B.decumbens). After 42 days of fermentation, the silage quality, proximate composition and nutrient digestibility were determined. All the treatments had silages that were firm and had olive green colour with patches of the by-products except in TR4 where light green colour was observed. All the treatments also had a pleasant odour and pH ranging from 3.2 to 3.9. The results showed that TR2 contained the highest crude protein (18.50%) which is enough to meet the nutrient requirement of ruminant animals while TR1 had the highest digestibility values. Dry Matter Intake significantly ranged from 267.37% to 450.70%. Variation occurred in Dry Matter Digestibility among the sheep ranging from 60.32% to 81.50%. Crude Protein Digestibility ranged from 72.52% to 86.25%. Animals fed TR2 had a significantly higher ($p<0.05$) Nitrogen Intake (13.13%), absorption (11.03%) and retention (10.88%) compared to other experimental silages. Nitrogen absorption expressed as percentage of intake (86.25%) and Nitrogen Retention expressed as percentage of Intake (84.91%) were significantly higher ($p<0.05$) in animals fed TR1 compared with other experimental diets. The positive N-balance observed in all animals suggested that Nitrogen absorbed was well tolerated and utilized by the animals. Results showed that silage quality, proximate composition, dry matter intake and digestibility were better in silages with grain by-products. It was also observed that the inclusion of the residues had significantly improved the nutrients and nitrogen balance of the experimental animals, therefore, ensiling B.decumbens with grain residues is sufficient to meet the nutritional requirements of ruminants' for optimal productivity.

Keywords: Silage, Dry Matter, Crude protein, Ruminants, Proximate composition

1.0 INTRODUCTION

Ruminant animals, which are raised worldwide for their numerous economic and social contributions, are a vital aspect of livestock production in the world (1). Sheep, constitute a very important part of livestock sub-sector in Nigerian agricultural economy (2), are used for religious and social ceremonies and have consistently played a significant role in the socio-economic growth of many Nigerians.

The attainment of sustainable livestock production largely depends on the sufficient availability of quality feed for livestock. However, due to seasonal fluctuations, scarcity of forage has become the major factor limiting the productivity of ruminant animals in Nigeria. The animals usually experience fluctuating growth and even death due to inadequate forage thus resulting in a great economic loss to the farmer (3). This severely limits successful ruminant keeping as there will be a shortage of grazing resources in terms of quantity and quality in meeting the nutrient requirement of animals (4).

In order to avoid the pasture scarcity during the off season and provide better quality feed for animals, silage making is paramount. Ensiling is an efficient method for forage preservation and also a form of treatment to occasionally salvage the underutilized pastures for better acceptability and degradability (5). This process could also help to increase the nutritional quality of forages when ensiled with readily fermentable carbohydrates. The main aim of silage making is to conserve the plants with a minimum loss of nutritive value by fermentation of soluble carbohydrates in an anaerobic environment into organic acids, preferably lactic acid, which reduces pH (6). The fermentation quality of silages has a major effect on feed intake, nutrient utilization and milk production in ruminants (7, 8). The use of additives in silages of tropical forages is important because they reduce the risks of the ensiling process and improve the nutritive value of silage. According to Zanine *et al* (9), a good additive for ensiling tropical grasses should have high dry matter content, excellent water absorption capacity, high nutritional value, good palatability and high content of soluble carbohydrates. It also needs to be easily manipulated, available at the market and be of low cost.

Signal grass (*Brachiaria decumbens*) is a trailing, perennial grass with upright, sword-shaped leaves native to East and Central Africa. Its hairy leaves are a key distinguishing feature with new shoots and roots developing from each node of its stoloniferous base. This grass is adapted to humid tropical areas with a minimum rainfall of 60mm per year and a dry season of not more than 4-5 months. Nitrogen content in early re-growth periods (2-5 weeks) ranged from 10 – 28gN/kg dry matter decreasing from 7-15gN/kg DM for 10-12 weeks regrowth (10). *In vitro* dry matter digestibility showed similar variation with early growth ranging from 56% to 78% up to five weeks of age decreasing to 41.6% to 63.7% as the pasture matures. The estimated nutritive value and therefore, the potential level of live weight gain of *B.decumbens* is similar to other tropical pasture species such as *Panicum maximum* (Guinea grass) and *Digitaria decumbens* (pangola grass).

