



Effect of *Sesbania sesban* fodder and Napier grass hay mixture diets on rumen metabolites of West African dwarf growing goats

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No conflict of interest is declared.

Ethical approval:

The Institutional Animal Care and Use Committee of the Oyo State College of Agriculture and Technology (Igboora, Oyo State, Nigeria) approved all experimental procedures. The study involve no endangered or protected animal species: A veterinarian helped in the blood sample collection and manually restrained the animals; no tranquilizers or short-acting anaesthetics used. Blood samples were collected using appropriate equipment. The Oyo State College of Agriculture and Technology, Igboora Animal Care and Use Committee approved the sampling procedures and number of animals sampled as part of obtaining the study permit.

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Meeting the nutritional requirements of ruminants during the dry season is challenging due to low-quality forage, which demands the use of browse legume fodder with grass species to provide an efficient rumen environment for microbes to flourish and ferment feeds, thereby increasing animal productivity. The effect of *Sesbania sesban* (SS) forage with Napier grass (NG) hay mixture diet on rumen metabolites of West African dwarf (WAD) bucks was evaluated after a 90-day feeding trial. A total of sixteen (16) growing WAD bucks between 6–9 months of age with an average body weight of 6.00–10.00kg were randomly allocated to four treatments with four bucks per treatment and two bucks per replicate in a completely randomized design, and were fed daily with varied experimental diets (T_1 = 100 % NG hay (100NG); T_2 = 25 % NG + 75 % SS hay (25NG75SS); T_3 = 50 % NG + 50 % SS hay (50NG50SS); T_4 = 100 % SS hay (100SS)) with a 500 g concentrate diet at 3 % body weight of individual animals. Significant ($P < 0.05$) differences were observed in rumen parameters across the dietary treatments. The pH value ranges from 7.40 (bucks fed T_1 diet) to 8.56 (bucks fed T_4 diet). Highest acetic acid value (13.80 mmole/100 ml), propionic acid (13.60 mmole/100 ml), butyric acid value (12.57 mmole/100 ml) and total volatile fatty acids (194.64 mmole/100 ml) was observed in bucks fed T_3 diet while the least acetic acid (10.19 mmole/100 ml), propionic acid (9.72 mmole/100 ml), butyric acid (9.27 mmole/100 ml) and TVFA (144.54 mmole/100 ml) was recorded in bucks fed T_2 diet respectively. The highest $\text{NH}_3\text{-N}$ (0.86 %) was observed in bucks fed T_3 diet, while the lowest value for $\text{NH}_3\text{-N}$ (0.70 %) was noted for bucks fed T_1 diet. It can be concluded that the combination of Napier grass with selected browse fodders at 50 % can enhance rumen metabolites in WAD bucks.

Key words: tropical browse fodders, Napier grass, WAD bucks, rumen ecology

Introduction

The changing climatic conditions in the past years have resulted in persistent droughts, heat waves and

shortages in animal feed [6]. This has severely affected ruminant animal production, leading to a dire need to address feed shortages, particularly in small-scale

farming systems. One of the most challenging factors in achieving this is the scarcity of feed, both in quantity and quality, especially during the dry periods of the year, thus resulting in animals' low productivity and even death [7]. Feed accounts for 60–70 % of the total cost of livestock production, and an inadequacy in quality and quantity could lead to a situation of low nutritional status, poor weight gain, poor reproductive ability, poor production, poor health condition and poor conversion ratio [5]. The rumen temperature and pH are critical phenomena that depend on the fermentation of ingested feeds in the rumen. R. Mohammed and A. Chaundry (2008) indicated that rumen fermentation products, such as volatile fatty acids, are essential nutrients to meet the demand of rumen microbes and the animal's body build-up [10]. This study was carried out to evaluate rumen parameters of growing West African Dwarf bucks fed varying proportions of *Sesbania sesban* fodder and Napier grass hay mixture.

Materials and Methods

Experimental site and animals

The experiment was conducted at the Sheep and Goat Unit, Teaching and Research Farm, Oyo State College of Agriculture and Technology, Igboora. Sixteen (16) growing West African dwarf bucks weighing 6.00–10.00 kg and 6–9 months of age were used. The animals were allowed to acclimatise for two weeks and treated before the commencement of the experiment. Fresh and clean water was also made available throughout the experiment.

