Indian Journal of Animal Sciences **95** (5): 451–456, May 2025/Article
https://doi.org/10.56093/ijans.v95i5.167366

Effect of feeding palas (*Butea monosperma*) leaves on performance of growing goats

DHARMENDRA KUMAR[1], RAGHUBAR SAHU[2], ANJANI KUMAR[3] and SANJAY KUMAR[1]

Krishi Vigyan Kendra, Banka, Bihar Bihar Agricultural University, Sabour, Bhagalpur, Bihar

Received: 30 May 2025; Accepted: 07 August 2025

ABSTRACT

In order to know the effect of feeding palas leaf on growth performance of black Bengal goat kid, ninety days' trials were conducted on 30 black Bengal growing goats of 3-4 month old. The average body weights were 7.01±1.12, 6.43± 1.07 and 7.07±1.28 kg in T1, T2 and T3, respectively. The group T1 was offered roughage and homemade concentrate feed in a ratio of 60:40, while groups T2 and T3 were fed homemade concentrate feed iso-nitrogenously replaced by *Butea monosperma* leaves at 12.5% and 25% levels, respectively. A growth trial of 90 days along with a 7-day digestion trial after 60 days of post feeding was conducted at Goat farm, Krishi Vigyan Kendra Banka, Bihar. The palas leaves had 13.76% crude protein, 32.72% crude fibre, 2.14% crude fat, 15.85% total ash, 5.35% silica, 3.21% calcium, 0.26% phosphorus on dry matter basis. The average body weight and average daily gain in the three groups (8.87±1.12, 8.67±1.02, 9.44±1.25 kg; 52.07±4.43, 60.50±7.46, 62.00±4.17g) were statistically non –significantly different. The FCR in relation to DM, CP, DCP and TDN were statistically non-significant. The blood haemato-biochemical parameters showing non -significant effect on feeding palas leaf. The parasitic load was reduced significantly in T2 and T3 group. It was concluded that the inclusion of Palas leaf as a replacement for up to 25% of concentrate mixture, on an iso-nitrogenous basis, has no detrimental effects on the nutritional and growth parameters of growing kids, rather, it reduces the parasitic load and promotes the animal wellbeing.

Keywords: Blood parameters, Digestibility, Palas leaf, Parasitic load

The estimated fodder requirement of India is 827.19 million tonnes (Roy *et al.* 2020). It is of vital importance to enhance the use of tree leaves in ruminant production. Tree leaves are being increasingly used to provide fodder for livestock, as they have a number of unique characteristics which make them attractive for both smallholder and large scale livestock enterprises. Research and development efforts have concentrated on broadening the resource base by evaluating a greater range of tree leaves, defining optimum management strategies, and developing appropriate systems which capitalize on the advantages of these species. On an average, 0.2 to 2.0 ton/ha/year tree leaf fodder can be obtained from the various agroforestry systems of different agro-climatic zones (Rai *et al.* 2007).

Palas (*Butea monosperma*) is commonly known as flame of forest, belonging to the family *Fabaceae*. Historically, palas originated in Bihar and Jharkhand. It is widely distributed throughout the India. The tree is very typical of open grassland. The literary review of the Palas was started right from the Vedas up to recent research works to obtain thorough knowledge of drug. On comprehensive review of Ayurvedic classics it was found that Palas is described in Vedas, Upanisads, Charaka Samhita, Susruta Samhita and both Astanga Sangraha and Astanga Hrdaya (Neelam *et al*. 2015). There is a scarcity of green grasses in March-June. Palas (*Butea monosperma*) trees can serve as a valuable source of nutrition for livestock due to their new green leaves. Hilly area of Bihar and Jharkhand state having forest of palas. So, use of palas leave as green fodder may combat the deficit of green fodder during scarcity period. Keeping this in view, the study was planned in black Bengal growing kids with the objective to know the effect of feeding palas leaf on feed intake, digestibility, growth performance, blood parameters and parasitic load.