2.0 MATERIALS AND METHOD

Experimental Method

The study was conducted at the Small Ruminant Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Oyo state

Silage Preparation

Signal grass (*Brachiaria decumbens*) was harvested manually from the already existing paddock after 8weeks of regrowth. The harvested grass was weighed in order to determine the expected amount for making of silage and chopped with a chopping machine for ease of compaction and consolidation for silage. The harvested samples

were wilted under shades in order to reduce the moisture content. Three grain by-products namely white maize residue, yellow maize residue and sorghum/guinea corn residue were sourced and used as additives. Chopped signal grass was weighed and mixed with just one additive at different ratio to be ensiled. Samples with no additive were also ensiled as control. Filling and compaction was done simultaneously to eliminate inherent air and the treatments were prepared in 50kg plastics. The plastics were each lined internally by polythene sheet bags in triplicates. Each layer of the grass and by-product was compacted manually to displace the air until the containers were filled. The final compaction was made after which the polythene sheet was wrapped over the material the polythene bags were sealed and compressed with piles of heavy sandbags in drums and plastics. Fermentation was done for 42 days. Representative samples of known weights were taken for dry matter analysis by drying in the oven for 48hours at 65°C until a constant weight was obtained. There were four treatments comprised of mixtures of the signal grass (BD):
Treatment A: 80% *Brachiaria decumbens*+ 20% white maize residue
Treatment B: 80% *Brachiaria decumbens*+ 20% yellow maize residue
Treatment C: 80% *Brachiaria decumbens* + 20% guinea corn residue
Treatment D: 100% *Brachiaria decumbens*

Animals and their management

Twelve West African Dwarf sheep, averaging one year old and weighing 12-15kg were purchased from the local market and used for the study. These were randomly divided into 3 animals per treatment with each animal constituting a delicate. The animals were transferred into individual pens having the floor covered with wood shavings for the growth trial study. They were conditioned to stability by feeding them adequately for 1 week. The animals were treated with Ivomec at 0.25ml/goat to control both *endo* and *ecto* parasites. They were also injected with antibiotics to take care of scouring, nasal and ocular discharges and to provide a good health status. The animals were ear-tagged for identification and were randomly divided into 4 treatments of 5 animals each.

Digestibility study

Twelve West African Dwarf sheep were used for a digestibility study. Three rams were selected per treatment. The animals were transferred into individual metabolic cages that allowed for a separate collection of faeces and feed. They were in cages for 14 days during which daily urine and faecal production were evaluated. Three animals received a given diet twice daily. The animals were allowed to acclimate for 14 days after which data in feed offered and faecal output were collected and weighed daily for 7 days. In the morning, before the animals were fed, the faecal output was evacuated and weighed. Sub samples of feed and faeces were taken and oven dried at 600°C for 24 hours to determine dry matter content. Samples of the feed and faeces were kept till required for chemical analysis. Ten percent of the urine collected daily was kept and pooled over the 7-day period for each animal. Nitrogen loss from the urine by volatization was prevented by introducing 20ml of 10% H_2SO_4 into the urine collection container. These were stored in the freezer at -5°C until needed for analysis of nitrogen content (11). The apparent digestibility of the diets were calculated between nutrient intake and excretion of nutrient in the feces, expressed as a percentage of nutrient intake.

Chemical Analysis

Collected feed samples and faeces were oven-dried at 60°C for 48 hours and then milled. Dry Matter was determined by oven-drying at 100°C for 24 hours. Finely ground samples were analyzed for Crude Protein, Crude Fiber, Ether Extract and ash content of the silages were carried out in triplicates as described by AOAC (11).

Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL) analysis was determined using the procedure of Van Soest *et al*. (12)

Statistical analysis

All data collected were subjected to one-way analysis of variance (ANOVA) using SAS (13) and significant differences were separated using Duncan's multiple range test of the same package.

