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Effect of inclusion level and feeding regime on Nutrient digestibility and Nitrogen retention of growing Yankasa rams fed concentrate supplement containing *Ficus sycomorus* leaf meal

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Abstract

A study was conducted to evaluate the effect of inclusion level and feeding regime of *Ficus sycomorus* leaf meal on the growth performance of Yankasa rams. A total of 36 rams weighing on the average 15.39kg were randomly assigned to four diets, containing 0, 5, 10, and 15% inclusion level of *Ficus sycomorus*, respectively. Each of the animals was fed 2% body weight of the experimental diet in three feeding regimes: daily, skip-a-day and skip-2-days in a 4x3 factorial arrangement in a completely randomized design. The effect of *F. sycomorus* supplementation on nutrient digestibility and nitrogen balance revealed that dry matter (DM), organic matter (OM) and crude protein (CP) digestibility were significantly (P<0.05) affected by the inclusion level. Nitrogen (N) retention and N retention as percent intake were affected significantly (P<0.05). Percent DM, OM and CP digestibility were influenced (P<0.05) by feeding regime, with daily feeding recording higher values (67.80, 63.05 and 62.23 respectively) when compared to skip-a-day and skip-2-days. It was concluded that the inclusion of *Ficus sycomorus* leaf meal in the diet of growing rams did not perform more than the control diet and also, daily feeding regime was better in nutrient digestibility, nitrogen intake and nitrogen retention.

Keywords: Nutrient digestibility, retention, *Ficus sycomorus*, rams
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Introduction

In Nigeria, sheep are an essential asset to the rural poor, both to those directly engaged in livestock production and to poor non-farming rural households who rely on local production for affordable nutrition. Sheep production confers many economic advantages on small farm operations, and in an era of rising urban incomes and improving market access to sheep products have increasing potential for marketability.

The low productivity of sheep among smallholder farmers during the dry season due to seasonality of the major feed resource which is the natural grassland has become a serious problem. This has led to malnutrition of these animals resulting in weight losses and low fecundity. Effort to reduce this problem through the introduction of drought resistant forages and forage conservation through different means of dry season feeding of ruminants has been successfully carried out by various researchers (Wanapat *et al.*, 1997; Yashim, 2014; Abdu, *et al.*, 2014).

One essential challenge for livestock managers is to regulate the flow of feed nutrients (Satter *et al.*, 2002). Yashim (2014) has suggested that dietary adjustment is an important element in regulating environmental contaminants released through livestock excreta. To achieve this, strategies on nutrient management to improve animal performance, prevent losses to the environment and enhance their cycling should be evolved. Therefore the manipulation of the animals' diets with the view of improving utilization of feeds, reducing the quantity and harmfulness of contaminants released to the environment has become a focal point for farming systems.

Manipulating rumen fermentation through strategic supplementation with concentrate and forages could improve rumen efficiency by maintaining higher pH and optimum rumen ammonia-nitrogen (NH_3-N) concentration, thus reducing methane (CH_4) production and increasing microbial protein synthesis and essential volatile fatty acid (VFAs), for enhanced ruminant production in the tropics (Khampa and Wanapat, 2007). The manipulation of the animals' diets through the use of strategic feeding regime has not been extensively investigated.

It is against this background that the present study was carried out to evaluate the effect of inclusion level and feeding frequency on growth performance of Yankasa rams fed concentrate containing *Ficus sycomorus* leaf meal

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Animal Farm of Animal Science Department, Ahmadu Bello University Zaria, Kaduna State, Nigeria. Zaria is located within the Northern Guinea Savanna Zone between latitudes 11^0 12' N and longitudes 7^0 33' E; at an altitude of 610m above sea level (Wikipedia 2013).

Experimental Material

The experimental material *Ficus* sycomorus was harvested and shade dried for 5 days. The leaves were separated from the stalk and crushed into pellets to allow for easy mixing with the other ingredients in the concentrate feed. It was then bagged in polythene bags (Jimbo® bags) and stored in a room until it was needed for the study. *Digitaria smutsii* hay was obtained from National Animal Production Research Institute (NAPRI) Shika-Zaria, Nigeria and stored until commencement of this study.

