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PB Mind

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

SM Bhalerao

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

VR Patodkar

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

SM Bhokre

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

TC Shende

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

AK Barate

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

SS Kadam

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

Corresponding Author:

SM Bhalerao

Department of Animal Nutrition,
Krantisingh Nana Patil College of
Veterinary Science, Maharashtra Animal
and Fishery Sciences University,
Shirwal, Satara, Maharashtra, India

Effect of arecanut sheath as roughage source in total mixed ration on haemato-biochemical and rumen fermentation parameters of growing goats

PB Mind, SM Bhalerao, VR Patodkar, SM Bhokre, TC Shende, AK Barate and SS Kadam

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Abstract

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 (T_0) received total mixed ration (TMR) containing maize kadbhi, green maize and concentrate mixture in a 50:20:30 ratio (on DM basis), whereas in T_1 and T_2 , 25% and 50% of the dry roughage component were replaced with arecanut sheath, respectively. 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 obtained was 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, 10.41 ± 0.07 , 10.39 ± 0.06 and 10.37 ± 0.11 for T_0 , T_1 , and T_2 , respectively, while PCV values (%) were, 30.96 ± 0.64 , 31.22 ± 0.83 and 31.87 ± 0.78 , respectively. The total protein (g/dL) levels were analysed as 6.64 ± 0.01 , 6.58 ± 0.05 and 6.65 ± 0.01 with serum albumin (g/dL) at 3.43 ± 0.01 , 3.46 ± 0.01 and 3.46 ± 0.02 , and serum globulin (g/dL) at 3.23 ± 0.01 , 3.27 ± 0.01 and 3.32 ± 0.02 . The serum creatinine (mg/dL) levels were, 1.32 ± 0.01 , 1.32 ± 0.02 and 1.33 ± 0.01 , while BUN (mg/dL) values were, 14.94 ± 0.02 , 15.01 ± 0.02 and 15.09 ± 0.03 , respectively. The liver function markers, ALT (U/L) and AST (U/L), remained stable, with mean values of 23.20 ± 0.86 , 26.90 ± 2.55 and 25.25 ± 0.93 for ALT and, 30.77 ± 0.42 , 30.51 ± 0.63 and 30.76 ± 0.41 for AST, respectively.

The rumen liquor pH values were observed as 6.53 ± 0.01 , 6.52 ± 0.01 and 6.54 ± 0.01 for T_0 , T_1 , and T_2 , respectively, while total protein values ($y \times 10^4/\text{ml}$) were analysed as 27.51 ± 0.16 , 27.60 ± 0.18 and 27.62 ± 0.19 . Total nitrogen (mg/dL) observations were as 34.85 ± 0.12 , 35.65 ± 0.04 and 34.62 ± 0.01 , 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 the values were well within normal physiological limits. Therefore, the present study demonstrated that the inclusion of arecanut sheath in TMR of growing kids had no adverse effects on haematological, biochemical and rumen fermentation parameters.

Keywords: Arecanut sheath, haemato-biochemicals, rumen parameters, growing kids

Introduction

India possesses a rich diversity of livestock which plays an important role in improving the socio-economic status of rural populations. India has 303.76 million bovines, 74.26 million sheep, and 148.88 million goats (20th Livestock Census, 2019) [1]; Goat rearing is practiced under intensive, semi-intensive, and extensive production systems (Kumar *et al.*, 2012). The intensive system involves stall feeding without grazing and is generally adopted in organized commercial farms (Singh and Kumar, 2007) [19]. However, goat productivity in developing countries is often constrained by feed scarcity and the high cost of feed resources (Oni *et al.*, 2010) [14]. During the dry season, available forages become mature and fibrous with high fiber and reduced protein content, resulting in poor nutritive value (Moyo *et al.*, 2012) [12].

Maize stover (maize kadbhi), the residue left after grain harvest consisting of stalks, leaves, cobs, and husks (ICAR, 2013) [8], is widely used as roughage.

However, because of its low protein and energy content, feeding maize kadbi alone often causes nutrient imbalance and poor productive performance in ruminants (Patle & Khawaskar, 2018) ^[15], particularly during the dry season when animals depend mainly on low-quality crop residues, leading to body weight loss and reduced productivity (Mahesh *et al.*, 2013) ^[11].

