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Seasonal Variation in Nutrient Utilization and Growth Performance of Small Ruminants Under Grazing on Silvipasture System

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ABSTRACT

Seasonal variation in chemical composition as well as nutrient utilization and growth performance of *Jalauni l*ambs and *Bundelkhandi*kids were studied under grazing on two tier silvipasture consisting (stocking rate of 2ACU/ha) of *Hardiwickia binata* tree (one tier) and grass species namely *Cenchrus ciliaris, Crysopogon fulvus, Panicum maximum and Stylosanthes hamata* (another tier) during growing (August-October) as well as post-growing (November-January) seasons in Bundelkhand region along with supplementation (1% of body weight) of concentrate mixture. Average dry matter (DM) content of pasture forages increased with advancement of maturity from 31.56% during growing season to 49.44% in post growing season, with concomitant increase in neutral detergent fiber (NDF) content from 70.23% to 73.11%, and reduction in crude protein(CP) content from 8.29% to 5.45%. DM intake was comparable in both the species, however, significantly ($P<0.05$) higher in growing than post growing season. Similarly, digestibility of nutrients namely DM, OM, NDF and CP were higher in growing season than post growing season in both the species. Intake (g/$W^{0.75}$) of digestible crude protein (DCP) in both lambs and kids was higher (5.76 vs 5.64) in September as compared to December (2.98 vs 3.14). Metabolizable energy (ME) intake (kj/$W^{0.75}$) also followed the same trend. Daily live weight gain (g/d) in both lambs and kids was comparable, however, significantly ($P<0.05$) higher in growing season than post growing season. It was concluded that nutrient intake, nutrient utilization and growth performance were significantly ($P<0.05$) affected during post growing season due to deterioration of nutritive value of available pasture biomass, however, comparable results were observed in both the species.

Key words: *Bundelkhandi* Kids, *Jalauni* lambs, Chemical composition, Growth performance, Nutrient utilization, Seasonal variation, Silvipasture

INTRODUCTION

Small ruminants play an important role in the food and nutritional security of millions of rural people especially the landless, marginal and small farmers in arid and semiarid rain-fed regions of India. The socio-economic value of small ruminant rearing as compared to other livestock species, for poor farmers is immense (Salem and Smith, 2008).Goats and sheep are multipurpose animals which provide hair, wool, meat, milk and skin. The production of meat from goats and sheep play a vital role in the supply of animal protein for the people of our country. Agricultural farming in semiarid and arid regions is practiced on a limited scale due to scanty and uncertain rains and shortage of irrigation water leaving most of these regions to be used as rangeland grazing. Sheep and goats raised under these conditions are generally grazing on degraded rangelands and or offered low quality fibrous feedstuffs like cereal straws and stubbles. Small ruminant production in village systems in tropical countries is often characterized by poor growth rates and high mortality (Devendra and Burns, 1983). The productivity of small ruminants can be improved by improving the nutrition either through concentrate feeding or provision of additional forage (Pathasarathy *et al.,* 1984; Das and Singh, 1999;Das *et al*, 2007; Das *et al.,* 2011a). Silvipasture system is an efficient and integrated land use management system of tree species, fodder and or livestock specially suited for rearing small ruminants. However, nutrient composition of pasture varies according to season (Das *et al.,* 2011b). The present experiment was conducted to study the seasonal variation in nutrient utilization and growth performance of sheep and goat under grazing on silvipasture system.

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MATERIALS AND METHODS

The experiment was conducted on 10-12 months aged growing lambs and kids. Twenty five each of Jalauni lambs (average body weight 26.20±0.91 kg) and Bundelkhandi kids (average body weight 25.15±0.78k g) were allowed to graze stocking rate of 2ACU/ha) on two tier silvipasture consisting of *Hardiwickia binata*tree (one tier) and grass species namely *Cenchrus ciliaris, Crysopogon fulvus, Panicum maximum ands tylosanthes hamata* (another tier) during growing (August-October) as well as post growing (November-January) seasons at Central Research Farm, ICAR-Indian Grassland and Fodder Research Institute, Jhansi. The total annual forage production potential of the silvi-pasture system from grass and tree component were estimated as per the procedure described by Prajapati(1980).The animals were allowed to graze on *H. binanata* based silvi-pasture for 7 hours from 9 am to 4 pm daily. All the animals were also supplemented with concentrate mixture (consisted of mustard cake, maize, wheat bran, mineral mixture and common salt at 35: 30: 33: 1: 1) at1.0% of their body weight at stall after returning back from grazing. Live weight changes of animals were recorded fortnightly. After 45 days of experimental grazing, digestion trial of 6 days duration was conducted in the month of September and December on 6 animals each from lambs and kids using lignin as internal marker (Costa *et al.,* 2019). Total faeces voided during 24 hrs were collected using faeces collection bags. A direct observation and simulation method was used to determine the botanical composition of the diet consumed by the animals. Forage samples of the ingested species that were consumed by the individual animals were hand clipped for three consecutive days for the entire grazing period from 9 am to 4 pm. The representative samples of forage as well as concentrate and faeces collected during digestion trial were analyzed for dry matter (DM), ash and ether extract according to AOAC (1995). Samples were also analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin (Goering and Van Soest, 1970).Total nitrogen was determined by micro-kjeldhal method (AOAC 1995). Data were subjected to analysis of variance. Mean data were compared for species and also compared over different seasons for statistical differences using Student's t-test (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Rain fall (Fig 1) during growing season (August to October) which is considered as the main season of the vegetative growth was 341.8 mm and during non-growing season (November to January) there was very little rainfall (24.4 mm). The mean biomass yield from pasture was 5.89 ton DM/ha and pruned foliage yield as top feed was 0.90 ton DM/ha. Thus, the total yield was 6.79 ton DM/ha, was similar (6.8 ton/ha) to *Albizia procera* based silvipastoral system (Palsaniya *et al.,* 2012).Ram *et al.* (2016) also recorded a similar biomass yield in *H. binata* based silvipastures of different grasses and legumes under semiarid climatic conditions of Bundelkhand region.