Harvesting and processing of experimental diets

Napier grass and *Sesbania sesban* forage were harvested around the college farm, chopped at 3 cm long, wilted for 2–3 hours in the sun and air dried under shade for 4–5 days to prevent bleaching and loss of nutrients, baled and stored for the experiment.

Experimental layout, design and feeding method

The animals were allocated by weight into four treatments of four bucks per treatment, and two bucks served as a replicate in a completely randomised design (CRD). The *Sesbania sesban* forage and Napier grass harvested and air-dried for 4 to 5 days were mixed in varying proportions

as the experimental diets (ED) and fed to each buck per day at 3 % body weight. The *Sesbania sesban* and Napier grass air-dried fodders combinations were thoroughly mixed to eliminate/minimise selection by the animal. The bucks were offered their respective experimental feeds (Forage hay) at 8.00 am. Each buck was offered 500 g of concentrate per buck per day at 2.00 pm, and 3 litres of fresh and clean water were also supplied daily.

The compared experimental diets (ED) were: T₁ = 100 % NG hay (100NG); T₂ = 25 % NG + 75 % SS hay (25NG75SS); T₃ = 50 % NG + 50 % SS hay (50NG50SS); T₄ = 100 % SS hay (100SS) with a 500 g concentrate diet at 3 % body weight of individual animals, and their proximate composition is shown in table 1. Each group of animals was assigned to an experimental diet.

Data Collection

Rumen samples were collected six hours post-feeding from the animals 90 days of supplementation using a suction tube. The samples were immediately measured for pH using a portable pH meter (*Universal pH Test Kit-Digital pH Meter*[®]). They were thereafter filtered with a four-layer cheesecloth, and subsamples were divided into two portions. The first portion was used to analysed for ammonia nitrogen (NH₃-N) using AOAC method [2], while the second portion was used to estimated total volatile fatty acids (VFAs) and the proportions of acetate (C₂), propionate (C₃), and butyric acid (C₄) as previously described by [9]. Briefly, the samples were centrifuged at 3,000x g for 10 minutes; allowed to settle, and then, decanted. The decant was titrated with 0.1 M of sodium hydroxide (4/1000 gml⁻¹ H₂O) solution, and 2–3 drops of phenolphthalein (1/1000 gml⁻¹ ethanol) were used as an indicator. Determination of the various fractions were as follows:

$$\text{Acetic acid} = \frac{(\text{Titre value} \times 0.1 \times 0.06 \times 100)}{5},$$

$$\text{Propionic acid} = \frac{(\text{Titre value} \times 0.1 \times 0.04 \times 100)}{5},$$

$$\text{Butyric acid} = \frac{(\text{Titre value} \times 0.1 \times 0.006 \times 100)}{5},$$

$$\text{Total volatile fatty acids} = \frac{(\text{Titre value} \times 0.1 \times 0.09 \times 100)}{5}.$$

Statistical analysis

Data were subjected to a one-way Analysis of Variance (ANOVA) procedure of SAS version 9.4 [14]. The difference among treatment means with P<0.05 were assessed using *Duncan's Multiple Range Test* (DMRT) [4].

Results and Discussion

The proximate composition and fibre fractions of the varied mixture of the experimental diets were presented in table 2. The diet T₁ (100 % NG) has the highest dry matter (DM) content, crude fibre (CF), Ash, Nitrogen free extract (NFE), Neutral detergent fibre (NDF), Acid detergent fibre (ADF), Acid detergent lignin (ADL) value of

Table 1. Composition of formulated low-cost concentrate for experimental West African Dwarf growing bucks

Ingredients	Level, %
Palm kernel cake	60.00
Wheat offal	20.00
Corn bran	9.75
Groundnut cake	8.00
Bone meal	2.00
Salt	0.25
Total	100

87.63 %, 29.57 %, 11.95 %, 36.84 %, 51.50 %, 40.09 %, and 14.03 %, respectively. In comparison, the lowest CF, NDF and ADL value of 19.01 %, 41.65 % and 10.27 % respectively was recorded in diet T₄ (100SS) while the lowest DM and NFE value of 71.59 % and 23.86 % respectively were observed in diet T₃ (NG50SS50). It was observed that crude protein in the forage diets enhances microbial multiplication, which determines the extent of the experimental diet's fermentation.

