

# Nutrients digestibility, nitrogen balance and rumen fermentation parameters of sheep fed on *Sesbania Sesban* and Reed Plants

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## Research Article

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# Abstract

This study was conducted to investigate the effect of feeding *sesbania sesban* and reed forage on nutrient digestibility, nitrogen retained, ruminal protozoa count and rumen fermentation in sheep. Twelve mature native rams (50.25 kg body weight) were used in three digestibility trials. The animals in group one were fed a basic diet consisting of a 700 g concentrate mixture with fresh Alfalfa *ad libitum*, which was kept as a control. The second group (T1) was fed 700 g concentrates with fresh Sesban *ad libitum* and the last one (T2) was fed 700 g concentrates with fresh Reed forage *ad libitum*. The rams were fed 60% of their daily requirements as a concentrate mixture based on NRC recommendations, while the rest was covered from green fodder. There were no significant differences ( $P > 0.05$ ) in nutrient digestibility among groups. The digestibility of most nutrients in reed forage group tended to be lower than the control and sesban groups. However, the digestibility rate of NDF and ADF were significantly ( $P < 0.05$ ) higher than those of control and sesban groups. The digestible crude protein (DCP) of the control and Sesbania groups was significantly ( $P < 0.05$ ) higher than the reed one. However, the feeding value expressed as total digestible nutrient (TDN) and a starch value (SV) did not differ among groups. The nitrogen retained was improved ( $P < 0.05$ ) of rams fed on alfalfa and Sesbania groups. Moreover, no significant differences were found among the treatments for ruminal pH,  $\text{NH}_3\text{-N}$ , TVFA's and total protozoa count. However, the ruminal  $\text{NH}_3\text{-N}$  and TVFA's concentrations tended to be lower in reed forage group than other groups. Concerning the effect of sampling time on the rumen liquor parameters, the mean values of pH were significantly ( $P < 0.05$ ) higher before feeding time, then decreased at 4 hrs. after feeding. However, all of  $\text{NH}_3\text{-N}$  and TVFA's concentrations were lower before feeding and increased after feeding to reach the peak at 4 hrs. post feeding. In conclusion, the nutrient digestibility of sesban and reed forage were near to alfalfa or higher than it. Also, the rumen fermentation activates and the total protozoa count was improved by feeding sesban and reed forages to rams. Therefore, it can be recommended to use these forages as alternative sources of alfalfa in the diets of sheep.

## Introduction

In the tropical and subtropical regions, insufficient feed, both in quantity and quality, is the main barrier to livestock production. Animals in these areas are frequently fed crop wastes and low-quality native hay or pasture. Furthermore, farm animals are malnourished, especially during the summer, when green forages with enough protein content are scarce (Ibrahim et al., 2012). According to government policy, Berssem area was reduced to allow more area for wheat. A possible alternative is *sesbania sesban* and reed forages which grow naturally over huge areas of lands.

Multipurpose tree legumes grow well in tropical environments without requiring a lot of agronomic inputs, indicating that they could be used as supplementary feeds by medium- and small-scale livestock farmers in the tropics to enhance livestock nutrition and productivity (Gebreyowhans and Zegeye, 2019). The New Valley is Egypt's largest governorate, occupying half of the western desert and accounting for 48% of the country's total surface area (Gameh et al., 2017). Some areas contain enough salts, so it makes growing of the crops difficult. Cultivation of *Sesbania Sesban* and reed plants considered one of these solutions to

overcome this problem, in addition to using it as a high quality green fodder for animals, especially small ruminants.

Reed plants have the ability to growing fast and having tolerance to soil salinity and can survive in high salinity water compared with other plants. It primarily grows at the shores of lakes and gulfs, riverbanks, and nutrient-rich peat areas. If the water is sufficiently clear, it can grow in deeper water. It's been used as a summer fodder plant for ages, and it's unlikely to compete for land that could be utilized for food production. It's a tall, slender, very productive grass (Poaceae) with up to 30 t/ha/y above-ground biomass. (Köbbing et al., 2013). Reed forage is more palatable and rich in nutritive value while young compared to older ones (Ahmed et al., 2009).