MATERIALS AND METHODS

Animals, housing and feeding management: Thirty Black Bengal (*Capra hircus*) kids, age 3-4 months of similar body weight were randomly divided into three groups comprising of ten kids each in a completely randomized design. The average body weights were 7.01±1.12, 6.43± 1.07 and 7.07±1.28 kg in T1, T2 and T3, respectively. The group T1 was offered roughage and homemade concentrate feed (maize crushed 20%, mustard cake 10%, ground nut cake 15%, chana besan 15%, rice polish 10%, wheat bran 25%, mineral mixture 2%, salt 1%

Present address: [1]Bihar Veterinary College, Bihar Animal Sciences University (BASU), Patna 800 014, Bihar. [2]Veer Kunwar Singh College of Agriculture, Dumraon, Bihar. [3]ICAR- Agricultural Technology Application Research Institute, Zone IV, Patna Bihar. ✉Corresponding author email: drdharmendravet2310@gmail.com

Table 1. Chemical composition (%) of palas leaf, homemade concentrate feed and wheat straw.

	Crude Protein	Crude Fiber	NFE	Crude Fat	Total Ash	Silica	Ca	P	Total tannin (mg)
Palas leaf	13.76	32.72	35.43	2.14	15.95	5.35	3.21	0.26	10.80
Homemade concentrate feed	19.8	6.40	59.19	2.16	12.31	5.91	1.2	0.80	
Wheat straw	2.5	41.6	47.9	1.4	6.6	3.0	0.4	0.07	

and calcite 2%) in a ratio of 60:40, while groups T2 and T3 were fed homemade concentrate feed iso-nitrogenously replaced by *B. monosperma* leaves at 12.5% and 25% levels, respectively. A growth trial of 90 days along with a 7-days digestion trial after 60 days of post feeding was conducted at Goat farm, Krishi Vigyan Kendra Banka, Bihar. Homemade concentrate feed was offered daily at 7.00 a.m. and 3.00 p.m with paddy straw in addition to *B.monosperma* leaves at 12.00 p.m. All the kids were housed under hygienic conditions in the stall. They were let loose for exercise in confined area, during which they had free access to fresh drinking water. Daily feed intake and fortnightly body weights for two consecutive days before feeding and watering were recorded throughout the 90 days of experimentation.

Digestion trial: To determine nutrient utilization and balance of nutrients, a digestion trial involving quantitative collection of feces for 7 days excluding 3 days' adaptation period was conducted on six experimental animals from each group at the final stage of feeding experiment. The feces voided during 24 h were weighed and 5% of total feces was taken for nitrogen analysis (commercial grade sulphuric acid was added as preservative) and dry matter content. The water intake by experimental growing kids were recorded at the time of digestion trial in the morning between 9.30 a.m. to 10.30 a.m. and in the afternoon between 3.30 p.m. and 4.00 p.m.

Analytical procedure of feeds and feces: Dry matter in feed and feces was determined by oven drying at 100°C overnight. For chemical analysis, per animal pooled samples of feed offered, refusals and feces were dried at 60°C and ground to pass through a 2 mm sieve. Wet feces samples were analyzed for nitrogen by the standard Micro Kjeldahl method. The chemical analysis of preserved samples of feeds and feces were carried out using AOAC (1999) methods. The method of Talpatra *et al*. (1940) was followed for the determination of calcium and phosphorus. The chemical analysis of feeds and fodder conducted at laboratory of Animal Nutrition, Bihar Veterinary College, Patna.

Collection of blood samples: At the end of experimental feeding, blood samples were collected early in the morning before feeding from jugular vein in vacuum tubes. The 2 mL whole blood was collected in vacuum tubes containing appropriate quantity of K3 EDTA and fluoride for haematological parameters and blood glucose, respectively. The 4 mL of blood collected in plain tube with clot activator and was allowed for clotting for separation of serum. The collected serum samples were stored at -20° C for further analysis.