Among alternative feed resources, arecanut sheath has gained attention as unconventional roughage for small ruminants. India contributes about 62% of the global cultivation area and nearly 60% of total production (Jaganathan *et al.*, 2013) ^[9]. The fallen areca sheath, available between November and June, is a major by-product with an estimated potential of about 1.20 million tonnes annually for ruminant feeding (Gaikwad & Bhargav, 2012) ^[5], while the estimated annual availability in India is around 500,000 tonnes (Gowda *et al.*, 2012) ^[6]. Fodder scarcity in areca-growing regions and the increasing cost of transported paddy straw have encouraged the use of areca sheath as alternative roughage. It is easily available at the coastal region of Indian states and studies have evaluated its suitability as a supplementary fodder capable of partially replacing conventional dry fodder (Gaikwad & Bhargav, 2012) ^[5]. Due to its rigid structure and large surface area, mechanical processing such as chopping or shredding into pieces of about 2×10 mm is required to improve intake. On a dry matter basis, areca sheath contains organic matter (93.65%), crude protein (3.50%) Its metabolizable energy is 7.52 MJ/kg DM and total digestible nutrients are 49.3%. The mineral profile includes calcium (0.25-0.60%), phosphorus (0.06-0.08%), and copper (15-23 ppm), along with low levels of anti-nutritional factors such as oxalic acid and tannins (Sachin *et al.*, 2023) ^[21]. Hence, due to its availability and low cost, areca sheath is considered a potential alternative roughage for livestock feeding in regions where conventional dry fodder is scarce and expensive.

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 maize kadbi, green maize and concentrate mixture in a 50:20:30 ratio (on DM basis), whereas in T₁ and T₂, 25% and 50% of the dry roughage component were replaced with arecanut sheath, respectively. 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. 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.

Haematological parameters

Hemoglobin (g/dl)

The haemoglobin values did not differ significantly ($p > 0.05$) among the treatment groups at any stage of the experimental period. The values recorded in the present study fall within

the normal physiological range reported for healthy growing goats, indicating that the experimental diets were safe and nutritionally balanced. These findings imply that inclusion of the experimental feed components did not impair blood health and maintained normal physiological function in goats during the feeding trial. Our study reports are in accordance with Ambhore *et al.* (2024) ^[2] which indicated that inclusion of areca sheath in TMR does not adversely affect haemoglobin status or blood health of goats. Similar findings were reported by Villar *et al.* (2024) ^[23] in Boer goats.

Packed Cell Volume (%)

The PCV values did not differ significantly ($p > 0.05$) among the treatment groups and only minor numerical variations were noted, and PCV values remained relatively stable in all groups, confirming that the experimental diets were nutritionally adequate and safe. These results demonstrate that inclusion of the experimental feed components had no adverse effect on blood health. The present study reports are in agreement with Alghazli and Al-Wazeer (2024) ^[24] who observed no significant ($p \geq 0.05$) changes in PCV among Awassi lambs. Similarly, Nagarajan *et al.* (2023) ^[25] reported no significant variation in PCV across different dietary treatments.

Total Protein (g/dl)

The total protein values did not differ significantly ($p > 0.05$) among the treatment groups during the experimental period. These findings demonstrated that the dietary treatments were nutritionally balanced and maintained normal serum protein levels without inducing metabolic stress. Similarly, Ambhore *et al.* (2024) ^[2] reported that serum total protein levels did not differ significantly ($p > 0.05$) among crossbred calves fed total mixed rations in which paddy straw was partially or completely replaced with shredded arecanut sheath.

Albumin (g/dl)

The serum albumin concentrations did not differ significantly ($p > 0.05$) among the treatment groups at any stage of the experimental period. The present findings are in agreement with earlier reports in small ruminants. Our study results are supported by Nagarajan *et al.* (2023) ^[25] and Ashokrao *et al.* (2023) ^[3].

Globulin (g/dl)

The statistical analysis revealed no significant differences ($p > 0.05$) among the treatment groups, although a gradual numerical increase in serum globulin levels was observed in T₂ compared to T₀ and T₁, the variation remained within the normal physiological range. These results suggest that the inclusion of alternative feed ingredients was nutritionally safe and did not compromise health or immune function in goats. Nagarajan *et al.* (2023) ^[25] documented comparable serum globulin concentrations across dietary treatments. Similar observations were reported by Ashokrao *et al.* (2023) ^[3] in Madgyal lambs fed spineless cactus as an alternative roughage source. Collectively, these findings suggest that the use of unconventional feed resources can sustain normal immune-related protein fractions.

Creatinine (mg/dl)

The average serum creatinine levels did not differ significantly ($p > 0.05$) among the treatment groups but the values were within the normal physiological range, suggesting that inclusion of the test feed ingredients was metabolically safe and did not compromise kidney health. The findings of

the present study align with Rivero *et al.* (2014) ^[16] and Beigh *et al.* (2018) ^[4] in crossbred lambs with serum creatinine levels stable.

