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Effect of replacement of green maize with jackfruit leaves in total mixed ration on haemato-biochemical and rumen fermentation parameters of growing goats

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Abstract

The present study evaluated the effect of incorporating jackfruit leaves into the total mixed ration (TMR) on rumen fermentation and hemato-biochemical parameters of eighteen Osmanabadi goats. The experimental goats were randomly divided into three groups (n=6): T₀ (control), T₁ (partial replacement of green maize), and T₂ (complete replacement with jackfruit leaves) for 91 days. The blood and rumen liquor samples were collected from all experimental kids at the monthly intervals for haematological, blood biochemical and rumen fermentation parameters studies. The data pertaining to different response variables were subjected to two-way analysis of variance (ANOVA) with repeated measures. The haemato-biochemical parameters were studied and analysed as the mean haemoglobin levels (g/dL) were, 10.45 ± 0.17 , 10.39 ± 0.14 and 10.49 ± 0.16 for T₀, T₁, and T₂, respectively, while PCV values (%) were, 29.98 ± 0.57 , 30.04 ± 0.47 and 30.32 ± 0.58 , respectively. The total protein (g/dL) levels were recorded as, 6.91 ± 0.08 , 6.91 ± 0.07 and 6.99 ± 0.05 , with serum albumin (g/dL) at, 4.09 ± 0.07 , 4.15 ± 0.04 and 4.15 ± 0.04 , and serum globulin (g/dL) at, 2.81 ± 0.05 , 2.76 ± 0.05 and 2.85 ± 0.03 . The BUN (mg/dL) values were, 15.08 ± 0.04 , 15.11 ± 0.16 and 16.08 ± 0.61 , respectively.

The rumen liquor pH values were recorded as 6.97 ± 0.05 , 6.99 ± 0.04 and 6.99 ± 0.04 for T₀, T₁, and T₂, respectively, while total protozoal values ($y \times 10^4/\text{ml}$) were analysed as 32.21 ± 0.35 , 31.97 ± 0.41 and 32.81 ± 0.47 . The total nitrogen (mg/dL) observations were as 85.09 ± 0.29 , 85.37 ± 0.26 and 85.67 ± 0.35 , respectively. The results of the present study found no significant ($p > 0.05$) difference with respect to the observations of haemato-biochemical and rumen fermentation parameters and values remained within normal physiological range and stable indicating no adverse effects on rumen and physiological health, confirming dietary safety.

Therefore, the present study demonstrated that the inclusion of jackfruit leaves in the total mixed ration (TMR) of growing kids had no adverse effects on haematological, biochemical and rumen parameters. Hence, it is concluded that the complete replacement of green maize with jackfruit leaves improved maintained physiological health.

Keywords: Jackfruit leaves, haemato-biochemicals, rumen parameters, growing kids

Introduction

In India, livestock serves as a vital source of livelihood security for smallholder and marginal farmers. India possesses the world's largest livestock population with 536.76 million animals, including 303.76 million bovines, 74.26 million sheep, and 148.88 million goats (20th Livestock Census (2019)). Goats account for nearly 27.7% of this population, making India the second-largest goat-rearing country globally. With this large livestock resource, India faces an estimated deficit of 44% in concentrate feed ingredients, 35.6% in green fodder, and 10.95% in dry crop residues. Goats traditionally depend on naturally available grasses from roadsides, field borders, fallow lands, and harvested fields; however, these feeds are often deficient in crude protein and digestible nutrients. Supplementation with nutrient-rich tree foliage has been shown to enhance feed intake, digestibility, and performance in small ruminants (Alam and Akbar, 1991) [1].

Agro-industrial by-products use is often restricted by anti-nutritional factors such as tannins and saponins and by economic constraints where the value of these resources is lower than their collection and processing costs, leading to their disposal as waste (Singh and Bhat, 2003). Therefore, identifying locally available, nutritionally adequate, and cost-effective feed resources is essential for improving small ruminant nutrition. Green maize, the fibrous residue remaining after grain harvest of *Zea mays*, is an important roughage source in mixed crop-livestock systems (Lizotte *et al.*, 2015) [9]. Although it provides substantial fiber and energy, its low crude protein and high fiber fractions limit digestibility and nutrient availability in growing animals. When maize stover forms the primary roughage in diets, supplementation with protein-rich feeds becomes essential. Among such resources, jackfruit (*Artocarpus heterophyllus*) foliage has considerable nutritional potential (Mui *et al.*, 2002; Van & Ledin, 2002) [10, 10]. Farmers commonly feed goats with fresh jackfruit leaves, petioles, and tender stems, which contain approximately 10-14% crude protein and 14-16% crude fiber along with appreciable calcium and phosphorus (Ghosh *et al.*, 2017) [4]. Chemical analysis by Bakshi *et al.* (2016) [3] reported 15.6% crude protein, 36.5% NDF, 26.9% ADF, and 10.51% ash with significant macro- and micro-minerals, while Umennadi *et al.* (2023) [19] recorded crude protein levels up to 19.25% along with considerable carbohydrates and trace minerals. Jackfruit leaves also contain bioactive compounds such as flavonoids, carotenoids, phenolics, and tannins (Pal *et al.*, 2015) [11]. However, jackfruit foliage remains largely underutilized as a livestock feed resource. Considering the browsing behaviour and dietary adaptability of goats, supplementation of maize stover-based diets with jackfruit leaves may enhance growth performance while reducing feeding costs and promoting sustainable smallholder livestock systems (Shaheen *et al.*, 2020) [13].