Significant differences ($P < 0.05$) were in all the parameters across the dietary treatments. The result of the rumen metabolites of WAD bucks fed air-dried *Sesbania sesban* and Napier grass hay mixture with concentrate diets (table 3) revealed that more dry matter degradation was still possible in the rumen as the highest pH of 8.56 was observed in bucks fed T₄ diet that contained solely (100SS+500 g concentrate) while the least pH of 7.40 was recorded in rumen metabolites of bucks fed T₁ diet containing only Napier grass (100NG+500g concentrate diet) ($P < 0.05$). The observed rumen pH values of range 7.40–8.56 in this current study were higher than the reported values of 6.00–7.20 as the suitable pH to facilitate

optimum growth and activities of rumen microbes [12], and also higher than 5.92–6.60 reported by M. Okoruwa et al. [11] for rumen metabolites of WAD sheep fed *Ficus* foliage with differently processed breadfruit meals. The higher rumen pH observed in bucks on experimental diets could be due to less fermentable feed components that the animals consumed. Browse legume fodders and herbs have anti-microbial properties and can modify the rumen to improve energy or protein use [8].

An increase in volatile fatty acids and their proportions as caused by browse fodder supplementation in this study indicates the efficiency of nutrient digestion. However, buck fed diet T₃ recorded the highest acetic acid value of 13.80 mmole/100ml while the lowest acetic value of 10.19 mmole/100ml was observed in buck fed diet T₂ (fig. 1). The obtained acetic acid values of acetic acid in this study were lower to 42.03–46.65 mmole/100 ml reported by M. Okoruwa et al. [11], which due to the difference in the varying levels of browse fodder in the diets. The lactic acid values recorded from this experiment were 12.68–17.16 mmole/100 ml and were lower compared to 5.00–21.00 mol/100 ml reported by B. Suárez et al. [15].

Table 2. Proximate composition of air-dried *Sesbania sesban* and Napier grass hay mixture and concentrate diets fed to bucks

Parameters, %	T ₁ 100NG	T ₂ NG25SS75	T ₃ NG50SS50	T ₄ 100SS	Concentrate
Dry matter	87.63	73.52	71.59	81.12	94.48
Crude protein	8.12	15.28	15.61	18.67	17.57
Crude fibre	29.57	20.34	20.12	19.01	8.75
Ether extract	1.15	2.28	2.33	2.37	10.39
Ash	11.95	7.06	9.67	10.69	5.85
Nitrogen free extract	36.84	28.64	23.86	30.38	50.21
Neutral detergent fibre	51.50	45.18	48.16	41.65	30.34
Acid detergent fibre	40.09	30.17	31.78	32.07	16.05
Acid detergent lignin	14.03	10.60	11.03	10.27	5.65
Calculated metabolizable energy, Kcal/Kg	1702.33	1676.15	1615.19	1963.15	3282.45

Table 3. Rumen metabolites of WAD bucks fed air-dried *Sesbania sesban* and Napier grass hay mixture with concentrate diets

Parameters	T ₁	T ₂	T ₃	T ₄	SEM (±)
pH	7.40 ^{cd}	7.80 ^{bc}	8.20 ^{ab}	8.56 ^a	0.22
Acetic acid, mmole/100 ml	12.25 ^{bc}	10.19 ^{cd}	13.80 ^a	13.28 ^b	0.69
Propionic acid, mmole/100 ml	11.69 ^{bc}	9.72 ^{cd}	13.16 ^a	12.67 ^b	0.66
Butyric acid, mmole/100 ml	11.17 ^{bc}	9.29 ^{cd}	12.57 ^a	12.10 ^b	0.63
Valeric acid, mmole/100 ml	11.11 ^{bc}	9.25 ^{cd}	12.51 ^a	12.05 ^b	0.62
Lactic acid, mmole/100 ml	15.24 ^c	12.68 ^d	17.16 ^a	16.53 ^b	0.86
Total volatile fatty acids, mmole/100 ml	173.74 ^{bc}	144.54 ^{cd}	194.64 ^a	188.34 ^b	9.66
Ammonia nitrogen (NH ₃ -N), %	0.70 ^d	0.72 ^{bc}	0.86 ^a	0.77 ^b	0.03

Note. ^{abcd} means on the same row with different superscript are significantly different ($P < 0.05$).