Feeding and management of animals

Thirty six growing Yankasa Rams of 6-8 months old with average weight of 15.39 kg were used for this study. Two weeks prior to the commencement of the experiment, the pens were thoroughly washed and cleaned with detergent and disinfectant (Izal) and allowed to dry. The animals were treated with prophylactics, dewormed with albendazole and were given Terramycin long acting (TLA) antibiotic injection at (1.0ml/10kg body weight) against bacterial infections. While ecto-parasites were checked using Ivermectin (Ivomec) at (2.0ml/10kg body weight). The animals were allotted to four dietary treatments with nine animals per treatment, three animals per feeding regime, in a 4x3 factorial arrangement in a Completely Randomized Design. The animals were housed individually in an open-sided, well-ventilated pens which was bedded with wood shavings to serve both as litter materials and beddings and each pen was equipped with feed and water troughs. The animals in first treatment (control) were served with the formulated concentrate diets at 0% inclusion level of *F. Sycomorus*, while the remaining three treatments were included at 5, 10 and 15% levels of inclusion. Animals were fed the concentrate containing varying levels of *Ficus sycomorus* leaf meal at 2.0 percent of their body weight. The daily allowance of the supplementary diet was offered as a single meal (at 08h) in the morning and *Digitaria smutsii* hay was offered *ad libitum*, after the animals on supplement for that day had consumed the entire supplement. The animals were allowed 3 hours to feed on the concentrate diet after which *Digitaria smutsii* hay were served *ad libitum*. Clean drinking water was provided to the animals daily *ad libitum*. The experiment lasted for 90 days after an initial adjustment period of 7 days.

Digestibility and Nitrogen balance trials

At the end of the growth study, all the animals were weighed and transferred to individual metabolic crates fitted with facilities for separate collection of voided faeces and urine. Experimental diets fed were the same as those used in the growth study. An adjustment period of 7 days was allowed before the faecal and urine samples were measured for subsequent 7 days. Faeces voided daily was collected separately from animals in each treatment and were bulked, thoroughly mixed and sub-samples taken. Feed intake was measured by finding the difference between the amount of feed offered and the amount refused. Nitrogen loss from urine and bacteria growth infestation were prevented by introducing into a well-labelled urine collection bottle containing 5ml 0.1M tetraoxosulphate (vi) acid ($H_2 SO_4$) and stored in a refrigerator for laboratory analysis. Feed and faecal samples were were oven dried at 65^oC to constant weight, milled and stored in air tight containers, until required for nutrient analysis in the laboratory. Apparent digestibility of the diets was calculated as the difference between nutrient intake and excretion in the faeces expressed as a percentage of the nutrient intake (Marshal, 2001; Aduku, 2004; Bello and Tsado, 2013). Thus, apparent nutrient digestibility was calculated using this formula as reported by Okoruwa *et al.* (2012).

Apparent Nutrient Digestibility

$$= \frac{\text{Nutrient Intake – Nutrient in faeces}}{\text{Nutrient Intake}} \text{ X } \frac{100}{1}$$

Chemical analysis

Ten percent representative of each feed offer and refusal was sampled every day and combined for the entire collection period on an individual animal basis using air tight containers. Sub-sampling was performed on the aggregated feed materials for both offer and refusal and kept in the refrigerator for analysis. Samples of feeds and faeces were weighed and oven dried at 105°C for 48 hours to constant weight. Both feed and faecal samples were ground using a hammer mill to pass through a sieve of 1 mm diameter and were analyzed for Dry matter (DM), Crude protein (CP) was calculated as N x 6.25, Crude fibre (CF) and Ether extract (EE). Nitrogen free extract (NFE) was determined by difference while Ash content was determined by combusting samples at 550^0 C overnight according to procedure described by A.O.A.C. (2001). The Nitrogen content of the urine was determined by the Kjeldahl method according to A.O.A.C. (2001) procedure.

Laboratory analysis

Samples of feed offered were analysed for dry matter, crude protein, crude fibre, ether extract, ash by using AOAC (2000). Neutral detergent fibre (NDF), acid detergent fibre (ADC) and hemicelluloses were determined by the method of Van Soest and Robertson, (1988). Tannin content and other antinutritional factors (ANFs) were analysed by Wheeler *et al*. (1994) methods.