*Sesbania sesban* can be used as a green or hay for animals, because of its easy digestion and high protein content (23.8%) (Al-Hamdani, 2011). Many studies have looked at the impact of *Sesbania sesban* supplementation on the performance of small ruminants (Khalili and Varvikko 1991; Mekoya et al. 2009; Desta et al. 2016). It's been utilized as a supplement to low-quality tropical grasses and crop wastes, as well as a replacement for more expensive protein sources. These studies indicated that supplementing *Sesbania sesban* increased feed intake, digestibility, nitrogen retention, and animal performance, especially in small ruminants, which could be attributable to its low fiber fractions and high nitrogen content. The main objectives of the present study were to investigate the effects of feeding *sesbania sesban* and reed plants to sheep on nutrients digestibility, nitrogen retained, and rumen fermentation activities. Moreover, the nutritive value of these forage sources was tested in comparison with alfalfa.

## Material And Methods

### Animals, management and feeding

Twelve mature native rams were used in the digestibility trials. The rams were two years old and weighed approximately 50 0.25 kg. Rams were assigned to three treatments at random and kept in metabolic cages with free access to water during the trial. The trial lasted 22 days, including a 15-day adaption period followed by a 7-day faecal collection period. The animals in group one were fed a basic diet consisting of a 700 g concentrate mixture with fresh Alfalfa *ad libitum*, which was kept as a control. The second group (T1) was fed 700 g concentrates with fresh Sesban *ad libitum*, and the last one (T2) was offered 700 g concentrates with fresh reed forage *ad libitum*. According to the NRC (1985), the rations were formulated to meet the requirements of rams. The rams were fed 60% of their daily requirements as a concentrate mixture based on NRC recommendations, with the remaining coming from green fodder. The components compositions of the concentrate mixture were: 11 % Soybean meal, 21% wheat bran, 65% yellow corn, 2% limestone, and 1% salt. Moreover, the concentrate and forages (Alfalfa, Sesban, and reed forages) were analyzed chemically for the nutrient contents according to AOAC (2005). The chemical composition of these forage sources is shown in Table 1.

### Nutrient digestibility coefficient and nitrogen balance measurements

Daily feed intake of concentrate mixture and forages (Alfalfa, Sesban, and Reed forage) was estimated by subtracting residual feed from that offered during the feces collection period. Diet and aorta samples were obtained, dried, combined, and crushed through a 1mm screen before being stored for chemical analysis. Daily feces and urine samples were obtained from each ram, weighed promptly, mixed, and 10% of the total amount was preserved at  $-20^{\circ}\text{C}$ . The feces or urine samples of each animal were pooled, mixed, and 10% of the total amount was taken for chemical analysis at the end of the collection period. The feces were dried for 24 hours at  $60-70^{\circ}\text{C}$ , then milled through a 1mm mill screen and kept until chemical analysis.

The chemical analysis of feed residue and feces was carried out using protocols developed by (AOAC, 2005). The Goering and Van Soest (1970) techniques were used to determine neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL). The difference between NDF and ADF was used to calculate hemicellulose, whereas the difference between ADF and ADL was used to calculate cellulose. The change in nutrients content between consumed feed and feces as a proportion of their intake was used to determine nutrient digestibility. The feeding values in terms of total digestible nutrient (TDN) and digestible crude protein (DCP) were estimated using chemical analyses of ingredients and apparent digestibility of various nutrients in the consumed rations (McDonald et al., 2010). According to Maaf (1975), gross energy (GE) was calculated.

$$\text{GE MJ /Kg DM} = 0.0226 \times \text{CP (gm)} + 0.0407 \times \text{EE (gm)} + 0.0192 \times \text{CF(gm)} + 0.0177 \times \text{NFE (gm)}.$$

### **Rumen liquor parameters**

Samples of rumen fluids were obtained on two consecutive days after the digestibility trial's collection period ended. Samples were obtained right before feeding time, as well as 4 and 8 hours afterwards. The rumen fluid samples were separated into two parts, the first of which was filtered through one layer of cheesecloth before being counted for protozoa. The total protozoa count was performed according to Abou El-Naga (1967). Nonetheless, the second half was filtered through four layers of cheesecloth, and the filtrate was then utilized to measure pH with a digital pH meter right away (Beckman, model 45, USA), and ammonia N concentration was determined according to Chibnal and Williams (1943). Strained rumen liquid samples were acidified with 0.1 N hydrochloric acid and concentrated orthophosphoric acid to inhibit microbial activity before storage for analysis, and then stored frozen at  $-20^{\circ}\text{C}$  for total volatile fatty acid measurement (VFAs). Using Markham micro distillation equipment, the concentration of TVFAs was measured using the steam distillation method (Warner, 1964).