Hematological constituents were estimated using Medonica CA620/530 Vet. fully- automated hematologyanalyzer. Blood biochemical and enzyme was estimated using Semi Automatic Analyzer for clinical chemistry test (Model 3000 EVOLUION) of Coral clinical systems. The commercial diagnostic kits for analysis were procured from CREST Biosystems, Ltd., Goa, India.

Study of parasitic load: At the initial and end of experimental feeding, faecal samples were collected directly from the rectum and subjected to quantitative analysis to access the parasitic load by modified McMaster's technique (Coles *et al*. 1992).

The data generated during the experiment were analyzed using according to Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The chemical composition of Palas leaf (*Butea monosperma*) is given in Table 1, which shows that the crude fibre and calcium content are higher than those reported by Neelam *et al.* (2015), the composition of plas leaf: crude protein 14.79%, crude fibre 21.74%, ether extract 2.80%, minerals 6.68%, calcium 2.54%, and phosphorus 0.24%.

Table 2. Digestibility (%) of kids fed on graded levels of palas leaf.

Attribute	T1	T2	T3	*p* value
DM	63.12±1.46	62.90±1.44	63.56±0.68	0.499
OM	66.87±0.95	67.26±1.04	69.70±0.88	0.114
CP	71.60±0.50	71.86±0.91	71.92±1.05	0.995
NFE	61.29±0.81	59.55±1.52	63.18±1.18	0.139
EE	63.45±0.59	62.44±0.37	62.50±0.30	0.233
NDF	57.62±0.54	57.24±0.71	55.53±0.51	0.055
ADF	43.24±1.10	43.66±0.74	45.30±0.52	0.225

Table 3. Feed and water intake, average daily gain and feed conversion efficiency

Attribute	Treatment			*p* value
	T1	T2	T3	
DMI (g/d)	303.3 ±24.46	299.7±8.52	302.25±13.18	0.312
DMI (% of BW)	3.63±0.23	3.80±0.34	3.58±0.34	0.469
Water intake				
kg/kg DMI	2.17±0.15	2.24±0.12	2.36±0.22	0.721
g/kgW$^{0.75}$	178.67±12.96	170.42±7.85	195.07±12.69	0.326
Feed conversion efficiency (kg/kg gain)				
DM	6.06±0.59	5.86±0.92	5.05±0.37	0.324
CP	0.88±0.06	1.0±0.16	0.89±0.09	0.763
DCP	0.63±0.04	0.72±0.11	0.64±0.04	0.767

The protein, crude fat and fibre content was within range but calcium content was higher compared to other plant leave as reported by Rai *et al*. (2007) that the average tree leaves contain 8-33% crude protein, 1-19% ether extract, 11-50% crude fibre, 36-66% nitrogen free extract, 0.2-3.0% calcium and 0.1-0.3% phosphorus.

The digestibility coefficient of various nutrients (Table 2) did not differ significantly among the treatment groups. This indicated that feeding palas leaf showed no adverse effect on rumen micro flora. The results showed higher DM and cell wall digestibility than findings of Neelam *et al*. (2015) reported *in vitro* dry-matter and cell-wall digestibility of the palas leaves was 53.20% and 34.46%, respectively.

The intake of dry matter in terms of kg/100kg body weight ranged between 3.58 and 3.80. The daily dry matter intake (Table 3) was statistically similar for all the three groups, indicating no effect of feeding palas leaf on palatability. Similarly, Lalhariatpuii *et al*. (2022) reported DMI in Black Bengal goat ranged from 2.7-3.0% of body weight. The daily water intake (Table 3) by the growing kids during digestion trial was statistically (p>0.05) similar and ranged between 2.13 and 2.34 kg/ kg DMI. Similarly, water intake in goat ranged from 2.17-2.36 kg/kg DMI reported by Kumar *et al*. (2016). The efficiency of nutrient utilization in terms of DM, CP and DCP were not influenced by feeding palas leaf.