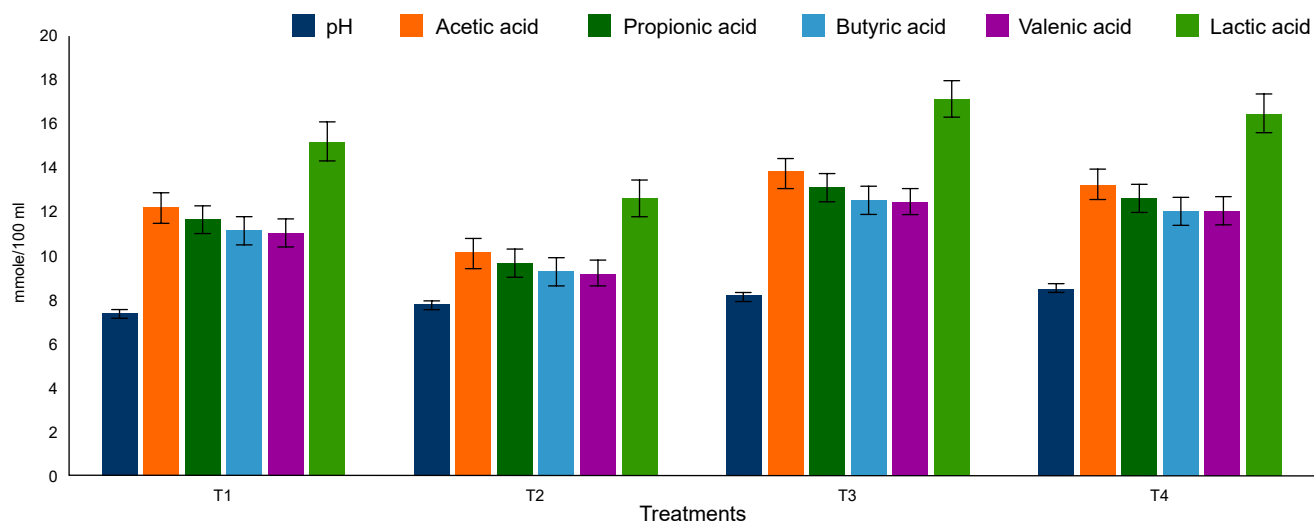


Fig. 1. Rumen metabolites of WAD bucks fed air-dried *Sesbania sesban* and Napier grass hay mixture with concentrate diets

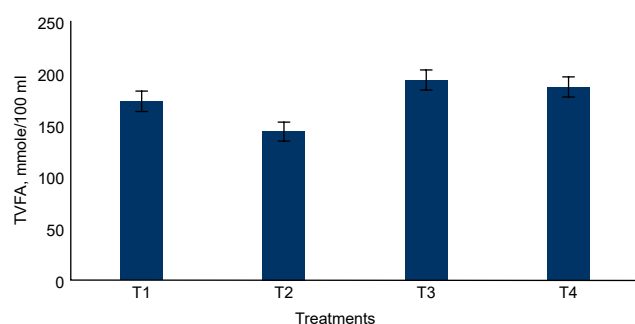


Fig. 2. Total volatile fatty acids in the rumen of WAD bucks fed air-dried *Sesbania sesban* and Napier grass hay mixture with concentrate diets

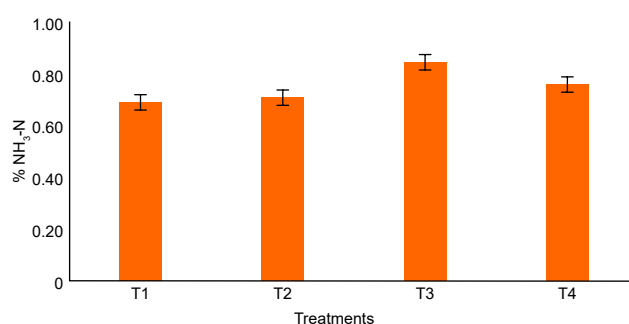


Fig. 3. Ammonia-Nitrogen in the rumen of WAD bucks fed air-dried *Sesbania sesban* and Napier grass hay mixture with concentrate diets

Butyric acid values recorded in this study ranges between 9.29–12.57 mmole/100 ml, which are within the range of 8.80–12.47 mmol/100 ml reported by K. Adebayo et al. [1]. The propionic acid values recorded from this study were within the range of 9.27–13.16 mmole/100 ml and were observed to lower than 21.6–28.8 mol/100 ml reported by B. Suárez et al. [15]. However, the high proportion of propionic and butyric acids was recorded in bucks fed diet T₃ revealed that equal proportion of air-dried *Sesbania sesban* and Napier grass hay mixture has a great and best effect on the rumen fermentation of the diets by microbial activity as well as good nutrient utilisation to yield energy [11].