Average chemical composition of pasture indicated that DM content varied from 31.56% during growing season to 49.44% in post growing season (Table 1). The total ash contents in all the feeds were similar during both the seasons. CP content varied from 10.10% in *S. hamata* to 6.26% in *C. ciliaris* during growing season, and 7.67% in *H. binata* to 4.02% in *C. fulvus* during post growing season. Keba *et al.* (2013) also reported similar CP content in *C. ciliaris* and *P. maximum*. However, Singh and Singh (2017) reported lower CP content in *C. ciliaris* (5.35%), *C. fuvus* (3.60 %)and in *H. binata* (7.80%) than the present findings which might be due to different stage of harvesting of plant samples. NDF contents of legume component varied from 62.21% in *H. binata* to 65.36% in *S. hamata,* whereas in grasses the NDF content ranged

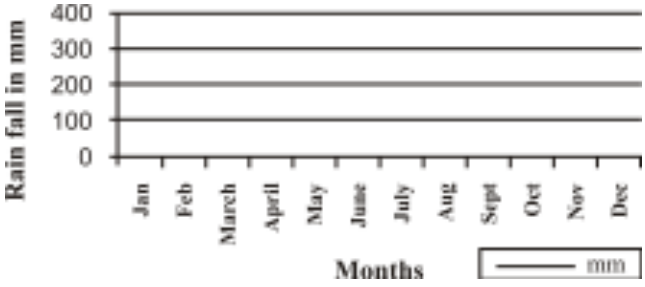

Fig. 1. Annual rain fall

from 73.86% in *P. maximum* to 80.35% in *C.fulvus*. Higher lignin content in *H. binata* leaves as compared to other component of pasture was observed in both the seasons and corroborated with the earlier study of Chitra (2018).The average crude protein content of pasture biomass varied from 8.29% in September to 5.45% in December whereas, on the other hand, NDF content increased from 70.23% during growing season to 73.11% in post growing season. Similarly, lignin content ranged from 7.92% in September to 9.36% in December. The differences in fiber components between season suggested that less amount of rainfall (Fig. 1) caused faster maturation during post growing season and this resulted in higher cell wall contents and lower cell contents than those of growing season. Shinde *et al.* (2001) earlier observed that crude protein (CP) content of ground vegetation under semi-arid condition declined from 9.9% in monsoon to 7.2% during winter. Evitayani *et al.* (2004) also observed that the crude protein (CP) content of pasture grasses declined from rainy season to dry season. Salim *et.al.* (2003) however, reported higher CP content during post growing season as compared to monsoon season which might be due to fertilizer application in the pasture 15 days before harvesting. Mero and Udén (1998) have reported that the levels of protein at young stages of plant growth during monsoon are usually high; at the end of vegetative stage achieve the maximum values and declining as plants matured. Subhalakshmi *et al.* (2011) reported that the chemical composition of pasture is influenced by season, type of soil, stocking density, type grazing pasture and climate. The nutritional content of any forage is dependent on its nutrient content such as protein, which is essential for the growth, development and production status of ruminant animals. During post growing season in the present experiment the crude protein content of herbaceous biomass was far below the critical level as recorded earlier by Mahala *et al.* (2009).

The plant species that were consumed by small ruminants under the trial primarily included *C. ciliaris, C. fulvus, P. maximum, S. hamata and H. binata.* DM intake data indicated that DM intake by lambs and kids was comparable in both the seasons (Table 2) and corroborated with the findings of Kabir *et al.* (2004) where no difference in DM intake was observed in sheep and goat grazed with protein supplementation. Salim *et al.* (2003),however, recorded significantly ($P<0.05$) higher herbage DM consumption by sheep than goat. Intake level of 40-90 g DM/kg$W^{0.75}$ has been reported as normal for grazing ruminants (Cordova *et al.,* 1978). The DM intake values in goats and sheep in the present

Table 1. Seasonal variation in chemical composition of pasture vegetation (%DM basis)