Statistical analysis

All data generated were expressed as means with the standard errors and subjected to analysis of variance (ANOVA) according to standard procedure using the General Linear Model (GLM) procedures of Statistical Analysis System (SAS version 9.0, 2002). Duncan's Multiple Range Test (DMRT) of the same software, was used to compare means that are found to be statistically significant (Duncan, 1955) and significant difference were tested at 5% probability level. The model used is given below:

$$Y_{ijk} = \mu + A_i + Bj + (AxB) + e_{ijk}$$

Where:
μ = overall mean
A_i = effect of inclusion levels (i = 1- 4)
$B_{j =}$ effect of feeding regimes (j = 1-3)
(AxB) = interaction between feeding regimes and inclusion levels.
e_{ijk} = uncontrollable error associated with feeding and other factors

Table 1: Ingredient composition of concentrate supplement fed to Yankasa rams.

	Inclusion level of *Ficus sycomorus* leaf (%)			
Ingredients	0	5	10	15
Maize offal	64.00	60.10	56.10	51.90
F.sycomorus	0	5.00	10.00	15.00
Cotton Seed Cake (CSC)	18.00	16.90	15.90	15.10
Rice bran	15.00	15.00	15.00	15.00
Bone meal	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Total	100.00	100,00	100.00	100.00
Calculated Analysis (%)				
CP	16.00	16.00	16.01	16.00
CF	21.23	21.73	22.26	22.83

Effect of inclusion levels of *F. sycomorus* in supplement diets on nutrient digestibility and nitrogen balance

Nutrients digestibility

The results of nutrient digestibility studies are presented in table 2. Dry matter digestibility (DMD), organic matter digestibility (OMD) and other nutrients digestibility were significantly (p<0.05) affected by inclusion levels of ficus leaf meal. DMD, OMD and crude protein digestibility were highest (p<0.05) for animals on 0% level of *Ficus*, while lowest digestibility was observed in animals fed 15% inclusion level of *Ficus.*

The NDF digestibility was significantly (p<0.05) depressed as the level of ficus supplementation increased. Rams fed diets with 5% and 10% *Ficus* inclusion had NDF digestibility values of 32.17 and 31.78% which were similar but higher (p<0.05) than rams offered supplementary diets with 15% level of *Ficus* inclusion, which had NDF digestibility of 29.72%. Acid detergent fibre digestibility followed similar trend as NDF digestibility.

Nitrogen Balance

The results of nitrogen balance study are also presented in Table 3. Total nitrogen intake was similar among treatment groups. Rams offered supplementary diets with 10% and 15% ficus inclusion level had significantly higher (p<0.05) amounts of daily faecal N output (16.43 and 23.05 g/day respectively), than rams on 0% and 5% ficus diets (15.31 and 15.65 g/day respectively). The daily faecal output was however, not significantly (P<0.05) different between 0% and 5% inclusion level of ficus leaf meal.

Nitrogen retention was significantly (P<0.05) affected by ficus inclusion levels in the experimental diets. The values were significantly (P<0.05) higher in rams on 0% and 5% (26.09 and 25.71 g/day respectively) level of ficus supplementation, followed by rams on 10 and 15% inclusion. The nitrogen retention as percent of intake was significantly (P<0.05) lower in 15% inclusion levels when compared to 0, 5 and 10% inclusion levels.

Table 2. Effect of level of F*icus sycomorus* supplementation on nutrient digestibility of Yankasa rams fed *D. smutsii* hay

	Inclusion Levels of *F. sycomorus* leaf meal (%)				
Parameters	0	5	10	15	SEM
Digestibility (%)					
Dry Matter	61.70[a]	57.83[b]	56.14[c]	55.43[c]	0.82*
Organic	65.08[a]	55.53[b]	52.62[c]	50.80[c]	0.92*
Crude protein	68.29[a]	60.40[b]	58.74[c]	56.59[d]	0.62*
NDF	68.29[a]	32.17[b]	31.78[b]	29.72[c]	0.79*
ADF	47.37[a]	30.03[b]	29.72[b]	27.63[c]	1.15*