### **Statistical Analysis:**

The experimental design was complete randomly design. The data were statistically analyzed using general linear model (G.L.M) procedure of S.A.S (2001) program, version 8.2. One-way ANOVA was used to compare the digestibility, nitrogen retention, and nutritive values of the different groups. Duncan Multiple Range Test was used to determine whether there were significant variations in treatment means.

The data is presented as mean  $\pm$  SE. Probability less than 0.05 (P 0.05) was deemed significant. The following model was used,  $Y_{ij} = \mu + T_i + E_{ij}$

The Rumen liquid parameters data were analyzed according to the following statistical model.

$$Y_{ijk} = \mu + T_i + M_j + (TM)_j + E_{ijk}$$

Where,  $Y_{ij}$  = experimental observation,  $\mu$  = general mean,  $T_i$  = the effect of treatment,  $i$  = control, T1, T2,  $E_{ij}$  = the errors related to individual observation,  $M_j$  = the effect of time sampling after feeding,  $j$  = zero, four hours and eight hours,  $(TM)_j$  = interactions between time and treatment.

## Results

### Chemical composition of *Sesbania sesban* and reed forage

Chemical composition of *Sesbania sesban*, reed forage and Alfalfa are shown in table (1). Dry matter content of *Sesbania sesban* was about 18.61% higher than Alfalfa. Also, crude protein content of *Sesbania sesban* was higher than that of Reed plants by 24.57%. Moreover, the ash content of *Sesbania sesban* was about 62.54% and 85.85% lower than Alfalfa and reed plants, respectively. Crude protein of reed plants is lower than that of Alfalfa by about 21.83%. The reed forage contains a high percentage of fiber fractions (NDF and ADF) as compared with alfalfa and sesban.

### Dry matter intake, nutrients digestibility and nutritive value of experimental rations

The daily DM intake of rams fed different forages showed in Table 2. It was found that the daily intake of reed plants was lower ( $p < 0.05$ ) by about 24.05 and 30.62 % than that of alfalfa and sesban, respectively. However, the roughages and total DM intake of the rams fed alfalfa and *sesbania sesban* did not differ ( $p > 0.05$ ).

It was observed that the digestibility of different nutrients in all groups fed on different forages were almost similar. According to statistical analysis, there were no significant changes ( $P > 0.05$ ) among the groups of most nutrients (Table 2). However, the digestibility of NDF and ADF in *Sesbania sesban* group was significantly ( $P < 0.05$ ) lower than that of control and reed forage groups. While, no significant differences were detected between reed plants and control groups. Also, the digestibility value of cellulose and hemicellulose of reed forage group were 32% and 17.95 % higher than that of sesban group, respectively.

The nutritive value in terms of total digestible nutrients (TDN) was not significantly ( $P > 0.05$ ) affected among the groups, but it tendency increase in *Sesbania* group than the control and reed groups. However, the digestible crude protein (DCP) of the control and *Sesbania* groups was significantly ( $P < 0.05$ ) higher than that of reed group (Table 2).

### Nitrogen retention

The amount of N intake was higher ( $p<0.05$ ) in groups of rams fed alfalfa and *Sesbania* than in those fed reed grass group (Table 3). Therefore, the amount of digested nitrogen and N-retention in these groups was higher ( $p<0.05$ ) than those fed the reed grass group. However, there was no difference ( $p>0.05$ ) in the percentage of N-retained to N-intake or N-digested among groups.

### 2.3 Rumen fermentation activities

Data of ruminal pH,  $\text{NH}_3\text{-N}$ , TVFAs, and total protozoa count showed no significant variations among the groups (Table 4). However, the ruminal  $\text{NH}_3\text{-N}$  and TVFA's concentrations tended to be numerically lower in Reed forage group than other groups. Concerning the effect of sampling time on rumen liquor parameters, the mean values of pH were significantly ( $P<0.05$ ) higher before feeding time then decreased at 4 hrs. after feeding, and then increased again at 8 hrs after feeding. However, all of  $\text{NH}_3\text{-N}$  and TVFA's concentrations were lower before feeding and increased after feeding to reach the peak at 4 hrs. post feeding and then decreased again at 8 hrs. after feeding. There was no significant interactions between the treatments and time effect for ruminal pH,  $\text{NH}_3\text{-N}$  and TVFA's. The only significant ( $P<0.05$ ) interaction between treatment and time effect were found in total protozoa count.

