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Effect of partial replacement of concentrate with hedge lucerne and mulberry leaves on growth performance and economics of production in Malabari kids#

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Abstract

Feed cost was the major limiting factor affecting profitability in goat production systems, particularly under smallholder conditions. The present study evaluated the effect of partial replacement of concentrate mixture with hedge lucerne (Desmanthus virgatus) and mulberry (Morus alba) leaves on growth performance and techno-economics of Malabari kids. Eighteen healthy Malabari kids (four months of age) were randomly allotted to three dietary treatments: control (100% concentrate), 50% concentrate replacement and 75% concentrate replacement using equal proportions of hedge lucerne and mulberry leaves. Dry matter intake remained comparable across all treatment groups throughout the experimental period, indicating good palatability and acceptance of the experimental diets. Body weight increased progressively in all groups, and no significant differences were observed among treatments at any stage of growth. The absence of growth depression in kids receiving tree fodder-based diets suggests that hedge lucerne and mulberry leaves adequately supported nutrient requirements when used as partial substitutes for concentrate. Economic analysis revealed a marked reduction in feed cost with increased levels of concentrate replacement. The feed cost per kilogram live weight gain was economical in the 50% replacement group, indicating improved cost efficiency without compromising growth performance. Although the 75% replacement group further reduced concentrate usage, marginally lower weight gain affected overall economic returns. The findings demonstrated that replacing up to 50% of concentrate with hedge lucerne and mulberry leaves was a viable feeding strategy for Malabari kids, offering comparable growth performance along with improved economic efficiency.

Keywords: *Growth performance, hedge lucerne, Malabari goats*, *mulberry leaves, techno economics*

Feed cost is the most critical factor determining profitability in small ruminant production systems, accounting for up to 70% of total expenses. In tropical regions, dependence on concentrate mixtures poses challenges due to high cost and limited availability. To overcome this, the incorporation of locally available, nutritionally rich and sustainable feed

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resources such as tree leaves and leguminous forages has gained considerable attention. Mulberry (*Morus alba*) leaves are highly palatable and serve as a good source of crude protein (15–25%) and digestible nutrients. Hedge lucerne (*Desmanthus virgatus*), a perennial legume, provides superior protein quality and adequate mineral content, improving growth and feed efficiency when used in livestock diets. Several authors have reported that partial replacement of concentrate mixture with these forages in goats enhances performance without adversely affecting intake or digestibility (Aganga and Tshwenyane, 2004; Ebrahim et al., 2017). The Malabari goat, native to Kerala, is an important dual-purpose breed valued for meat production. However, feeding management remains a major constraint in its productivity. Limited scientific data exist on the combined use of hedge lucerne and mulberry leaves as substitute feed resources in indigenous goat breeds. The present study was therefore designed to evaluate the impact of partial replacement of concentrate mixture with hedge lucerne and mulberry leaves on dry matter intake, growth performance, techno economics and proximate composition in Malabari kids.

Materials and methods

The experiment was conducted at the Livestock Research Station (LRS), Thiruvazhamkunnu, Palakkad, Kerala, Kerala Veterinary and Animal Sciences University (KVASU). Eighteen healthy Malabari kids (average age four months) were selected and randomly distributed into three treatment groups with six animals in each group, following a Completely Randomised Design (CRD). The experimental period lasted 90 days after a 15-day adaptation phase. All animals were maintained under uniform management and hygienic conditions, housed individually in well-ventilated pens and dewormed prior to the experiment.

Feeding and management

Hedge lucerne and mulberry were cultivated. The first harvest was carried out at 90 days after planting and subsequent harvests were made at 30-day intervals throughout the experimental period. Feeding was carried out as per Table. 1.

Concentrate mixture (18% CP, 68% TDN) was supplied as per ICAR (2013) standards. The feed was offered twice daily (8:30 AM and 3:00 PM), and clean water was made available ad libitum.

Dry matter intake (DMI) was calculated on a dry matter basis as the difference between feed offered and refusals, with the feed offered equivalent to 5% of the body weight of the animals. Body weight was measured fortnightly using a digital weighing balance

Proximate composition

Samples of mulberry, hedge lucerne, guinea grass and concentrate were analyzed for moisture, crude protein (CP), crude fibre (CF), ether extract (EE), total ash and acid insoluble ash (AIA) as per AOAC (2019) procedures.

Economic evaluation

The techno-economic assessment was based on feed consumption and feed cost during the 90-day period. The cost of feed and fodder was calculated based on the actual harvesting and processing expenses incurred on the experimental farm, as all fodder components were cultivated and utilized on-site.

The cost of fodder varieties used in the study were as follows; Mulberry leaves – ₹4.5/kg (fresh), Hedge lucerne – ₹4.5/kg (fresh) and Guinea grass – ₹3.5/kg (fresh).The cost of the concentrate mixture used in the study was₹30/kg (dry matter basis). The Feed cost per kilogram live weight gain (Rs/kg) was calculated using the formula given below as described by Gawali et al. (2023)

Feed Cost per kilogram live weight gain

= Total Feed Cost / Total Live Weight Gain (kg)

Statistical analysis

All data were analysed using SPSS version 24.0. One-way ANOVA was performed and treatment means were compared using Duncan's Multiple Range Test (DMRT). Significance was declared at $p<0.05$.

