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# Feeding Value of Different Levels of Leucaena Hay and Coconut Oil Meal as a Supplementary Feed for Goats

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***ABSTRACT.*** *Feeding value of five supplementary diets consisting of coconut oil meal (COM) and leucaena hay (LH) at the ratios of 100/00 (T1), 75/25 (T2), 50/50 (T3), 25/75 (T4), 00/100 (T5) and control diet (T0) as Guinea grass only, were studied under intensive conditions using cross bred (Local × Jamnapari) male goats. Replacement of coconut oil meal with leucaena hay supplemented up to 50%, increased ration dry matter intake (g/kg $BW^{0.75}$) from 64.4 to 80.9. Digestibility of drymatter, organic matter and crude protein were highest when LH was substituted at 50% level, with digestibility values of 80.6, 82.6 and 86.7%, respectively. Average daily weight gain (g/head/d) increased from 35.6 to 113.5 at 50% of leucaena substitution. The concentration (mg/dl) of rumen volatile fatty acids, rumen ammonia nitrogen and blood urea nitrogen also showed the highest values of 11.2, 23.0, 35.2 mg/dl, respectively, when LH was substituted at 50% level. Daily nitrogen retention increased from 6.3 to 11.4 g/day as level of LH substitution increased up to 50%. In all treatments animals performed in a positive nitrogen balance. It was concluded that leucaena hay can be used to supplement coconut oil meal up to 50% level of substitution.*

## INTRODUCTION

Although goat production at present is not a profitable industry in Sri Lanka, a high potential exists due to high demand for goat meat both in rural and urban areas. Under many agricultural systems goats are preferred to cattle due to smaller body size and lower feed requirement, early maturity and shorter generation interval, superior prolificacy, ready market, easy management, low inputs and less capital investment.

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At present, goats are mainly raised on the biomass available in natural grazing lands, where the quality of the feed is poor. This adversely affect the growth and reproductive performance of goats. To improve the production performance supplementation of feed is necessary. Coconut oil meal and rice bran are the major feed constituents used for supplementation. However, compared to the input price the resultant income at present is not satisfactory. Although considerable amount of coconut oil meal is produced as a by-product of coconut oil industry, it is greatly demanded by the poultry industry. Therefore, finding a cheap natural protein substitute has become vital. Leucaena hay is freely available and provides a valuable source of supplemental energy and protein (Devendra, 1982), and may be a better alternative for coconut oil meal in ruminants.

The objectives of this study are to investigate the possibility of substituting Leucaena hay for Coconut Oil Meal, the optimum substitution level and the effect of substitution on rumen fermentation characteristics and blood constituents.

## MATERIALS AND METHODS

This experiment was conducted at the Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka using twenty four (24) young cross bred goats (Local × Jamnapari). Goats were grouped by weight (15 ± 1.7 kg), and were kept in individual metabolic cages. Treatments were arranged in a randomized complete block design with four replicates.

The experimental period consisted of 10 days transition period, 10 days adaptation period, followed by a 10 days total collection period. All animals were given a basal diet of fresh medium quality (CP; 12%) Guinea grass (*Panicum maximum*, ecotype A) *ad libitum*, offered from 0800 h to 1600 h. The test diets consisted of different proportions of coconut oil meal (COM) and leucaena hay (LH) at the ratios of 100/00 (T1), 75/25 (T2), 50/50 (T3), 25/75 (T4) and 00/100 (T5), respectively. The test diets were offered from 1600 h to 0800 h, while for the control diet, grass was offered continuously. Feed offered and refusals were recorded daily at each feeding. All animals were given free access to clean drinking water throughout the experimental period. Samples of feed offered and refusal were collected for chemical analysis. Urine was collected in plastic buckets containing 50 ml of 25% hydrochloric acid and measured daily in the morning and 10% aliquots were taken as a sub sample from each goat in each treatment. Daily faecal samples were collected and dried at 60°C for analysis. After ten days of collection period, rumen liquor samples (approximately 50 ml) were obtained from each animal at 4 h post-feeding of the test diet. Rumen samples were drawn using a mouth tube and were strained through a double layer of cheese cloth. The pH of the rumen liquor was measured electrometrically immediately after straining. Blood samples were drawn from jugular vein through veni puncture.