A protein intake for a goat weighing 9.98 kg at maintenance was 0.023 kg, and an extra 0.014 kg was recommended for growth at 0.05 kg per day by NRC (2007). On the other hand, a protein intake of 55 g/day for a goat weighing 10 kg growing at the rate of 50 g/day was recommended by ICAR (2013). The daily average total protein intake of the animals in the present experiment was adequate to support the growth of animals as per the ICAR and above the NRC recommendation.

The mean body weight of all treatment groups (Table 4) was similar though there was a slight increase in the mean body weight of T3 groups. It may be due to antiparasitic effect of palas leaf.

Blood profile: The average values of various blood parameters estimated at the end of experimental feeding in kids has been presented in Table 5. There was no significant difference in hematological parameters, indicating adequate availability of digestible nutrients and plane of nutrition. The levels were within the normal range reported by Kaneko *et al*. (1997) and Rodostits *et al*. (2003) for goats. The results indicated no deleterious effect on feeding of palas leaf.

The average serum protein, albumin, globulin, glucose, cholesterol, triglycerides, Blood Urea Nitrogen (BUN) and creatinine (Table 6) of the kids under different dietary treatments were statistically similar. The levels were within the normal range reported by Kaneko *et al*. (1997) for goats. Blood urea nitrogen reflects the dietary CP intake. Thus, similar plasma urea-N and protein in the present study among treatment groups indicated that protein utilization was not disturbed due to the replacement of concentrate

Table 4. Effect of feeding palas leaf as green fodder on performance of goats

Attribute	T1	T2	T3	*p* value
Total Gain (kg)	3.91±0.33	4.54±0.56	4.65±0.31	0.244
ADG (g/day)	52.07±4.43	60.63±7.46	62.00±4.17	0.159
Feed cost (Rs)	272.30±3.67	235.91±1.28	204.19±1.98	0.142
Daily fed cost (Rs)	3.63±0.05	3.15±0.02	2.72±0.03	0.432
Gross profit (Rs)	1562±133	1819±222	1860±125	0.233
Net profit (Rs)	1290±131	1583±223	1656±125	0.114

*Gross profit: Rate of goat Rs 400/kg

Table 5. Effect of feeding graded levels of palas leaf on hematological profile

Day	T1	T2	T3	*p* value
		Red blood cells (10^6/µL)		
0	15.9 ±0.8	17.7±0.9	17.6±0.8	0.054
90	17.2±0.4	18.3±0.3	17.2±0.5	0.08
Av.	16.4	17.5	17.9	
		Haemoglobin (g/dL)		
0	8.4±0.4	8.3±0.6	8.9±0.4	0.615
90	9.1±0.4	9.7±0.3	9.3±0.3	0.505
Av.	8.9	9.1	9.2	
		White blood cells (10^3/ µL)		
0	20.8±0.7	21.6±0.4	20.2±0.9	0.431
90	19.7±0.4	16.5±0.5	18.2±2.2	0.279
Av.	20.4	19.2	19.5	
		Lymphocytes (10^3/ µL)		
0	8.8±0.8	8.3±0.28	9.4±1.1	0.512
90	5.6±0.2	5.7±0.3	6.9±1.1	0.369
Av.	7.3	7.1	8.3	
		Monocytes (10^3/ µL)		
0	0.16±0.01	0.13±0.01	0.23±0.02	0.051
90	0.15±0.01	0.11±0.01	0.14±0.02	0.086
Av.	0.15	0.12	0.18	
		Neutrophils (10^3/ µL)		
0	11.3±1.3	12.3±1.2	15.6±2.0	0.158
90	11.6±0.6	10.2±0.4	12.0±1.1	0.293
Av.	11.6	11.4	13.9	
		Haematocrit %		
0	21.13±0.50	21.17±1.37	21.35±0.33	0.559
90	23.9±1.28	24.7±0.87	23.6±0.46	0.614
Av.	22.4	22.9	22.4	
		Mean cell volume of red cells (fL)		
0	13.7±0.5	12.8±0.2	11.8±0.3	0.055
90	14.1±0.5	13.3±0.4	13.1±0.5	0.291
Av.	14	13.1	12.6	
		Mean corpuscular hemoglobin (pg)		
0	5.5±0.1	5.1±0.1	4.9±0.1	0.143
90	5.6±0.2	5.7±0.14	5.3±0.1	0.158
Av.	5.6	5.2	5.1	
		Mean cell hemoglobin concentration (g/dL)		
0	40.2±0.9	39.7±0.3	42.2±1.3	0.155
90	39.5±0.5	39.8±0.5	39.7±0.9	0.823
Av.	39.8	39.7	41.1	