## Discussion

### Chemical composition of *Sesbania sesban* and reed forage

The chemical composition of *Sesbania sesban*, Alfalfa, and reed plants differs due to differences in plant growth stage, cutting frequency, harvesting regimen, soil type, fertility status, parts of the plant (leaves, twigs, whole forage, and green pods) included during feeding, and environmental conditions in which the plant grows (Tekliye et al., 2018). The *Sesban* tree has high nitrogen content in its foliage and is a great protein supplement for roughage that is lacking in protein (Sabra et al., 2010; Manaye et al., 2009). This tree's leaves and branches provide significant levels of protein (ranging from 20 to 25 percent) that are easily digested by ruminants (Pravin et al., 2012). *Sesbania sesban* contain a high level of CP, indicating that it might be used to supplement protein in ruminant diets that were low or lacking in CP (Gebreyowhans and Zegeye, 2019). Reed grass had a moderate level of crude protein (12.25%), which was similar to that found (12.25%) by De la Cruz (1983). The higher percentage of fiber fractions (NDF and ADF) in reed forage than alfalfa and sesban may be due to its low CP content. Mahmoud et al. (2017) in a study, using some grass and legume, and other plants, found that the crude fiber and ether extract contents were high in the species that contained less protein and low in species with high protein content.

The chemical composition of sesban and reed forage in the present study was close to alfalfa or higher than it in some components. Hence, we can consider sesban and reed forage can be used as sources of protein and energy to feed lambs during the summer season. Moreover, the chemical compositions of *sesbania sesban* in our study are similar to those reported by ElKholany (2004), Zaki (2015), and El-Moghazy et al. (2017).

## Dry matter intake, Nutrient digestibility and nutritive value of experimental rations

The lower intake in the reed plant group than in other forage groups may be due to higher fiber contents in reed plants and low nitrogen, both of which limited dry matter intake (DMI). Moreover, the higher NDF (57.26%) contents of the reed plant are always negatively correlated with DMI (Mokhtarpour and Jahantigh 2018). However, the improved forage intake of rams fed on *Sesbania* and alfalfa may be attributed to its lower NDF and ADF and higher CP with more palatable parts and thus increased DM intakes (Tekliye et al. 2018). Similar results of feed intake were observed with growing lambs (Farghaly et al., 2022).

The higher nutrient digestibility of all forage types could indicate the benefits of combining concentrates with fodder like *Sesbania* and reed plants, which had moderate tannin levels. Tannin levels in *Sesbania* and reed forages are modest, which may help to slow down the rate of degradation of concentrate feeds. Our findings are consistent with those of Mekoya et al. (2009) and Nsahlai et al. (1999), who found that a ration with a moderate tannin content or a combination of rapidly degradable concentrates and forage legumes with moderate tannin levels can provide adequate levels of both rumen degradable and by-pass protein to ruminants. Mekoya et al. (2009) reported that replacing concentrate mixture by *Sesbania sesban* at level 47.5 and 95% as a source of protein in lamb diets increased DM, OM and N digestibility. The higher protein contents in all forage in this study particularly alfalfa and *Sesbania* may improve the nutrient digestibility. These results coincide with that of McDonald et al. (2010) found that including dietary protein in the supplement enhanced protein availability to rumen bacteria, allowing the digestion process to be sped up. Tekliye et al. (2018) reported that supplementing *Sesbania sesban* leaves to ration enhanced significantly apparent nutritional digestibility. Zaki (2015) stated that the digestion coefficients were affected by different factors such as animal species, activities of rumen microbes, feed components, and associated effects. The improvement in nutrients digestibility due to the associative effect between feeds was approved by ElKholany (2004) when comparing *Sesbania*-corn in both forms fresh and silage than other treatments. Also, he attributed the improved digestibility of CP due to higher CP content in *Sesbania* forage than corn plants in both forms fresh and silage as well as the differences in chemical nature of each protein of each forage.