All dried samples of feeds, refusals and faeces were ground to pass a 2-mm screen and analyzed for dry matter (DM), organic matter (OM) and crude protein (CP) according to standard procedures (AOAC, 1980). Feed and faeces samples were also analyzed for acid detergent fibre (ADF), acid detergent lignin (Georing and Van Soest, 1970) and acid insoluble ash (Van Keulen and Young, 1977). Faeces and urine samples were analysed for nitrogen content by the Kjeldhal method (AOAC, 1980). *In vivo* digestibility of each component was determined by the difference of intake and output ratio. Rumen fluid samples were analysed for rumen ammonia-N (Conway, 1958) and the total volatile fatty acids. Blood samples were analysed for blood urea nitrogen (Coulombe and Favreau, 1963). Data were statistically analysed using analysis of variance (Steel and Torrie, 1980) and mean separation was done by Duncan multiple range test (Snedecor and Cochran, 1968), using SAS package (1985).

## RESULTS AND DISCUSSION

### Composition of the supplementary diets

The proximate composition of the diets are presented in Table 1. The dry matter content ranged from 91.9–93.2% (92.6±0.5), organic matter from 77.4–85.5% (81.7±2.6), ash from 7.7–14.5% (10.7±2.3), and the crude protein from 12.2–25.9% (22.5±5.2). The ADF ranged from 15.2–39.3% (23.5±9.6) and cellulose from 10.8–30.8% (16.5±7.2).

### Dry matter intake and nutrient digestibility

The dry matter intake (DMI) of goats fed with different diets are given in the Table 2. The average daily total DMI ranged from 348.5 to 593.4 g between treatments. The lowest DMI of 2.2% of the body weight (corresponding to 44.9 g/kg $BW^{0.75}$) was recorded in goats fed grass alone, while the maximum intake of 3.9% of the body weight (corresponding to 80.9 g/kg $BW^{0.75}$) was recorded in goats fed diet T3 (50% COM : 50% LH). These

**Table 1. Proximate and cell wall composition of the ingredients, concentrate diets and guinea grass (% dry matter basis).**

| | Ingredients | | Test Diets | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Constituents | COM | LH | T0 | T1 | T2 | T3 | T4 | T5 | Mean | ± SD |
| DM | 91.9 | 92.4 | 91.9 | 91.9 | 92.4 | 93.2 | 92.9 | 92.4 | 92.6 | 0.5 |
| OM | 82.4 | 80.8 | 77.4 | 82.4 | 82.0 | 85.5 | 82.2 | 80.8 | 81.7 | 2.6 |
| Ash | 9.5 | 11.6 | 14.5 | 9.5 | 10.4 | 7.7 | 10.7 | 11.6 | 10.7 | 2.3 |
| CP | 22.3 | 25.7 | 12.2 | 22.3 | 23.8 | 25.9 | 24.8 | 25.7 | 22.5 | 5.2 |
| NDF | 34.8 | 49.5 | 67.0 | 34.8 | 39.1 | 42.0 | 45.3 | 49.5 | 46.3 | 11.3 |
| ADF | 15.2 | 23.6 | 39.3 | 15.2 | 19.4 | 20.5 | 23.1 | 23.6 | 23.5 | 9.6 |
| AIA | 0.3 | 2.1 | 3.6 | 0.3 | 1.7 | 2.6 | 2.1 | 2.1 | 2.1 | 1.1 |
| Cellulose | 10.8 | 16.5 | 30.8 | 10.8 | 13.2 | 12.9 | 15.5 | 15.6 | 16.5 | 7.2 |
| Hemicellulose | 19.6 | 25.9 | 27.7 | 19.6 | 19.7 | 21.5 | 22.2 | 25.9 | 22.8 | 3.3 |

T0 = Guinea grass alone
T1 - T5 = Concentrate feeds with different proportions of COM and LH

values were within the reported range from 32 to 130 g of DMI/kg $BW^{0.75}$ per day for goats consuming tropical forages and forages supplemented with concentrates (Norton. 1984; Upadhya *et al.* 1974). Significant (P<0.05) differences were observed in the daily dry matter intake of goats fed on different diets.