Table 6. Effect of feeding graded levels of palas leaf on serum biochemical profile

Day	T1	T2	T3	*p* value
		Total protein (g/dL)		
0	6.10±0.06	6.87 ±0.25	6.42±0.2	0.052
90	5.82±0.07	5.33 ±0.14	5.61±0.2	0.147
Av.	5.98	6.15	6.08	
		Albumin (g/dL)		
0	2.48±0.09	2.33±0.09	2.35±0.19	0.569
90	2.36±0.03	2.31±0.06	2.68±0.1	0.331
Av.	2.43	2.32	2.31	
		Globulin (g/dL)		
0	3.62±0.05	4.53±0.3	4.07±0.17	0.054
90	3.45±0.08	3.14±0.18	3.55±0.17	0.338
Av.	3.55	3.83	3.76	
		Glucose (mg/dL)		
0	47.67±1.50	47.33±1.28	48.17±2.82	0.994
90	45.6±1.55	47.7±1.89	44.5±3.4	0.619
Av.	46.34	47.5	44.5	
		Cholesterol (mg/dL)		
0	71.67±2.43	73.67±1.73	63.5±7.2	0.103
90	69.34±1.82	75.86±2.91	74.72±5.8	0.121
Av.	70.5	74.75	69.1	
		Triglycerides (mg/dL)		
0	88.5±3.77	93.67±5.46	93.5±7.61	0.779
90	27.7±3.4	33.2±13.34	29.0±3.2	0.824
Av.	58	63.84	60.75	
		Blood urea nitrogen (mg/dL)		
0	15.83±1.54	14.17±0.54	13.17±1.89	0.324
90	26.8±1.48	21.3±1.51	26.3±2.57	0.179
Av.	20.9	18	20	
		Creatinine (mg/dL)		
0	1.0±0.1	0.9±0.1	1.0±0.1	0.964
90	0.8±0.1	0.9±0.1	0.9±0.1	0.869
Av.	0.95	0.9	0.95	

feed with palas leaf.

The values of serum enzyme were comparable, among different dietary treatment groups. It indicates that the feeding of palas leaf had no adverse effect on physiological functions of liver, heart or skeletal muscles. The serum Ca and P values were statistically similar among different dietary treatment groups and within the normal range given by Kaneko *et al.* (1997).

The average parasitic load (eggs per gram) at the beginning of the trial was 562.9±23.6, 500.1± 16.2 and 774.5 ± 59.3, in T1, T2 and T3, respectively. At the end of experimental trial, parasitic load (eggs per gram) was 762.8±27.4, 400.2 ±29.6 and 338.4 ±39.8 in T1, T2 and T3, respectively. The decrease in parasitic load by more than 50% by feeding palas leaf.