3.0 RESULTS

Table 1 shows the colour, pH, smell, texture and temperature of silage made from *Brachiaria decumbens* with different grain by-products. The colour of the silage was observed to be olive green in the silages made with by-products while sole *Brachiaria decumbens* had a light green colour. The odour observed in the silages ranged from fairly pleasant observed in TR1 to pleasant in the other silages. All silages had a firm texture. The acidity (pH) of the silages ranged from 3.2 to 3.9 with the highest pH observed in TR4

Table 1: Silage characteristics of *Brachiaria decumbens* ensiled with different grain residues

Parameters	TR1	TR2	TR3	TR4
Colour	Olive green with white patches	Olive green with yellow patches	Olive green with red patches	Light green
Odour	Fairly pleasant	Pleasant	Pleasant	Pleasant
Texture	Firm	Firm	Firm	Firm
pH	3.5^c	3.7^b	3.2^d	3.9^a

^{abc} means with different superscript along the same row are significantly different ($p<0.05$).

SEM = Standard Error of Mean

TR1: 80% *B. decumbens*+ 20% white maize by-product; TR2: 80% *B. decumbens*+ 20% yellow maize by-product; TR3: 80% *B. decumbens*+ 20% guinea corn by-product;TR4: 100% *B. decumbens*

Table 2 shows the chemical composition of *Brachiaria decumbens* ensiled with residues showed significant effects ($p<0.05$) differences in dry matter, crude protein (CP), crude fiber (CF), ether extract (EE), and Ash assessed. It was observed that the dry matter was highest in TR2 (40.28%) followed by TR1 (32.64%), TR4 (32.24%), and TR3 (30.92%) recorded the lowest. The crude protein contents of the silages was observed to be highest (18.15%) in TR2 which differed from other silages, while the lowest recorded in TR1 (15.20%). The crude fibre content on the other hand showed that TR2 had the lowest value (14.80%) while TR4 has the highest (19.30%). Ether extract values decreased across the silages with grain by-products. TR2 and TR4 had similar Ether Extract values but significantly different from TR1 and TR3. Ash values ranged from 8.00 – 14.20%.

Neutral Detergent Fibre ranged from 50.81% to 68.92%. Acid Detergent fibre ranged between 35.40% and 41.40%. Acid detergent lignin value was highest in diet TR3 with the value 21.20%.

Table 2: Chemical composition of ensiled *Brachiaria decumbens* with grain residues.

VARIABLES	TR1	TR2	TR3	TR4	SEM
Dry Matter	32.64^b	40.28^a	30.92^d	31.24^c	0.22
Crude Protein	15.20^d	18.15^a	17.03^b	15.80^c	0.16

Crude Fibre	16.40^{c}	14.80^{d}	19.00^{b}	19.30^{a}	0.08
Ether Extract	9.90^{a}	9.00^{b}	7.10^{c}	9.00^{b}	0.04
Ash	8.00^{d}	12.00^{b}	9.40^{c}	14.20^{a}	0.14
NDF	50.81^{d}	55.45^{c}	68.92^{a}	65.25^{b}	1.38
ADF	36.60^{c}	35.40^{d}	41.40^{a}	40.80^{b}	0.18
ADL	17.50^{c}	16.80^{d}	21.20^{a}	19.80^{b}	2.70

^{abc} means with different superscript along the same row are significantly different (p<0.05).

SEM = Standard Error of Mean NDF: Neutral detergent fibre; ADF: acid detergent fibre; ADL: Acid detergent lignin;

TR1: 80% *B. decumbens*+ 20% white maize by-product; TR2: 80% *B. decumbens*+ 20% yellow maize by-product; TR3: 80% *B. decumbens*+ 20% guinea corn by-product;TR4: 100% *B. decumbens*

Table 3 shows the apparent nutrient digestibility of *Brachiaria decumbens* silages. Total dry matter intake was significantly (P<0.05) highest in TR2 (450.70%) with the lowest recorded in TR1 (267.37%). Faecal output values ranged from 135.14% in TR4 to 49.15% in TR1. All the digestibility indices evaluated were significantly different across the treatments (p<0.05) with Dry Matter Digestibility (DMD), Crude Protein Digestibility (CPD), Ether Extract Digestibility (EED) coefficient decreasing across the diets. The highest DMD (81.50%), CPD (86.25), CFD (63.35%), EED (76.66 %) and ASHD (70.42%),NDF (74.55%), ADF (69.59%) and ADL (67.14%) were recorded in animals fed TR1 and the lowest values were recorded in in animals fed TR4 except AshD coefficient.