It could be noticed that the nutrient digestibility of the reed forage group tended to be lower than the control and *Sesbania* groups. However, the digestibility of NDF and ADF were significantly ( $P < 0.05$ ) higher than that of the control and *Sesbania* groups. The improvement in the digestibility of the structural carbohydrates of the reed forage group may be attributed to reducing the intake level which decreased the passage rate and exposed the feed to microbial attack for a long time (Fenner et al., 1966). Moreover, the higher protozoa count in the rumen liquor of the reed forage group (Table 4) may be participating in improving the digestibility of fiber fractions. McSweeney and Mackie (2012) reported that protozoa are responsible for 30–40% of overall fiber digestion under specific conditions. The same author also stated that protozoa are also involved in lipid hydrolysis and are thought to account for 30-40% of total ruminal activity. Previous studies have shown that the nutrients digestibility of fresh reed forage can be improved by ensiling it as a result of improved digestion of the plant cell wall components (Saeed and Al-Sultani,

2017; Hassan et al., 2009), or by adding yeast culture and urea during the ensiling process (Saeed, 2015; Saeed and Al-Sultani, 2017; Mokhtarpour and Jahantigh, 2018), which stimulates the rumen bacterial activity leading to increased ruminal digestion and improved DM, OM, CP, NDF, and ADF digestibility rates.

The higher DCP value of Alfalfa and Sesbania rations may be due to increasing nitrogen content in Alfalfa and Sesbania. Similar results have been reported by Zaki (2015) who attributed the improvement in the DCP value of ration-contained concentrate feed mixture with Sesbania due to an increased digestibility of CP. Jayanegara et al. (2010) found that the addition of *S. sesban* leaves to concentrate-based diets dramatically reduced in vitro CH<sub>4</sub> generation, implying enhanced protein utilization. Also, the value of TDN is differing as a result of different chemical compositions and nutrient digestibility of rations. These results were confirmed by Ahmed et al. (2017) who found that the feeding value expressed as TDN and DCP was improved with feeding *Sesbania Sesban* and corn silage when compared with other treatments.

It could be observed that the nutritive value of the reed plant ration tended to be lower than other forage sources. Moreover, the feeding value of reed forage was varying according to the maturity phase and parts of the plant. Al-Sodany et al. (2012) stated that the nutritive value and content of nutrients of reed forage was better in younger plants than the older ones and in leaves than stems, which had a strong relationship with the digestibility of the plant. Furthermore, many previous studies approved that the nutritive value in terms of TDN and DCP of *Sesbania sesban* and reed forage can be improved by ensilage or ensilage with additive other forage plants (Shehata et al., 2006; Zaki, 2015; Ahmed et al., 2017; El-Moghazy et al., 2017).

### **Nitrogen retention**

Rams fed reed grass retained less nitrogen than rams fed alfalfa or sesbania. This could be attributed to lower nitrogen intake as a result of lower reed forage DM intake. However, the percentage of N-retained to N-intake or N-digested in the reed forage group was similar to that of the alfalfa and sesbania groups. The increased nitrogen retention in rams fed alfalfa and sesbania could be related to increased CP intake and digestibility, or it could be connected to improved rumen fermentation (Zaki, 2015).

### **Rumen liquor parameters:**

It could be observed that the rumen pH tended to be lower with feeding alfalfa than in other groups. This is maybe due to an increase in TVFA's production in this group compared with other groups. These results agree with that reported by Zaki (2015) who stated that the pH values were affected by different factors such as drinking water, ruminal ammonia, and TVFA's. Similarly, ElKholany (2004) reported that the main reason for decreasing rumen PH is mainly due to the increase in TVFA's production in the rumen. El-Moghazy et al. (2017) found that the highest concentration of total TVFA occurred at 4 hours after feeding, which was revealed in a decrease in pH values at that time.

It could be noticed that the values of NH<sub>3</sub> and TVFA's concentrations in rumen fluid decreased with feeding reed forage as compared with other groups, which may be attributed to its lower content of crude protein. ElKholany et al. (2018) found that the differences in rumen ammonia: N concentrations among treatments are correlated with differences in CP content in different roughage feeds. Moreover, Fenner et al. (1966) found that the rate and level of ammonia production were directly related to the solubility of the N- the source of the feed and the proportion of protein of the all-roughage ration. Also, the results showed that there was a significant effect of sampling times for all treatments on NH<sub>3</sub> and TVFA's concentrations which reached to peak at 4 hours after feeding. This peak was noticed by Shehata et al. (2006) who found that the peak of pH values, NH<sub>3</sub>-N, and TVFA's ammonia concentrations appeared at 3 hrs post-feeding, these results were noticed when fed Zaraibi bucks reed forage in the form of silage or hay. Moreover, the reduction in the ammonia levels in the rumen at 8 hrs after feeding probably reflects the uptake of this nutrient by the rapidly growing microbial population (Losada et al., 1979). The significant effects among times for all treatments on NH<sub>3</sub> and TVFA's may be related to the digestion of forages by microorganisms in rumen after feeding and absorption of them after that by rumen cell and used by microorganisms to produce micro-protein. This action is important for rumen nitrogen recycling and protein synthesis efficiency (McSweeney and Mackie, 2012).