Total tannin content was found 10.80 ± 0.70 mg of GAE/g of extract in palas leaf. Similarly, Rubanza *et al*. (2005) reported total tannins 8.4-25.6 mg of GAE/g in Browse tree leaves. Singh *et al* (2015) reported that complete mortality of *H. contortus* worms at the concentrations of 100 mg/mL in 6 h and of 50 mg/mL in 8 h. Tannins at more than 50 g/kg DM, affect the feed intake and rumen function (Norton and Ahn 1997) also as an anti-nutritional factor to ruminants (Kemboi *et al.* 2023). Nguyen (2005) reported that anthelmintic-resistant gastrointestinal parasites was

Table 8. Effect of feeding palas leaf on parasitic load in black Bengal goat

	Egg per gram			
	Initial	Final	Difference	% decrease
FP	562.9 ±23.6	762.8±27.4	199.9±22.0	+36.6
T1	500.1± 16.2	400.2 ±29.6	-99.9 ± 28.7	- 19.8
T2	774.5 ± 59.3	338.4 ±39.8	-436.1 ± 70.6	-53.4
CD (0.05)	1.75	1.75	1.75	

Table 7. Effect of feeding palas leaf on serum enzyme and mineral profile

Day	T1	T2	T3	*p* value
	Alanine aminotransferase (U/L)			
0	14.67±1.26	13.83±0.6	10.33±1.58	0.054
90	20.83±3.06	21.83±0.87	20.17±2.14	0.867
Av.	17.75	17.83	15.25	
	Aspartate aminotransferase (U/L)			
0	61.5±1.78	60.33±1.05	64.83±2.12	0.190
90	66.5±1.52	63.33±0.88	69±4.28	0.349
Av.	64	60.83	66.92	
	Lactate dehydrogenase (U/L)			
0	423±21	434±23	463±11	0.641
90	428±25	428±20	455±14	0.569
Av.	425	431	459	
	Alkaline phosphatase (U/L)			
0	120±4	138±12	133±8	0.431
90	116±6	136±13	131±7	0.328
Av.	118	137	132	
	Calcium (mg/dL)			
0	10.05±0.45	8.83±0.37	9.65±0.76	0.316
90	9.22±0.29	8.77±0.19	9.42±0.49	0.418
Av.	9.64	8.8	9.54	
	Phosphorus (mg/dL)			
0	8.85±0.28	8.00±0.42	8.28±0.67	0.323
90	11.07±0.53	10.15±0.54	11.05±0.57	0.305
Av.	9.96	9.08	9.67	

controlled by condensed tannin-containing forages and decrease fecal egg counts and may decrease hatch rate and larval development in faeces of sheep and goats. Similarly, Iqbal *et al.* (2006) reported dose dependent (1-3 g/kg) and a time - dependent anthelmintic activity in sheep by crude powder of *Butea monosperma* seeds. Ash of leaves of *B. monosperma* and stem, root, flower of *Piper longum* (Pippali) has 98% recovery from giardiasis (Fageria and Rao 2015). The current research findings indicate that incorporating Palas leaf as a replacement for up to 25% of concentrate mixture, on an iso-nitrogenous basis, has no detrimental effects on the nutritional and growth parameters of growing kids. In addition it offers antiparasitic benefits to the small ruminants.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support received from ATARI, Patna to carry out this work as a part of technical programme of on -farm testing.

REFERENCES

AOAC. 1999. Official Methods of Analysis. 14th ed. Association Official Analytical Chemists Washington DC, USA.

Coles G C C, Bauer F H M, Borgsteede S, Geerts T R, Klei M A and Waller Taylor P J. 1992. World association for the advancement of veterinary parasitology (W.A.A.V.P.) methods for the detection of anthelmintic resistance in nematodes of veterinary importance. *Veterinary Parasitology* **44**: 35-44.

Fageria D and Rao D V. 2015. A review on *Butea monosperma* (Lam.) kuntze: A great therapeutic valuable leguminous plant. *International Journal of Scientific and Research Publications* **5**(6): 1-9.

ICAR. 2013. *Nutrient Requirement of Sheep, Goat and Poultry.* Indian Council of Agricultural Research, New Delhi, India.