*In vivo* dry matter digestibility (DMD), organic matter digestibility (OMD) and crude protein digestibility (CPD) of the diets are given in Table 2. Significant (P<0.05) differences were observed between treatments (P<0.05). The DMD ranged from 41.9–80.6% while OMD value were 46.8–82.6% between different diet mixtures. The digestibility of CP ranged from 48.4–86.7%. Digestibility of organic matter and crude protein was higher for diet that composed of 50% COM + 50% LH. However, DMD, OMD and CPD did not significantly differ between the treatments of 75% COM + 25% LH

**Table 2. Dry matter intake, digestibility co-efficients and weight gain of goats fed on guinea grass with or without concentrates of different proportions of COM and LH.**

| | Test Diet | | | | | | |
|---|---|---|---|---|---|---|---|
| Item | T0 | T1 | T2 | T3 | T4 | T5 | ± SE |
| Dry Matter Intake (g/head/d) | | | | | | | |
| Grass | 348.5 | 268.5 | 232.2 | 196.2 | 193.6 | 256.9 | 13.5 |
| Concentrates | - | 265.6 | 361.4 | 397.2 | 353.9 | 151.8 | 36.8 |
| Total | $348.5^{d}$ | $533.9^{b}$ | $593.4^{a}$ | $593.4^{a}$ | $547.5^{b}$ | $408.7^{c}$ | 24.1 |
| $g/kg^{0.75}$ Body Weight | $44.9^{d}$ | $64.4^{b}$ | $78.1^{a}$ | $80.9^{a}$ | $70.2^{b}$ | $55.2^{c}$ | 03.3 |
| kg/100kg Body Weight | 2.2 | 3.3 | 3.4 | 3.9 | 3.8 | 2.8 | 00.1 |
| Digestibility co-efficient (%) | | | | | | | |
| Dry matter | $41.9^{d}$ | $80.6^{a}$ | $80.6^{a}$ | $80.6^{a}$ | $77.5^{b}$ | $66.0^{c}$ | 03.6 |
| Organic matter | $46.8^{d}$ | $82.4^{a}$ | $80.7^{a}$ | $82.6^{a}$ | $79.4^{b}$ | $67.4^{c}$ | 04.1 |
| Crude protein | $48.4^{c}$ | $82.7^{a}$ | $85.8^{a}$ | $86.7^{a}$ | $78.7^{b}$ | $71.6^{c}$ | 04.2 |
| Weight gain (g/h/d) | $20.0^{d}$ | $89.3^{b}$ | $112.3^{a}$ | $113.5^{a}$ | $90.6^{b}$ | $35.6^{c}$ | 09.4 |

Means in the same row bearing the same superscript are not significantly different ($P<0.05$).

and 50% COM + 50% LH. It has been reported that the apparent digestibility of CP increases with increasing levels of nitrogen in the diet of ruminants (Perera and Perera, 1996) since essential nutrients for microorganisms also increase with more protein resulting in an increased digestibility (Ranjhan, 1990). Increasing nitrogen containing constituents in the diet improves the soluble nitrogen fraction in the diet, thus maintaining an optimum rumen ammonia nitrogen level for efficient rumen microbial function.

## Rumen parameters and blood urea nitrogen

The results of rumen parameters and blood urea nitrogen are presented in Table 3. Goats fed with diet T3 (50% COM + 50% LH) recorded relatively higher total volatile fatty acid concentrations (11.2 mg/dl) in the rumen fluid. Church (1976), observed that increasing amounts of carbohydrates and protein supplement tend to result in higher volatile fatty acid levels. Low TVFA concentration found in goats fed with only grass may be the result of either low soluble carbohydrate and protein level or decreased digestibility of the soluble carbohydrates.

**Table 3. Effects of Guinea grass supplemented with or without concentrate of different proportions of COM and LH on rumen parameters and blood urea nitrogen.**

| Parameters | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | T4 | T5 | ± SE |
| TVFA (mg/dl) | 6.9 | $8.2^{a}$ | $10.4^{a}$ | $11.2^{a}$ | $8.5^{a}$ | $7.6^{b}$ | 0.3 |
| RAN (mg/dl) | 9.2 | $18.8^{b}$ | $22.8^{a}$ | $23.0^{a}$ | $18.9^{a}$ | $14.2^{c}$ | 1.3 |
| pH | 6.8 | $6.9^{a}$ | $6.9^{a}$ | $6.9^{a}$ | $6.7^{a}$ | $6.9^{a}$ | 0.01 |
| BUN (mg/dl) | 20.0 | $31.8^{a}$ | $34.1^{a}$ | $35.2^{a}$ | $31.9^{a}$ | $28.3^{b}$ | 1.3 |

Means in the same row bearing the same superscript are not significantly different ($P<0.05$).