Materials and Methods

The eighteen experimental kids were randomly allotted to three dietary treatments with six animals in each group for a period of 91 days. The control group (T₀) received total mixed ration (TMR) containing jowar kadbi (jowar dry fodder), green maize and concentrate mixture in a 50:20:30 ratio (on DM basis). Whereas, T₁ was fed with total mixed TMR having Jackfruit leaves (10 parts of DM) and maize green (10 parts of DM) as green, jowar kadbi (50 parts of DM) as dry roughage along with concentrate mixture (30 parts of total DM). The treatment group T₂ was fed with TMR having Jackfruit leaves (20 parts of DM) as green roughage, jowar kadbi (50 parts of DM) as dry roughage along with concentrate mixture (30 parts of total DM).

All experimental goats were provided with diets formulated to be iso-caloric and iso-nitrogenous, and they were individually fed throughout the experimental period. The blood and rumen liquor samples were collected from all experimental kids at the intervals i.e on the 0th, 30th, 60th, and 90th days of the trial period for haematological, blood biochemical and rumen fermentation parameters studies. The statistical analysis was carried out according to the procedures described by Snedecor

and Cochran (1994). The data pertaining to different response variables were subjected to two-way analysis of variance (ANOVA) with repeated measures.

Results and Discussion

The observations with respect to the haematological, blood biochemical and rumen fermentation parameters are presented in the Table 1.

Hemato-Biochemical Parameters

Haemoglobin (g/dl)

The haemoglobin values did not differ significantly ($p>0.05$) among the treatment groups and values recorded within the normal physiological range reported for healthy growing goats. Our study reports are supported by Das (2007) [4] who reported that replacing concentrate with jackfruit leaves in Black Bengal kids had no negative effect on blood parameters, including haemoglobin. Similarly, Satpute *et al.* (2024) found that growing goats fed a diet containing 75% jackfruit leaves plus 25% guinea grass showed similar haemoglobin levels compared to goats fed 100% guinea grass.

Packed Cell Volume (%)

The PCV values did not differ significantly ($p>0.05$) among the treatment groups and values recorded within the normal physiological range, indicating that the experimental diets were safe and nutritionally balanced. Das (2007) [4] reported that replacing a portion of the concentrate with jackfruit leaves (*Artocarpus heterophyllus*) in Black Bengal kids did not adversely affect haematological parameters, including packed cell volume (PCV). It indicates that the diet's nutritional quality remained adequate to support normal haematological function. Similarly, Satpute *et al.* (2024) found that growing goats fed a diet containing 75% jackfruit leaves.

Total Protein (g/dl)

The total protein values did not differ significantly ($p>0.05$) among the treatment groups and values recorded within the normal physiological range reported for healthy growing goats, indicating that the experimental diets were safe and nutritionally balanced. Das (2007) [4] reported that partial replacement of concentrate with *Artocarpus heterophyllus* leaves in Black Bengal kids did not adversely affect blood biochemical parameters, including total protein levels. This indicates that jackfruit leaves provided adequate protein nutrition and did not impair protein synthesis or metabolic functions in growing kids. Utari *et al.* (2022) evaluated the effect of jackfruit leaves (*Artocarpus heterophyllus*) and moringa leaves (*Moringa oleifera*) on serum biochemical parameters in goats using four dietary treatments. The serum total protein concentration ranged from 6.08 to 7.29 g/dL, with an average of 6.76 g/dL, and remained within the normal physiological range. The highest value was observed in treatment B (7.29 g/dL), indicating adequate protein intake and efficient protein metabolism in goats fed diets containing jackfruit leaves. Similarly, Satpute *et al.* (2024) reported that growing goats fed a diet containing 75% jackfruit leaves.