Iqbal Z, Lateef M, Jabbar A, Ghayur M N.and Gilani A H. 2006. *In vivo* anthelmintic activity of *Butea monosperma* against Trichostrongylid nematodes in sheep. *Fitoterapia* **77**: 137-40

Kaneko J J, Harvey J W and Bruss M L. 1997. *Clinical Biochemistry of Domestic Animals*. 5th ed., Academic press, San Diego, USA.

Kemboi F, Ondiek JO, King'ori A M and Onjoro P A. 2023. Effects of anti-nutritive factors on ruminants and methods to alleviate them: A review. *International Journal of Veterinary Sciences and Animal Husbandry* **8**(1): 18-27

Kumar D, Parnerkar S, Patel G R and Thube H. 2016. Effect of substitution of soybean meal by detoxified Jatropha (*Jatropha curcas)* cakes on diet digestibility, kid's growth and nutrient efficiency. *Animal Nutrition and Feed Technology* **16**: 143-54.

Lalhriatpuii M, Chatterjee A, Satapathy D, Mohammad A, Rai S, Bhakat C, Mandal D K, Dutta T K, and Patra A K. 2022. Effect of dietary inorganic and organic chromium on nutrient utilization and growth performance in Black Bengal goats (*Capra hircus*) *Small Ruminant Research* **216**: 106797.

Neelam, Dwivedi K N and Ram B. 2015. Palash (*Butea monosperma* lam. Kuntze.): A Review**,** *International Journal of Ayurveda and Pharmaceutical Chemistry* **2**(3): 95-104.

Nguyen Kim Lin T, Preston R, Dinh Van Binh and Nguyen Duy Ly. 2003. Effects of tree foliages compared with grasses on growth and intestinal nematode infestation in confined goats. In: *Proceedings of the National Seminar*-Workshop on Sustainable Livestock Production on Local Resources, Hue City.

Nguyen T M, Binh D V and Ørskov E R. 2005. Effect of foliages containing condensed tannins and on gastrointestinal parasites. *Animal Feed Science and Technology* **121**: 77-87

Norton B W and Ahn J H. 1997. A comparison of fresh and dried *Calliandra calothyrsus* supplements for sheep given basal diet of barley straw. *The Journal of Agricultural Sciences* **129**: 485-94.

NRC. 2007. *Nutrient requirements of small ruminants: Sheep, goats, cervids, and new world camelids*. National Academy Press, 384 pp.

Rai P, Gupta A and Samanta A K. 2007. Tree leaves, their production and nutritive value for ruminants: A review. *Animal Nutrition and Feed Technology* **7**(2):135-59.

Rodostits O M, Gay C C, Blood D C and Hinchcliff K W. 2003. *In Veterinary Medicine- A text book of the diseases of cattle, sheep, pig, goats and horses*. 9th ed. Book Power, China.

Roy A K, Agrawal R K, Chand S and Ahmed S. 2020. Database of forage crop varieties: 2020. AICRP on forage crops and utilization, ICAR-IGFRI, Jhansi.

Rubanza C D K, Shem M N, Otsyina R, Bakengesa S S, Ichinohe T and Fujihara T. 2005. Polyphenolics and tannins effect on *in vitro* digestibility of selected *Acacia* species leaves. *Animal Feed Science and Technology* **119**(1-2): 129–42.

Singh A K, Das G, Roy B, Nath S, Naresh R and Kumar S. 2015. Prevalence of gastro-intestinal parasitic infections in goat of Madhya Pradesh, India. *Journal of Parasitic Diseases* **39**: 716–19.

Snedecor G W and Cochran W G. 1991. *Statistical Methods*, 8th ed. Oxford and IBH Publishing Company, Kolkata, India.

Talapatra S K, Ray S C and Sen K. 1940. Estimation of phosphorous, chloride, calcium, sodium and potassium in food stuffs. *Indian Journal of Veterinary Science and Animal Husbandry* **10**: 243-58