TVFA = Total volatile fatty acids    RAN = Rumen ammonia nitrogen
BUN = Blood Urea Nitrogen

Rumen ammonia concentration ranged from 9.2 – 23 mg/dl between different treatments. Ammonia nitrogen level was significantly ($P<0.05$) higher (23 mg/dl) in T3 (50% COM + 50% LH) treatment than other treatments. The increased rumen ammonia concentration is attributed to the greater intake of nitrogen (20.3 g/d) by these animals (Table 4). Furthermore, the presence of higher ammonia nitrogen content indicated that the crude protein in the diet T3 was easily degraded and hydrolysed in the rumen compared to other diets possibly due to increased solubility of protein. However, animals in all treatments maintained an optimum level of rumen ammonia nitrogen level for efficient microbial activity (Hoover, 1986; Perera and Perera, 1996). The rumen pH is of importance for the digestion of cell wall constituents. It has been shown *in vivo* (Mould and Orskov, 1983) that cellulase activity and hence the fermentation of fibre decreases with a reduction in pH and is negligible when pH is less than 6. The pH in the rumen is inversely related to the TVFA concentration. The differences in rumen pH were minimal and non-significant (P<0.05) between different diets. However, it was not possible to find a relationship between rumen pH with TVFA and ammonia-N concentrations in the rumen using the results of different treatments. This may be due to the buffering capacity of the rumen liquor. The levels of blood urea concentration ranged from 20.0-35.2 mg/dl. When the ammonium nitrogen concentration increases blood urea nitrogen level also tended to increase.

**Table 4. Nitrogen balance of goats fed Guinea grass with or without concentrates of different proportions of COM and LH.**

| Item | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | T4 | T5 | ± SE |
| Nitrogen Intake (g/d) | | | | | | | |
| Grass | 6.7 | 5.7 | 4.5 | 3.8 | 3.7 | 5.0 | 0.3 |
| Concentrates | - | 9.4 | 13.8 | 16.5 | 14.0 | 6.2 | 1.0 |
| Total | 6.7 | 15.1 | 18.3 | 20.3 | 17.7 | 11.2 | 1.2 |
| Nitrogen Excretion (g/d) | | | | | | | |
| Faecal | 3.7 | 3.7 | 3.3 | 3.8 | 4.1 | 6.0 | 0.2 |
| Urinary | 1.8 | 5.1 | 5.0 | 5.1 | 5.0 | 2.1 | 0.4 |
| Total | 5.5 | 8.8 | 8.3 | 8.9 | 9.1 | 8.1 | 0.3 |
| Retention (g/d) | +1.2[e] | +6.3[c] | +10.0[a] | +11.4[a] | +8.6[b] | +3.1[d] | 0.9 |
| Retention as % intake | 17.9 | 41.4 | 54.6 | 56.2 | 48.6 | 27.6 | 3.6 |

Means in the same row bearing the same superscript are not significantly different (P<0.05)

## Nitrogen balance

The results of the nitrogen balance experiment are presented in Table 4. Nitrogen intake, excretion and retention increased as the level of LH increased in the diet T3 (50% COM + 50% LH). This is due to increased protein levels in the diet. A similar trend has been observed by Reynold (1981) in Malawi goats. In all treatments, animals maintained a positive nitrogen balance irrespective to the treatment.

## CONCLUSIONS

The results revealed that indices related to feed intake, digestibility, rumen parameters such as total volatile fatty acids and rumen ammonia, blood parameters and nitrogen balance had higher values in all five treatments (with concentrates) compared to control (without concentrates) diets. Among the treatments, diet T3, where 50% of COM was substituted by LH, performed better than other treatments. Therefore, it can be concluded that leucaena hay could be supplemented to replace expensive COM up to 50% in concentrate diets for ruminants.

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