The total protozoa count was decreased by about 24.6% of *Sesbania* group as compared with groups fed on alfalfa and reed forage. The results obtained are consistent with the findings of Newbold et al. (1997) who stated that *sesbania sesban* was toxic to rumen protozoa and that this was due to the saponin-containing component of the plant. The total protozoa count was increased at 4 hrs. after feeding than before feeding. These results were confirmed by Zaki (2015) when fed first and second cuts of *sesbania sesban ad liptum*. Similarly, Nhan (1998) found that the protozoa number of growing goats fed *Sesbania grandiflora* was 4.38 and 4.56 10<sup>6</sup>/ ml for 0 and 4 hours after feeding, respectively. Aziz et al. (2018) reported that there was an increase in the protozoa number and improving in the rumen liquor parameters with the increase in roughage ratio in the diets.

## Conclusion

The chemical analysis, nutritive value and nutrient digestibility of *sesban* and reed forage in the present study were close to that of alfalfa or higher than it. Also, the rumen fermentation activities and the total protozoa count were improved by feeding these forages sources, particularly *Sesbania sesban*. Therefore, it can be recommended to use these unconventional forages (*Sesbania sesban* and reed plants) in diets of sheep as alternatives sources of alfalfa.

## Declarations

- i. **Funding:** Not applicable
- ii. **Conflict of interest:** The authors declare no competing interests.

- iii. **Ethics approval:** All the experimental procedures and the study protocol have been approved by the National Animal Care and Use Committee, and the experiments were performed in accordance with the internationally accepted standard ethical guidelines for animal use and care.
- iv. **Consent to participate:** Not applicable.
- v. **Consent for publication:** Not applicable.
- vi. **Availability of data and material:** The data of this study are available from the corresponding author upon reasonable request.
- vii. **Code availability:** Not applicable.
- viii. **Author contribution:** M. Farghaly, S. M. Mousa, M. A. Abd El-monaime, A. I. Suliman and H. A. Hamdon shared in designing the experimental plan, evaluation of the results, and writing of the manuscript. M. M. Farghaly, M. A. Abd El-monaime, A. I. Suliman and H. A. Hamdon participated in collection and analyses of the samples. M. M. Farghaly and S. M. Mousa contributed in reviewing, finalization, and publication of this paper.

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## Tables

**Table (1): Chemical composition (%) of alfalfa, *sesbania sesban*, reed plants and CFM (as DM basis).**

| Item, %                     | Alfalfa | Sesban | Reed  | CFM   |
|-----------------------------|---------|--------|-------|-------|
| Dry matter (DM)             | 31.33   | 37.16  | 33.08 | 94.79 |
| Organic matter (OM)         | 89.89   | 93.78  | 88.44 | 85.8  |
| Crude protein (CP)          | 15.67   | 16.24  | 12.25 | 14.56 |
| Crude fiber (CF)            | 21.64   | 18.69  | 22.80 | 8.82  |
| Ether extract (EE)          | 3.56    | 3.86   | 3.27  | 5.34  |
| Nitrogen free extract (NFE) | 49.02   | 54.99  | 50.12 | 57.08 |
| Ash                         | 10.11   | 6.22   | 11.56 | 14.20 |
| NDF                         | 32.73   | 24.69  | 57.26 | 14.71 |
| ADF                         | 19.63   | 22.08  | 29.90 | 2.70  |
| Cellulose                   | 9.46    | 11.64  | 22.04 | 1.29  |
| Hemicellulose               | 13.10   | 2.61   | 27.36 | 12.01 |
| ADL                         | 10.17   | 10.44  | 7.86  | 1.41  |
| Gross energy (MJ /Kg DM)    | 17.82   | 18.56  | 17.35 | 17.26 |