Table 3: Apparent Nutrient digestibility of *Brachiaria decumbens* ensiled with grain by-products.

PARAMETERS	TR1	TR2	TR3	TR4	SEM
Total dry matter intake (g/day)	267.37^{c}	450.70^{a}	380.88^{b}	342.31^{b}	15.72

Faecal dry matter (g/day)	49.15^{b}	126.28^{a}	131.35^{a}	135.14^{a}	13.83
Dry matter	81.50^{a}	72.04^{ab}	65.83^{b}	60.32^{b}	3.54
Crude protein	86.25^{a}	84.10^{b}	77.37^{b}	72.52^{b}	2.96
Crude fibre	63.35^{a}	28.68^{b}	32.59^{b}	22.82^{b}	8.80
Ether extract	76.66^{a}	71.45^{a}	60.49^{b}	56.32^{b}	3.01
Ash	70.42^{a}	67.66^{a}	52.43^{b}	64.91^{ab}	3.95
NDF	74.55^{a}	62.63^{ab}	63.47^{ab}	56.38^{b}	4.38
ADF	69.59^{a}	49.62^{b}	58.53^{ab}	47.44^{b}	4.55
ADL	67.14^{a}	44.90^{b}	56.42^{ab}	44.75^{b}	4.65

^{abc} means with different superscript along the same row are significantly different (p<0.05).

SEM = Standard Error of Mean

TR1: 80% *B. decumbens*+ 20% white maize by-product; TR2: 80% *B. decumbens*+ 20% yellow maize by-product; TR3: 80% *B. decumbens*+ 20% guinea corn by-product;TR4: 100% *B. decumbens*

Nitrogen (N) intake (6.25 -13.13g/day), faecal (0.89 – 2.37g/day), absorption (5.63 to 11.03), percentage intake (72.52% - 86.25%), retention (5.54 – 11.03) and percentage retention intake (70.84 – 84.91%) were significantly different (p<0.05).However, excretion (urinary) (0.08 – 0.15) was not significantly different (p>0.05). The animals fed TR2 had a significantly higher Nitrogen intake compared to other experimental treatments. Nitrogen absorption expressed as percentage of intake (86.25%) and Nitrogen retention expressed as percentage of intake (84.91%) were significantly higher (p<0.05) in animals fed with TR1 compared to other experimental diets.

Table 4: Nitrogen balance of West African Dwarf Sheep fed *Brachiaria decumbens* ensiled with different grain residues.

Items	TR1	TR2	TR3	TR4	SEM
Intake (g/day)	6.52^{d}	13.13^{a}	10.41^{b}	8.68^{c}	0.44
Faecal	0.89^{b}	2.09^{a}	2.37^{a}	2.37^{a}	0.28
Urinary	0.08	0.15	0.09	0.14	0.03
Absorption (g/day)	5.63^{c}	11.03^{a}	8.03^{b}	6.31^{c}	0.42
% of intake	86.25^{a}	84.10^{a}	77.37^{ab}	72.52^{b}	2.96
Retention (g/day)	5.54^{c}	10.88^{a}	7.94^{b}	6.16^{c}	0.43
% of intake	84.91^{a}	82.92^{a}	76.45^{ab}	70.84^{b}	2.82

^{abc} means with different superscript along the same row are significantly different (p<0.05).