[abc] Mean values with different superscripts within a row differ significantly P<,0.05) *Significant at 0.05
NDF= Neutral detergent fibre; ADF= Acid detergent fibre

Table 3. Effect of level of *Ficus sycomorus* supplementation on nitrogen balance of Yankasa rams fed *D. smutsii* hay

	Inclusion Levels of *F. sycomorus* leaf meal (%)				
Parameters	0	5	10	15	SEM
Nitrogen balance (g/day)					
Nitrogen intake	54.38	54.35	53.59	52.26	1.38
Faecal N	15.31[c]	15.65[c]	16.43[b]	23.05[a]	0.09*
Urinary N	12.98[a]	12.99[a]	12.12[b]	11.16[b]	0.23*
N retained	26.09[a]	25.71[a]	25.04[b]	18.05[c]	0.30*
N retained as % of intake	47.98[a]	47.30[a]	46.73[a]	34.54[b]	1.01*

[abc] Mean values with different superscripts within a row differ significantly P<,0.05) *Significant at 0.05
N= Nitrogen

Effect of feeding regime on nutrient digestibility and nitrogen balance
Nutrients digestibility

Table 4 shows the effect of feeding regime on nutrient digestibility of Yankasa rams fed *D. smutsii* hay supplemented with concentrate containing *F. sycomorus.* Percent DM, OM and CP digestibility significantly (P<0.05) decreased in the skip-a-day and skip-2-days feeding regime when compared to the daily feeding regime. A significant (P<0.05) higher percent ADF digestion was reported for skip-a-day and skip-2-days feeding regime (43.65 and 43.34% respectively) than for the lower value (42.90%) observed in daily feeding of the supplement.

Nitrogen balance

The result of nitrogen balance study is presented in Table 5. Total nitrogen intake was significantly (P<0.05) influenced by feeding regime. Animals on daily feeding of the supplement had the highest nitrogen intake of 55.76 g/day, while those on skip-2-days feeding of the supplement recorded the least nitrogen intake (50.25 g/day). Daily urinary N output (g/day) was significantly (P<0.05) higher and similar in rams on daily feeding and skip-a-day feeding of the supplement (11.02 and 10.99 g/day respectively) compared to those on skip-2- days feeding (10.06 g/day) of the supplement containing ficus leaf meal. Nitrogen retention declined (P<0.05) with decrease in feeding frequency. The retained N in daily feeding and skip-a-day feeding of supplement was similar (23.87 and 24.06 g/day respectively) but significantly higher than that in skip-2-days feeding regime (23.11 g/day). Nitrogen retention as % of intake was lower (P<0.05) in daily feeding of the supplement (42.81%) as compared to 44.97 and 45.99% in skip-a-day and skip-2-days feeding regime respectively.

The overall effect of inclusion level and feeding regime on nutrient digestibility and nitrogen balance

The overall effect of inclusion level and feeding regime on nutrient digestibility of Yankasa rams in the experimental diets is shown in Table 6. The DMD, OMD and CP digestibility were significantly (P<0.05) affected by level of inclusion and feeding regime. Daily feeding at 10 and 15% inclusion levels of *F. sycomorus* had significantly (P< 0.05) higher DMD (65.12 and 65.99%, respectively) compared to 0% and 5% (63.54 and 63.23% respectively). The interaction between supplement containing 10% inclusion levels with feeding regime recorded the highest CP digestibility of 57.33% while the least digestibility of 53.00% of supplement containing 15% inclusion level was recorded at skip-2-days feeding. There was a significantly (P<0.05) interaction between inclusion level and feeding regime. The interaction significantly (P<0.05) influenced Nitrogen intake at all inclusion levels (0, 5, 10 and 15%), with daily feeding across treatment diets recording the highest values of N intake (55.78, 55.32, 55.18 and 55.00g/day respectively) while skip-2-days had the least (50.99, 50.44, 50.06 and 49.28 g/day respectively). This interaction (P<0.05) also influenced N retained and N retained as % of intake. The highest values were observed on skip-a-day feeding at 10% level of inclusion.