CFM: Concentrate feed mixture

**Table (2): Effect of feeding *Sesbania sesban* and reed plants to ram's on dry matter intake, nutrient digestibility rates and nutritive values of experimental rations fed to sheep.**

| Item %                   | Treatment                    |                              |                              | P-Value |
|--------------------------|------------------------------|------------------------------|------------------------------|---------|
|                          | Control                      | T1                           | T2                           |         |
| DM intake g/h/d*         |                              |                              |                              |         |
| Concentrate              | 663.53                       | 663.53                       | 663.53                       | -       |
| Roughage                 | 923.32 <sup>a</sup> ± 71.15  | 1010.83 <sup>a</sup> ± 64.80 | 701.30 <sup>b</sup> ± 40.25  | 0.026   |
| Total DM intake          | 1586.85 <sup>a</sup> ± 71.15 | 1674.36 <sup>a</sup> ± 64.80 | 1364.83 <sup>b</sup> ± 40.25 | 0.026   |
| Nutrient digestibility,% |                              |                              |                              |         |
| DM                       | 82.92 ± 2.05                 | 82.51 ± 1.19                 | 80.49 ± 3.28                 | 0.744   |
| OM                       | 84.73 ± 1.85                 | 83.60 ± 1.11                 | 81.60 ± 3.71                 | 0.682   |
| CP                       | 82.07 ± 2.38                 | 80.98 ± 0.98                 | 79.93 ± 2.74                 | 0.793   |
| CF                       | 78.13 ± 3.49                 | 80.45 ± 2.21                 | 80.29 ± 4.43                 | 0.874   |
| EE                       | 83.94 ± 2.37                 | 79.33 ± 0.36                 | 83.15 ± 2.45                 | 0.300   |
| NFE                      | 87.63 ± 1.22                 | 85.51 ± 1.01                 | 82.27 ± 3.85                 | 0.350   |
| NDF                      | 70.40 <sup>a</sup> ± 4.49    | 53.62 <sup>b</sup> ± 4.54    | 78.96 <sup>a</sup> ± 5.21    | 0.024   |
| ADF                      | 60.26 <sup>ab</sup> ± 5.71   | 46.50 <sup>b</sup> ± 4.05    | 72.12 <sup>a</sup> ± 5.26    | 0.032   |
| Cellulose                | 58.53 ± 9.31                 | 52.71 ± 2.92                 | 77.56 ± 10.26                | 0.160   |
| Hemocel.                 | 80.42 ± 4.63                 | 69.49 ± 8.70                 | 84.69 ± 5.32                 | 0.302   |
| ADL                      | 31.85 ± 3.67                 | 9.68 ± 1.25                  | 28.30 ± 4.10                 | 0.139   |
| Nutritive value,%        |                              |                              |                              |         |
| TDN                      | 79.22 ± 1.72                 | 80.16 ± 1.11                 | 75.56 ± 3.37                 | 0.381   |
| DCP                      | 12.48 <sup>a</sup> ± 0.34    | 12.61 <sup>a</sup> ± 0.16    | 10.69 <sup>b</sup> ± 0.34    | 0.172   |

<sup>a,b</sup> Means within the same row bearing different superscripts differ significantly (p<0.05).

Control: Lambs fed alfalfa, T1: Lambs fed *Sesbania sesban*, T2: Lambs fed reed forage

\* g/h/d: gram/head/day.

**Table (3): Nitrogen balance of rams fed on *Sesbania sesban* and reed plants**

| DM intake (g)             | Treatment                 |                           |                           | P-Value |
|---------------------------|---------------------------|---------------------------|---------------------------|---------|
|                           | Control                   | T1                        | T2                        |         |
| N-intake, g               | 38.60 <sup>a</sup> ± 1.79 | 41.68 <sup>a</sup> ± 1.68 | 29.14 <sup>b</sup> ± 1.54 | 0.002   |
| Fecal-N, g                | 7.39 ± 1.28               | 8.43 ± 0.41               | 6.15 ± 0.69               | 0.259   |
| N-digested, g             | 31.18 <sup>a</sup> ± 0.53 | 33.25 <sup>a</sup> ± 1.59 | 22.99 <sup>b</sup> ± 1.40 | 0.003   |
| Urinary-N, g              | 4.38 ± 0.59               | 4.26 ± 0.20               | 3.08 ± 0.38               | 0.131   |
| N-Retained, g             | 26.80 <sup>a</sup> ± 0.21 | 28.98 <sup>a</sup> ± 1.54 | 19.91 <sup>b</sup> ± 1.69 | 0.006   |
| N-Retained / N-intake,%   | 69.81 ± 3.59              | 69.50 ± 1.45              | 68.65 ± 4.32              | 0.933   |
| N-Retained / N-digested,% | 86.01 ± 1.69              | 87.14 ± 0.72              | 86.36 ± 2.46              | 0.900   |

<sup>a,b</sup> Means within the same row bearing different superscripts differ significantly (p<0.05).