Table 1: Details of Haematological, Biochemical and Rumen Fermentation Parameters of Experimental Growing Kids

Parameters	Treatment			p Value
	T ₀	T ₁	T ₂	
Haematological Parameters				
Hemoglobin (g/dl)	10.45 ± 0.17	10.39 ± 0.14	10.49 ± 0.16	0.564 ^{NS}
Packed Cell Volume (%)	29.98 ± 0.57	30.04 ± 0.47	30.32 ± 0.58	0.472 ^{NS}
Blood Biochemical Parameters				
Total Serum Protein (g/dl)	6.91 ± 0.08	6.91 ± 0.07	6.99 ± 0.05	0.595 ^{NS}
Albumin (g/dl)	4.09 ± 0.07	4.15 ± 0.04	4.15 ± 0.04	0.537 ^{NS}
Globulin (g/dl)	2.81 ± 0.05	2.76 ± 0.05	2.85 ± 0.03	0.422 ^{NS}
Blood Urea Nitrogen (mg/dl)	15.08 ± 0.04	15.11 ± 0.16	16.08 ± 0.61	0.126 ^{NS}
Rumen Fermentation Parameters				
Rumen liquor pH	6.97 ± 0.05	6.99 ± 0.04	6.99 ± 0.04	0.794 ^{NS}
Total protozoa (y*10 ⁴ /ml)	32.21±0.35	31.97±0.41	32.81±0.47	0.373 ^{NS}
Total Nitrogen (mg/dL)	85.09±0.29	85.37±0.26	85.67±0.35	0.429 ^{NS}

NS: Non-Significant

Albumin (g/dl)

The albumin values did not differ significantly ($p>0.05$) among the treatment groups, indicating that the experimental diets were safe and nutritionally balanced. Das (2007) [4] observed that partially substituting concentrate with leaves of *Artocarpus heterophyllus* in Black Bengal kids did not negatively affect blood biochemical indices, including total protein and albumin concentrations. These findings suggest that incorporation of jackfruit leaves maintained adequate protein status and did not interfere with protein synthesis or normal metabolic functions in the growing animals. Similarly, Satpute *et al.* (2024) reported serum biochemical parameters, including total protein and albumin, did not differ significantly between the two groups of goats fed with jackfruit leaves. Similarly in study by Utari *et al.* (2022) reported the differences were not statistically significant. The normal albumin levels observed in all treatment groups suggest proper liver function and adequate protein nutritional status in goats.

Globulin (g/dl)

The globulin values did not differ significantly ($p>0.05$) among the treatment groups, this indicates that the inclusion of jackfruit leaves in goats fed with jackfruit leaves did not disrupt metabolic activities in the growing kids. Utari *et al.* (2022) in their study on jackfruit leaves reported non-significant differences among the treatments, indicating that supplementation with jackfruit leaves did not negatively affect globulin levels. The present study reports Rae in agreement with reports of Satpute *et al.* (2024), Zhu *et al.* (2026) in their respective studies.

Blood Urea Nitrogen (mg/dl)

Das (2007) [4] reported that plasma urea nitrogen levels in Black Bengal kids decreased significantly as the level of jackfruit leaves in the diet increased, suggesting improved nitrogen utilisation. Further studies by Thanh (2022) [17] studied the effect of replacing Para grass with jackfruit leaves in the diet of lactating crossbred Saanen goats using a 4×4 Latin square design. Jackfruit leaves replaced Para grass at 0%, 50%, 75%, and 100% levels. Increasing jackfruit leaf inclusion resulted in higher faecal nitrogen and nitrogen retention, and lower urinary nitrogen, indicating improved nitrogen utilisation. Similarly, Satpute *et al.* (2024) also found comparable serum BUN levels in growing goats fed a diet containing 75% jackfruit leaves.

Rumen Fermentation Parameter

Rumen liquor pH: The rumen pH values recorded at

different intervals did not differ significantly ($P>0.05$) among the treatment groups throughout the experimental period. However, the differences were statistically non-significant, suggesting that the treatments did not markedly affect rumen pH. Das (2007) [4] reported decreased rumen ammonia-N with increasing JFL levels, while rumen pH remained unchanged. Escala *et al.* (2014) [5] demonstrated that feeding jackfruit by-product concentrate (JBC) increased rumen bacterial counts and optimised rumen fermentation in suckling kids, and no change in rumen pH. Phengvilaysouk and Kaensombath (2006) [12] studied feeding of *Artocarpus heterophyllus* foliage to goats and found that feeding method did not affect rumen pH or ammonia concentration.

Protozoal count

The protozoal count values recorded at different intervals did not differ significantly ($P>0.05$) among the treatment groups throughout the experimental period. The present study reports are in accordance with Thanh *et al.* (2021) [16], Thakuria *et al.* (2020) [15] and Malik *et al.* (2017) in their respective studies.

Total nitrogen

The total nitrogen values recorded at different intervals did not differ significantly ($P>0.05$) among the treatment groups during the experimental period. The present study reports are supported by the observations recorded by Mui *et al.* (2002) [10], Thanh *et al.* (2021) [16], Das (2007) [4] and Eyoh and Udoh (2020) [6] in their respective trials.

Conclusion

The present study demonstrated that the inclusion of jackfruit leaves in the total mixed ration TMR of growing kids had no adverse effects on haematological, biochemical and rumen parameters. Hence, it is concluded that the complete replacement of green maize with jackfruit leaves improved physiological health status of goats.

Conflict of Interest

Not available.

Financial Support

Not available.

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