Results and discussion

Dry Matter Intake (DMI)

Dry matter intake (DMI) is one of the most critical determinants of animal productivity, as it directly influences nutrient availability for maintenance and growth. In the present study, DMI increased gradually across all treatments with the progression of the feeding trial (Table 2), reflecting normal growth-related increases in appetite and feed capacity of growing kids. Although there was no statistically significant ($p > 0.05$) difference among treatments, animals in the T-50 group consistently showed

Table 1. Experimental dietary treatments and feeding regimes of goats

Treatment	Feeding regime
T0 (Control)	100% concentrate mixture
T-50	50% of the concentrate replaced with equal quantities of hedge lucerne and mulberry leaves
T-75	75% of the concentrate replaced with equal quantities of hedge lucerne and mulberry leaves

higher numerical values for DMI compared to T0 and T-75. This trend indicated good palatability of the rations and adaptation of the experimental animals to the inclusion of hedge lucerne and mulberry leaves in their diet.

The higher intake in the 50% replacement group might be attributed to the balanced roughage-to-concentrate ratio and the high palatability of both mulberry and hedge lucerne. Comparable results were reported by Ebrahim et al. (2017), who found that replacing concentrate mixture with mulberry leaves in lamb diets up to 100 % did not significantly alter DMI. Similarly, Sambul and Barman (2010) and Singh et al. (2003) also recorded no reduction in feed intake in goats when concentrate mixture was replaced with leguminous tree leaves. Aganga and Tshwenyane (2004) further emphasized that tree forages such as *Morus alba* and *Desmanthus virgatus* are highly palatable to small ruminants due to their favorable aroma and high nutrient density.

The results of the present experiment thus confirmed that substitution of concentrate mixture up to 75% with hedge lucerne and mulberry leaves does not impair feed intake or palatability in Malabari kids. It was observed that moderate inclusion at the 50% level was optimal for maintaining feed acceptability and balanced nutrient intake.

Body weight and growth performance

All experimental groups exhibited a progressive increase in body weight throughout the 90-day feeding period (Table.3), signifying that all dietary combinations supported satisfactory growth. Although statistical analysis revealed no significant differences ($P > 0.05$), the final mean body weight of kids in the T-50 group (14.33 ± 1.39 kg) was marginally higher than that of the control (T0) (13.73 ± 0.93 kg) and T-75 (13.22 ± 1.09 kg) groups.

The improved growth in T-50 may be due to the optimum nutrient balance and digestibility obtained when concentrate mixture was replaced partially with the two high-protein forages. These observations are consistent with the findings of Sonawane et al. (2019), who reported similar body weight gains in Osmanabadi goats supplemented with hedge lucerne, and Ebrahim et al. (2017), who also found non-significant differences in lamb growth when concentrate was replaced with mulberry leaves. Malisetty and Jatoth (2013) further demonstrated that partial replacement of concentrate with mulberry hay maintained weight gain in crossbred calves, showing that mulberry is a suitable forage alternative in ruminant feeding systems.

Thus, the present study observed that replacement of concentrate mixture with hedge lucerne and mulberry up to 75% could sustain growth performance. Nevertheless the 50% replacement was nutritionally most efficient in terms of weight gain and feed utilization efficiency.

Proximate composition of feed and fodder

The proximate analysis revealed considerable variation in nutrient fractions among the experimental feeds (Table 4). Hedge lucerne contained the highest crude protein (19.05%), followed by concentrate (18.65%) and mulberry leaves (17.14%), while guinea grass had the

Table 2. Fortnightly average daily dry matter intake of experimental kids in (g)

Fortnight intervals	Control (T0)	50% Replacement group (T-50)	75% Replacement group (T-75)	P-value
1	485.67 ± 34.64	499.9 0± 43.8	503.42 ± 51.29	0.955
2	480.90± 29.91	510.31 ± 38.83	510.85 ± 49.63	0.836
3	512.56 ± 29.91	560.2 ± 43.58	545.22 ± 53.05	0.733
4	578.86 ± 38.97	604.23 ± 56.14	573.13 ± 51.12	0.894
5	618.36 ± 41.78	633.24 ± 58.65	585.65 ± 50.67	0.798
6	648.63 ±43.49	675.98 ± 67.99	626.28 ± 53.4	0.822

Table 3. Fortnightly average body weight of experimental kids

Days	Control (T0)	T-50	T-75	P-value
Day 0	10.23 ± 0.73	10.72 ± 0.77	10.43 ± 0.95	0.917
Day 15	10.03 ± 0.73	10.70 ± 0.87	10.55 ± 1.04	0.858
Day 30	10.15 ± 0.55	10.92 ± 0.79	10.70 ± 1.03	0.792
Day 45	11.53 ± 0.75	12.40 ± 1.04	11.68 ± 1.03	0.791
Day 60	12.33 ± 0.81	12.73 ± 1.14	11.78 ± 0.99	0.796
Day 75	13.32 ± 0.94	13.53 ± 1.27	12.35 ± 1.03	0.720
Day 90	13.73 ± 0.93	14.33 ± 1.39	13.22 ± 1.09	0.794