Control: Lambs fed alfalfa, T1: Lambs fed *Sesbania sesban*, T2: Lambs fed reed forage

**Table: (4) Effect of feeding *Sesbania sesban* and reed plants on rumen fermentation activities**

| Item                                        | Treatment | Hours after feeding      |                           |                           | Means of treatment | P-value |
|---------------------------------------------|-----------|--------------------------|---------------------------|---------------------------|--------------------|---------|
|                                             |           | zero                     | 4 hours                   | 8 hours                   |                    |         |
| PH                                          | Control   | 7.34 ± 0.05              | 6.15 ± 0.15               | 7.29 ± 0.26               | 6.92 ± 0.21        | 0.529   |
|                                             | T1        | 7.30 ± 0.08              | 6.45 ± 0.05               | 7.45 ± 0.13               | 7.06 ± 0.16        |         |
|                                             | T2        | 7.29 ± 0.06              | 6.39 ± 0.28               | 7.46 ± 0.18               | 7.05 ± 0.19        |         |
| Means of time                               |           | 7.31 <sup>a</sup> ± 0.03 | 6.33 <sup>b</sup> ± 0.10  | 7.4 <sup>a</sup> ± 0.10   |                    |         |
| P- value                                    | 0.001     |                          |                           |                           |                    | 0.848   |
| NH3 mg/100ml                                | Control   | 6.08 ± 2.09              | 17.19 ± 7.06              | 6.82 ± 2.15               | 10.03 ± 2.85       | 0.753   |
|                                             | T1        | 5.48 ± 1.32              | 17.94 ± 7.58              | 6.37 ± 1.41               | 9.93 ± 3.02        |         |
|                                             | T2        | 5.93 ± 1.29              | 11.27 ± 2.57              | 6.67 ± 0.68               | 7.96 ± 1.19        |         |
| Means of time                               |           | 5.83 <sup>b</sup> ± 0.81 | 15.47 <sup>a</sup> ± 3.27 | 6.62 <sup>b</sup> ± 0.77  |                    |         |
| P- value                                    | 0.001     |                          |                           |                           |                    | 0.855   |
| TVFA meq/100ml                              | Control   | 8.49 ± 0.55              | 19.96 ± 2.35              | 10.84 ± 0.27              | 13.09 ± 1.88       | 0.271   |
|                                             | T1        | 8.48 ± 0.55              | 16.03 ± 2.88              | 13.20 ± 2.18              | 12.57 ± 1.52       |         |
|                                             | T2        | 6.91 ± 0.31              | 17.13 ± 1.50              | 9.12 ± 0.31               | 11.05 ± 1.62       |         |
| Means of time                               |           | 7.96 <sup>c</sup> ± 0.36 | 17.7 <sup>a</sup> ± 1.3   | 11.05 <sup>b</sup> ± 0.87 |                    |         |
| P- value                                    | 0.001     |                          |                           |                           |                    | 0.346   |
| Total protozoa count (×10 <sup>6</sup> /ml) | Control   | 1.98 <sup>b</sup> ± 0.32 | 3.17 <sup>a</sup> ± 0.70  | 2.43 <sup>a</sup> ± 0.24  | 2.53 ± 0.29        | 0.207   |
|                                             | T1        | 2.77 <sup>a</sup> ± 0.46 | 1.57 <sup>b</sup> ± 0.11  | 1.74 <sup>ab</sup> ± 0.12 | 2.03 ± 0.24        |         |
|                                             | T2        | 2.19 <sup>b</sup> ± 0.40 | 3.29 <sup>a</sup> ± 0.19  | 2.09 <sup>a</sup> ± 0.47  | 2.52 ± 0.27        |         |
| Means of time                               |           | 2.32 ±                   | 2.68 ±                    | 2.08 ±                    |                    |         |

|                 |       |      |      |      |
|-----------------|-------|------|------|------|
|                 | 0.23  | 0.35 | 0.19 |      |
| <b>P- value</b> | 0.187 |      |      | 0.03 |

<sup>a,b,c</sup> Means within the same row bearing different superscripts differ significantly ( $p < 0.05$ ).

Control: Lambs fed alfalfa, T1: Lambs fed Sesbania sesban, T2: Lambs fed reed forage