Table 4. Effect of feeding regime on Nutrient digestibility of Yankasa rams fed concentrate containing F*icus sycomorus* leaf meal

	Feeding regime			
Parameters	Daily	Skip-a-day	Skip-2-days	SEM
Digestibility (%)				
Dry Matter	67.80[a]	64.98[b]	63.26[b]	0.98*
Organic matter	63.05[a]	60.76[b]	59.01[b]	1.02*
Crude Protein	62.23[a]	61.31[b]	60.85[b]	0.44*
NDF	46.68	46.50	45.32	1.43
ADF	42.90[b]	43.65[a]	43.34[a]	0.19*

[abc] Mean values with different superscripts within a row differ significantly (P<,0.05) *Significant at 0.05
NDF= Neutral detergent fibre; ADF= Acid detergent fibre

Table 5. Effect of feeding regime on nitrogen balance of Yankasa rams fed concentrate containing *Ficus sycomorus* leaf meal

	Feeding regime			
Parameters	Daily	Skip-a-day	Skip-2-days	SEM
Nitrogen balance (g/day)				
Nitrogen intake	55.76[a]	53.50[b]	50.25[c]	0.98*
Faecal N	20.87[a]	18.45[b]	17.08[c]	0.46*
Urinary N	11.02[a]	10.99[a]	10.06[b]	0.26*
N retained	23.87[a]	24.06[a]	23.11[b]	0.24*
N retained as % of intake	42.81[b]	44.97[a]	45.99[a]	0.49*

[abc] Mean values with different superscripts within a row differ significantly P<,0.05) *Significant at 0.05
N= Nitrogen

Table 6: Overall effect of inclusion level and feeding regime on nutrient digestibility and nitrogen balance of Yankasa rams fed concentrate containing *Ficus sycomorus* leaf meal and *D. smutsii* hay as basal diet

Parameters	*F. sycomorus* inclusion levels/Feeding Regime												
	0%			5%			10%			15%			
	Daily	Skip-a-day	Skip-2-days	Daily	Skip-a-day	Skip-2-days	Daily	Skip-a-day	Skip-2-days	Daily	Skip-a-day	Skip-2-days	SEM
Digestibility (%)													
Dry Matter	63.54^{b}	62.57^{b}	62.21^{b}	64.68^{ab}	63.23^{b}	62.45^{b}	65.12^{a}	63.30^{b}	64.11^{ab}	65.99^{a}	64.01^{ab}	64.98^{ab}	0.68*
Organic Matter	62.00^{b}	64.23^{ab}	63.46^{b}	62.98^{b}	64.89^{ab}	63.32^{b}	63.01^{b}	65.43^{a}	63.29^{b}	63.47^{b}	64.99^{ab}	63.25^{b}	0.80*
Crude Protein	56.23^{b}	55.67^{b}	53.55^{cd}	55.98^{b}	56.34^{b}	53.23^{cd}	54.21^{c}	57.33^{a}	53.33^{cd}	54.03^{c}	56.20^{b}	53.00^{d}	0.45*
NDF	45.29	44.11	43.22	45.26	44.21	43.98	45.19	44.34	44.21	45.00	44.32	44.88	1.12
ADF	42.43	43.87	44.02	42.08	43.66	43.32	41.88	43.41	42.67	41.37	43.18	41.87	1.42
Nitrogen Balance (g/day)													
Nitrogen Intake	55.78^{a}	53.22^{b}	50.99^{c}	55.32^{a}	53.87^{b}	50.44^{c}	55.18^{a}	53.86^{b}	50.06^{c}	55.00^{a}	53.15^{b}	49.28^{c}	0.52*
Faecal N	19.89^{a}	17.97^{b}	17.16^{b}	20.08^{a}	17.56^{b}	16.76^{bc}	20.57^{a}	17.25^{b}	16.49^{bc}	20.90^{a}	17.24^{b}	15.86^{c}	0.90*
Urinary N	10.03	10.00	10.91	10.54	10.44	10.89	11.31	10.01	10.42	11.63	11.06	10.08	0.97*
N retained	25.86^{b}	25.25^{bc}	22.92^{cd}	24.70^{c}	25.87^{b}	22.79^{cd}	23.30^{c}	26.60^{a}	23.15^{c}	22.47^{d}	24.85^{c}	23.34^{c}	0.31*
N retained as % of intake	46.36^{b}	47.44^{b}	44.95^{c}	44.65^{c}	48.02^{b}	45.18^{bc}	42.23^{d}	49.39^{a}	46.24^{b}	40.85^{e}	46.75^{b}	47.36^{b}	0.62*