Table 4. Proximate analysis of feed and fodder

Sl. No.	Parameter	Mulberry (%)	Hedge Lucerne (%)	Guinea grass (%)	Concentrate (%)
1	Moisture	67.15	62.52	75	9.55
2	Crude Protein	17.14	19.05	16.13	18.65
3	Crude Fibre	22.16	17.26	30	10.93
4	Crude Fat	4.34	4.73	2.46	3.59
5	Total Ash	7.18	5.02	7.14	11.69
6	Acid Insoluble Ash	0.29	0.41	1.63	2.32

Table 5. Average total intake of mulberry, hedge lucerne, green fodder and concentrate by each animal in 3 treatment groups

Treatment groups	Total mulberry intake (kg)	Total hedge lucerne intake (kg)	Total concentrate Intake (kg)	Total fodder Intake (kg)	Total cost of feed (₹)	Feed cost per kg live weight gain (₹)
T-0			33.790	81.12	1297.62	414.3169
T-50	26.625	22.816	17.747	85.14	1052.901	317.6909
T-75	37.972	32.544	8.45	81	854.3243	309.6732

Table 6. Feed cost per kg live weight gain

	Control (T0)	T-50	T-75	P-value
Feed cost per kg live weight gain (Rs)	414.31 ±63.9	317.69 ± 31.03	309.67 ± 19.96	0.189

lowest (16.13%). The high protein and moderate fibre levels in hedge lucerne and mulberry suggests their potential to support microbial activity and nitrogen metabolism in the rumen.

Crude fibre content ranged from 10.93% in concentrate to 30% in guinea grass, while hedge lucerne (17.26%) and mulberry (22.16%) showed intermediate levels, suitable for maintaining rumen health without reducing digestibility. Ether extract (crude fat) values were also higher in hedge lucerne (4.73%) and mulberry (4.34%) than in concentrate (3.59%) or guinea grass (2.46%), indicating improved energy density.

These findings concur with Srivastava et al. (2006) and Radhakrishnan et al. (2007), who emphasized the superior nutritive quality of hedge lucerne and mulberry compared to grasses. Mynavathi et al. (2021) also highlighted the high protein and low lignin content of hedge lucerne, supporting its suitability as a ruminant feed component.

Therefore, the proximate composition supports the inference that both hedge lucerne and mulberry are rich in nutrients required for growth, carcass development, and maintenance, making them ideal substitutes for a portion of concentrate mixture in goat diets.

Feed cost per kilogram live weight gain

The feed cost per kilogram live weight gain (Rs/kg) for the different treatments is shown in Table 5 & 6. The mean values were Rs-414.31 ± 63.9 (T-0), Rs-317.69 ± 31.03 (T-50), and Rs-309.67 ± 19.96 (T-75). Although the differences were not statistically significant (P>0.05), the cost decreased by nearly 25% in T-50 and 28% in T-75 compared to the control.

This trend indicates that incorporating hedge lucerne and mulberry leaves into goat diets effectively reduces feed costs while maintaining comparable growth performance. The reduction in feed cost is attributed to the minimal cultivation expense and local availability of these forages, reducing the need for purchased concentrate ingredients. Similar reductions in cost of production with forage-based feeding have been reported by Sambul and Barman (2010) in goats fed mulberry leaves and by Premalatha et al. (2012) in rabbits fed hedge lucerne and mulberry.

Techno-economic feasibility

The economic efficiency of the feeding system depends not only on biological performance but also on input costs and resource utilization. In this study, the combination of hedge lucerne and mulberry offered a balanced nutrient profile, reducing dependency on expensive concentrate feed.

The T-75 group, which had the highest level of concentrate replacement, recorded the lowest feed cost, indicating superior economic efficiency. This demonstrates that locally grown forage-based feeding systems can be both nutritionally and financially viable, especially for smallholder farmers in Kerala.

Aganga and Tshwenyane (2004) emphasized that incorporation of tree forages such as mulberry and Leucaena into goat diets improves economic returns by reducing feed costs. The findings of the present study are in line with these observations, reaffirming the value of hedge lucerne and mulberry as cost-effective feed resources.

Conclusion

The cumulative results from this experiment demonstrate that feeding hedge lucerne and mulberry leaves in combination as a partial replacement for concentrate mixture can effectively sustain feed intake, growth rate, body development, and carcass yield in Malabari kids. The combination provided a cost-efficient feeding strategy that maintained performance comparable to a full concentrate diet, while reducing dependence on expensive and less sustainable concentrate ingredients.

Among the tested treatments, the 50% replacement level (T-50) offered the best compromise between growth rate and feed economy, suggesting that this ratio provides an optimal balance between energy and protein supply. Replacement at 75% (T-75) also maintained performance without significant reduction, indicating a wide flexibility of these forages in feeding systems.

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Conflict of interest

The authors declare no conflict of interest.

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