SEM = Standard Error of Mean

TR1: 80% *B. decumbens*+ 20% white maize by-product; TR2: 80% *B. decumbens*+ 20% yellow maize by-product; TR3: 80% *B. decumbens*+ 20% guinea corn by-product;TR4: 100% *B. decumbens*

Discussion

The colour, smell and texture of silage apparently improved with the byproducts residues compared to the sole ensiled Bracharia . Colour of the silage varied from pale green to light green, this colour is indicative of improved fermentation. All silages had a pleasant and slightly alchoholic smell typical of fermented grain by products which is relished by ruminants. The acidity (pH) showed that the by products improved fermentation of Bracharia silage. The pH of these silages was within acceptable range. McDonald *et al*. (14) reported that well-preserved silages had a pH range of 3.8 to 4.2

The dry matter content of the silages ranged from 30.92% 40.28% TR2. The differences observed in DM content of the diets are probably due to the different additives included in the diets. The dry matter production of the silages were similar to 35.18%DM reported by Babayemi (5) and also similar to the report of 34.60 -40.70%DM reported by Abegunde *et al*. (15) The differences could be as result of differences in additives used. It is noteworthy that the grain by-products in the present study had the potential to absorb water from *B.decumbens* by the process of osmosis. The Crude Protein, Crude Fibre Ether Extract and Ash values of the diets are reflection of the effects of grain residues on *B. decumbens* silage.

Brachiaria decumbens ensiled with grain by-products showed higher crude protein than in the treatment without by-product. The crude protein (15.20-18.15%) content reported in this study were above 10-12% CP requirement for sheep and goats (16) and 7-8% recommended for efficient functioning of rumen microorganism (17). The high crude protein content of the diets obtained in this study can be attributed to early vegetative stage when the plants were harvested. Crude protein (CP) values reported for silage diets in this study were similar to the report of Asaolu *et al (*18) who reported 18.15%CP and 12.56 to 16.05 % reported by Binuomote *et al*. (19) for ensiled signal grass and cassava leaves with millet additive but lower than 23.63 and 31.46 g/kg for elephant grass ensiled with 10% wheat bran and 20% wheat bran, respectively as reported by Silva *et al.* (20).

The CF of 20.75% can be tolerated by ruminants (21). It implies that 14.80% to 19.30% CF recorded for this study is much lower to the CF recommended by NRC. The CF (14.80% to 19.30%) reported in the present study compares with 11.94-16.45% reported by Odeyinka *et al* (22) but lower than 20.8% reported by Babayemi (5).

The ether extract obtained in this study was 7.10-9.90% fell below the range 3.36 – 9.90% as reported by Jolaosho *et al*. (23). However, the range of EE of the silages were similar 80g/kg level established by NRC (20) as the limitfor which reductions would occur in the DM intake by ruminants. Mean ash represents inorganic matter which mainly includes plant materials. The ash content ranged from 8-12%.

Fibre fractions are important as they describe those forage components that have low solubility in a specific solvent system and are relatively less digestible than starch (24). NDF is relevant to improvement of forage nutritional value and can be an important parameter in defining forage quality. More fibrous pasture is associated to longer ruminal retention and limits the intake rate. A high NDF that is above 72% will cause low intake of forage (25) and as NDF percentages increase, dry-matter intake generally will decrease. For this study, the value of NDF varied between 50.81-68.92%. As NDF increases, nutritive value declines because fiber is increasing (26).

ADF is the value that refers to the cell wall portions of the forage that are made up of cellulose and lignin. These values are important because they relate to the ability of an animal to digest the forage. The digestibility of foods is related to the fiber because the indigestible portion has a proportion of ADF, and the higher the value of ADF the lower the food digestibility (27). Nussio *et al* (28) reported that forage with ADF content around 40%, or more, shows low intake and digestibility. The NDF (50.81-68.92) and ADF (35.40-41.40%) contents reported in this study were higher than the NDF (43.00%-48.14%,) and ADF (31.01%-34.27%,) reported by Ukanwoko and Igwe, (29) The observed variations in the proximate composition of the silages may be due to the differences in geographical location, age of the grasses, soil characteristics, season and time of harvesting (30).