^{abc} Mean values with different superscripts within a row differ significantly ($P<0.05$) *significant at 0.05 NDF= Neutral detergent fibre; ADF= Acid detergent fibre; N= Nitrogen

Discussion

Nutrient digestibility

Effect of inclusion level on nutrient digestibility

A significant difference in percentage digestibility of DM, OM, NDF and ADF across the inclusion levels was observed in this study. The significant reduction in organic matter digestibility observed in the present study is in accordance with the report of Rotger *et al.* (2006) who stated that a change in feed ingredients alters the amount of OM and N and their fermentation rate in the rumen. With increasing inclusion of ficus, the organic matter, crude protein decreased across treatments. Puppo *et al* (2002) had indicated that increasing contribution of roughage in a ration could lead to a decline in cellulose digestion. The observed decreased in NDF digestibility affirm the assertion that the escape of potentially degradable fibre substrate from the rumen, possibly resulted in a depression in NDF digestibility (Robbles *et al.,* 2007). However, Pereira *et al.* (2007) found no effect of concentrate supplementation on ruminal apparent digestibility of nutrients.

It is well accepted that forage degradation in the rumen is mainly affected by the cell wall content and its degree of lignification. Lignin is indigestible and acts as a barrier limiting the access of microbial enzymes to the structural polysaccharide of the cell wall.

Effect of feeding regime on nutrient digestibility

Diet DM digestibility was influenced by feeding regime in this study. This agrees with earlier findings that increased feeding frequency has a positive impact on digestibility of DM, OM and CP, as greater feeding frequencies have been shown to result in increased numbers of protozoa (Weimer, 1998; Atkinson *et al.*, 2010). Abouheif *et al.*, (2010) attributed the positive effects of increased meal frequency to a more stable rumen environment and thereby a more efficient digestion. In contrast, Bunting *et al.* (1987) observed that CP digestibility decreased with increasing meal frequency. Also, restricted feed intake has been reported to increased nutrient digestibility and decreased methane loss in goats (Tovar-Luna *et al.*, 2007).

The overall effect of inclusion level and feeding regime on nutrient digestibility

There was a significant interaction between inclusion level and feeding regime in dry matter, organic matter and crude protein digestibility (DMD, OMD and CPD respectively). The improvement in DMD, OMD and CPD as influenced by feeding frequency observed in this study agrees with the report of Rotger *et al*. (2006). They reported that a change in feed composition and frequency of feeding influenced digestibility of nutrients in feeds.

Nitrogen Balance

Effect of inclusion level on nitrogen balance

The results of nitrogen balance showed increased faecal and reduced urinary losses with increasing levels of ficus in the diets. The observed result on faecal and urinary nitrogen does agree with the findings of Al-Asfoor, (2010) who reported that the nitrogen concentration of faeces strongly depends on the N concentration of the diet. The reduced N retention in animals fed the supplement containing ficus may suggest that probably much of the protein is unavailable for digestion owing to formation of tannin-protein complexes. Elseed *et al.,* (2005) however observed that supplementation of protein sources improved microbial N yield and N retention.

Effect of feeding regime on Nitrogen balance

Nitrogen retention declined ($P<0.05$) with decrease in feeding frequency. The observed decrease in nitrogen intake, faecal nitrogen and urinary nitrogen with decrease in feeding frequency is in line with the report of Borsting *et al.,* (2003) who stated that the faecal N concentration can be influenced by dietary manipulation. Excess supply of N is avoided through the manipulation of feeding frequency and the N efficiency is maximized. It has also been observed that N and starch in faeces are positively and moderately related to N and starch in the feed (Al-Asfoor, 2010).

The overall effect of inclusion level and feeding regime on Nitrogen balance

The increase in nitrogen intake as inclusion level and feeding regime reduces from daily feeding to skip-2-days is similar to the findings of Soto-Novarro *et al.*, (2000), who reported an increased in nitrogen intake of feed offered to steers as treatment x feeding frequency interacted.

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