Blood Urea Nitrogen (mg/dl)

The blood urea nitrogen (BUN) levels recorded did not differ significantly ($p > 0.05$) among the treatment groups, indicating a uniform nitrogen metabolism throughout the experimental period. The results of the present study are in agreement with Rivero *et al.* (2014) ^[16] who reported no significant variation in serum urea nitrogen in Awassi lambs.

Alanine Aminotransferase (IU/L)

The serum alanine aminotransferase (ALT) activity did not

differ significantly ($p > 0.05$) among the treatment groups throughout the experimental period. The present results are in agreement with Rivero *et al.* (2014) ^[16], Beigh *et al.* (2018) ^[4], Vallejo *et al.* (2016) ^[22]. Collectively, these studies support the present findings that the alternative roughage sources can be safely incorporated without adversely affecting hepatic metabolism.

Aspartate Aminotransferase (IU/L)

The serum alanine aminotransferase (ALT) activities did not differ significantly ($p > 0.05$) among the treatment groups throughout the experimental period. Similar findings were observed by Roba *et al.* (2022) ^[17], Ashokrao *et al.* (2023) ^[3].

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)	10.41 ± 0.07	10.39 ± 0.06	10.37 ± 0.11	0.93 ^{NS}
Packed Cell Volume (%)	30.96 ± 0.64	31.22 ± 0.83	31.87 ± 0.78	0.63 ^{NS}
Blood Biochemical Parameters				
Total Serum Protein (g/dl)	6.64 ± 0.01	6.58 ± 0.05	6.65 ± 0.01	0.29 ^{NS}
Albumin (g/dl)	3.43 ± 0.01	3.46 ± 0.01	3.46 ± 0.02	0.367 ^{NS}
Globulin (g/dl)	3.23 ± 0.01	3.27 ± 0.01	3.32 ± 0.02	0.145 ^{NS}
Creatinine (mg/dl)	1.32 ± 0.01	1.32 ± 0.02	1.33 ± 0.01	0.91 ^{NS}
Blood Urea Nitrogen (mg/dl)	14.94 ± 0.02	15.01 ± 0.02	15.09 ± 0.03	0.12 ^{NS}
Alanine Aminotransferase (IU/L)	23.20 ± 0.86	26.90 ± 2.55	25.25 ± 0.93	0.38 ^{NS}
Aspartate Aminotransferase (IU/L)	30.77 ± 0.42	30.51 ± 0.63	30.76 ± 0.41	0.93 ^{NS}
Rumen Fermentation Parameters				
Rumen liquor pH	6.53 ± 0.01	6.52 ± 0.01	6.54 ± 0.01	0.84 ^{NS}
Total protozoa (y*10 ⁴ /ml)	27.51 ± 0.16	27.60 ± 0.18	27.62 ± 0.19	0.83 ^{NS}
Total Nitrogen (mg/dL)	34.85 ± 0.12	35.65 ± 0.04	34.62 ± 0.01	1.00 ^{NS}

NS: Non-Significant

Rumen Fermentation Parameters

Rumen liquor pH

The rumen pH values were recorded at different intervals did not differ significantly ($p > 0.05$) among the treatment groups but remained within a narrow and optimal physiological range, indicating stable rumen fermentation and effective buffering capacity across all diets. The stability of rumen pH observed in the present study is consistent with previous reports of Vallejo *et al.* (2016) ^[22], Sheikh *et al.* (2017) ^[18], Roba *et al.* (2022) ^[17]. Collectively, these findings indicate that diets maintain rumen pH within the normal physiological range.

Protozoal count

The rumen protozoal counts remained statistically similar ($p > 0.05$) among all treatment group. However, minor numerical fluctuations were observed, but overall protozoal populations were stable. Similar observations have been reported by Sheikh *et al.* (2017) ^[18], Vallejo *et al.* (2016) ^[22], Roba *et al.* (2022) ^[17].

Total nitrogen

The total nitrogen (TN) values remained consistent across all treatment groups throughout the experimental period, with no significant differences ($p > 0.05$) observed at any time point. These findings are in agreement with previous studies reported by Sheikh *et al.* (2017) ^[18] and Vallejo *et al.* (2016) ^[22].

Conclusion

Incorporation of arecanut sheath as a dry roughage source in the total mixed ration (TMR) of growing Osmanabadi kids did not produce any significant alteration in haemato-biochemical and rumen fermentation parameters suggesting that arecanut sheath can be effectively utilized as an alternative dry roughage source in TMR for growing goats without compromising metabolic health or rumen environment.

Conflict of Interest

Not available

Financial Support

Not available

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