Productivity of ruminants is influenced primarily by feed intake, which, in turn, is determined by feed digestibility and the capacity of the diet to supply the correct balance of nutrients required by the animals. The Dry Matter Intake (DMI), faecal output, Dry Matter Digestibility, Crude Protein Digestibility, Ether Extract Digestibility and Ash digestibility coefficient were highest for animals on TR1. Dry Matter Intake by sheep varied from 267.27-450.70 g/day with rams on TR2 having the highest Dry Matter Intake (450.70%) which might be indicative that the diet was highly palatable. This was lower than values of 484.47–742.96 g/ day reported by Eyoh *et al.* (31) when they fed different forms of processed guinea grass to WAD bucks. Dry matter digestibility (DMD), which is related to nutrient composition, varied widely among the experimental silages. The different inclusion of grain residues in the grass silage significantly enhanced Dry Matter Digestibility by sheep. The values obtained in this study were within the range of 61.8-73.5% reported by Babayemi (5). The dry matter digestibility coefficients were above 40-50% recommended for any feedstuff or ration for ruminant feed (32).
The Crude Protein Digestibility ranged from 72.52%-86.25. The digestibility coefficient of CP was significantly higher for TR1, followed by TR2 , TR3 and the least recorded in TR4. Observed differences in value obtained in this study might be due to variations in additives used, whereas, agro-industrial by-products were used in this study, the readily fermentable carbohydrates in the agro-industrial by-products used must have contributed positively.
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Crude protein digestibility, which shows the extent to which microbial protein is made accessible to the animals daily (33), was significantly higher in TR1 silage than in the others. The finding is in agreement with McDonald *et al.* (14) who reported that higher CP intake is associated with better CP digestibility. Low CP digestibility observed in TR4 silage is probably due to the absence of additives during ensiling or low protein levels in the grass ensiled. Olorunnisomo (34) reported the better digestibility of DM and CP in Red Sokoto goats fed elephant grass, and cassava peels silage compared to silage diets without cassava peels. Apparent digestibility results generally indicate that in ruminant nutrition, CP and CF are important in enhancing microbial activities in the rumen (35). This condition was achieved with the mixture of grass and residues, which showed the improved digestibility of nutrients in this study.

The high digestibility values obtained for most nutrients suggest that the diets were highly degraded in the rumen. Petterson *et al* (36) reported that the extent of degradation by rumen microflora has important implications for both intake and digestibility. Animal fed TR2 had the highest N-intake (13.13g/day), this might be attributed to the protein content of the feedstuff, this finding corroborate Lamidi (37) who reported higher N-intake for diet that had higher CP content. The variation in the N-intake might be related to the protein profile of the feedstuff. The higher N-faecal (2.37g/day) indicated that T3 andT4 had larger endogenous and undigested CP. The excretion (faecal) (0.89 to 2.37) for this study was higher which may be due to high N-intake. This corroborate Alli-Balogun *et al*. (38) and Ahamefule *et al*. (39) who reported that N-faecal depends on the N-intake. Van Soest (16) stated that when the requirement of N is met, additional dietary N increases urinary N output. N retention is considered a better criterion for measuring protein quality than digestibility because it is associated with the amount of N used for protein deposition and biological value is a measure of protein quality (40, 41). Also, nitrogen retention is well established to depend on the intake of nitrogen and the level of fermentable carbohydrates in the feed (42).

The experimental diet promoted positive nitrogen balance with all the animals. The positive N-balance observed in all animals suggested that N absorbed was well tolerated and utilized by the animals as observed by Ahamefule *et al*. (43). This observation is attributable to the total nitrogen content of the silage diets fed to animals in this study.

4.0 CONCLUSION

Silage with different residues had a better chemical composition and influenced the nutrient digestibility of WAD sheep. Based on the results obtained in this study, *Brachairia decumbens* ensiled with different grain residues in the diets of growing West African Dwarf sheep has the potentials of meeting the nutritional needs of the animals without adverse effects on the digestibility parameters. Therefore it can be engaged as ruminant feed for WAD sheep, thus serving as feed during the dry season.

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