The highest TVFA value of 194.64 mmole/100 ml was recorded in the buck fed diet T₃ that contained NC50SS50+500 g concentrate while the least value of 144.54 mmole/100 ml was noted in the buck fed T₂ diet that contained NG25SS75+500g concentrate (fig. 2). However, the observed TVFA values were lower than 66.00–72.00 mmol/litre recorded by M. Okoruwa et al. [11] who fed WAD sheep with differently processed breadfruit meals and *Ficus* foliage.

The highest NH₃-N value of 0.86 % was recorded in the buck fed diet T₃ while the lowest value of 0.70 %

was noted in the buck fed T₁ diet, these values fell within the normal range (0.5–2.5 %) of optimum ammonia level for growth and microbial activity [13]. Furthermore, the obtained rumen ammonia levels were within the normal range of 0–13 % as reported by K. Yusuf et al. [16].

The study revealed that feeding varying levels of Napier grass (*Pennisetum purpureum*) hay supplemented with browse fodder increase in nutrient intake, especially CP intake, posed no adverse effects on rumen ecology of the animals and enhanced rumen fermentation in WAD growing bucks. Hence, farmers can incorporate *S. sesban* fodder hay up to 50 % inclusion levels in the diets of their goats to help alleviate the challenge of feed availability all year round.

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Вплив кормої суміші *Sesbania sesban* та сінної суміші зі слонової трави на метаболіти рубця молодняку західноафриканських карликових кіз

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Задовольнити потреби жуйних тварин у поживних речовинах в сезон посухи складно через низьку якість кормів. Тому виникає потреба доповнити пасовищні раціони травами, щоб забезпечити оптимальне середовище в рубці для розвитку мікробіому та ферментації кормів, що підвищує продуктивність тварин. Оцінювали вплив корму *Sesbania sesban* (SS) з сінною сумішшю слонової трави (NG) на метаболіти рубця самців західноафриканської карликової кози після 90-денного згодовування. Шістнадцять (16) молодих козенят віком від 6 до 9 місяців із середньою масою тіла 6,00–10,00 кг випадковим чином розподілили на чотири групи по четверо в групі та двоє як повторність за повністю рандомізованим дизайном. Тварин щодня годували різноманітними експериментальними раціонами: T₁ = 100 % сіна слонової трави (100NG); T₂ = 25 % слонової трави + 75 % сіна *Sesbania sesban* (25NG75SS); T₃ = 50 % слонової трави + 50 % *Sesbania sesban* (50NG50SS); T₄ = 100 % *Sesbania sesban* (100SS), з розрахунку 500 г концентрованого раціону на 3 % маси тіла тварини. Спостерігали вірогідні (P<0,05) відмінності в параметрах рубця за різних варіантів раціону. Значення pH коливається від 7,40 (раціон T₁) до 8,56 (раціон T₄). Найвище значення оцтової кислоти (13,80 ммоль/100 мл), пропіонової кислоти (13,60 ммоль/100 мл), масляної кислоти (12,57 ммоль/100 мл) та летких жирних кислот (194,64 ммоль/100 мл) спостерігали у цпків, яких годували раціоном T₃, тоді як найменше оцтової кислоти (10,19 ммоль/100 мл), пропіонової кислоти (9,72 ммоль/100 мл), масляної кислоти (9,27 ммоль/100 мл) та ЛЖК (144,54 ммоль/100 мл) було зафіксовано у самців, яких годували раціоном T₂, відповідно. Найвищий вміст NH₃-N (0,86 %) спостерігали у тварин на раціоні T₃, тоді як найнижче значення NH₃-N (0,70 %) виявили у цпків, яких годували раціоном T₁. Можна зробити висновок, що поєднання слонової трави з вибраними кормами для худоби у кількості 50 % може підвищити рівень метаболітів у рубці самців західноафриканської карликової кози.

Ключові слова: тропічні пасовищні корми, слонова трава, західноафриканська карликова коза, екологія рубця*