Forage species	Season					
	Growing season					
	DM	CP	NDF	ADF	ADL	Ash
C. fulvus	31.35	8.17	75.08	46.93	4.97	10.70
P. maximum	21.22	7.51	73.86	49.82	6.47	10.79
S. hamata	29.32	10.10	62.41	43.82	8.56	5.88
C. ciliaris	37.63	6.26	77.60	48.20	9.25	10.79
H. binata	38.29	9.40	62.21	44.20	10.38	9.12
Post growing						
C. fulvus	52.56	4.02	80.35	48.33	6.60	10.22
P. maximum	37.71	4.89	75.95	48.55	7.93	10.02
S. hamata	58.74	6.30	65.36	51.43	10.75	4.88
C. ciliaris	51.77	4.35	78.29	55.82	8.59	7.99
H. binata	46.43	7.67	65.61	50.37	12.94	8.09

study also fall within this range and were in agreement with earlier report of Sharma *et al.* (1998) and Chaturvedi and Sahoo(2013). In the present experiment, total DM intake or DM intake as percentage of body weight was comparable in both kids and lambs and intake of pasture dry matter decreased by 19.93% in kids and21.48% in lambs from growing to post-growing season. Similarly, Sankhyan *et al.* (1999) also observed that the DMI of sheep decreased from monsoon (2.1%BW) to winter(1.8% BW). Pasture intake depends upon digestibility of pasture, rumen fill, metabolic factors, chemical and physical properties of concentrate and stage of growth (Das and Singh, 1999).Sharma *et al.* (1998),however, found no seasonal difference in feed consumption by goats grazing in semi-arid pasture. In the present study, more biomass intake by both sheep and goats during growing season than post growing season might be due to differences in palatability and lower nutritive value of pasture biomass. The digestibility of DM, OM and NDF were comparable in

Table 2. Nutrient utilization and growth performance of *Jalauni* lambs and *Bundelkhandi* kids grazed on *H. binata* based silvopasture system

Particulars	Season/Species				
	Growing		Post growing		
	Kids	Lambs	Kids	Lambs	SE
DMI%, BW	3.84^{b}	4.05^{b}	3.39^{a}	3.50^{a}	0.08
Pasture intake,% BW	2.90^{b}	3.15^{b}	2.34^{a}	2.45^{a}	0.09
Pasture intake,% DM	75.63	77.76	68.85	69.88	1.07
DMI (g/$W^{0.75}$ kg)	85.96^{b}	91.54^{b}	77.77^{a}	80.39^{a}	1.70
DCP intake (g/d)	64.56^{b}	65.35^{b}	35.80^{a}	38.10^{a}	3.12
DCPI (g/$W^{0.75}$ kg)	5.76^{b}	5.64^{b}	2.98^{a}	3.14^{a}	0.29
DOMI (kg/d)	0.63^{b}	0.68^{b}	0.53^{a}	0.54^{a}	19.93
DOMI (g)/kg $W^{0.75}$	56.64^{b}	59.01^{b}	43.39^{a}	44.05^{a}	1.67
N intake(g/kg DOMI)	27.92	27.48	31.09	30.50	0.50
ME (MJ/d)	9.97^{b}	10.31^{b}	8.31^{a}	8.55^{a}	0.17
ME (kJ/$W^{0.75}$)	890^{b}	893^{b}	687^{a}	696^{a}	23.92
Apparent digestibility (%)					
DM	68.55^{b}	66.44^{b}	58.67^{a}	56.84^{a}	1.18
OM	71.67^{b}	69.85^{b}	62.05^{a}	61.10^{a}	1.09
CP	58.30^{b}	55.83^{b}	35.49^{a}	37.84^{a}	2.31
NDF	69.15^{b}	67.00^{b}	58.75^{a}	55.60^{a}	1.30
ADF	63.43^{b}	61.78^{b}	47.36^{a}	46.87^{a}	1.75
EE	73.94	72.20	71.24	69.55	0.78
NFE	76.03^{bq}	71.91^{bp}	67.42^{a}	64.24^{a}	1.12
Nutritive value (%)					
DCP	6.70^{b}	6.16^{b}	3.87^{a}	3.96^{a}	0.29
TDN	68.31^{b}	64.48^{b}	58.44^{a}	57.19^{a}	1.13
ME(MJ/kg)	10.36^{b}	9.78^{b}	8.86^{a}	8.67^{a}	0.17
Daily gain (g/d)	55.74^{b}	52.38^{b}	20.56^{a}	21.67^{a}	2.98

^{a,b}Means bearing different superscripts in each species class indicate difference (P<0.05)due to season; ^{p,q}Means bearing different superscripts in each species class indicate difference (P<0.05) due to species

both the species as reported earlier by Salim *et al.* (2003) and Ranilla *et al.* (2005). However, significant($P<0.05$) seasonal variation in digestibility was observed in both the species which might be related to changes in the chemical composition particularly in fiber, lignin and silica contents and corroborated with the findings of Sun *et al.* (2014) where it was reported that the nutrient digestibility of forages in goats under grazing were higher during rainy season and decreased significantly during the winter ($P<0.05$).Digestibility of crude protein of ingested forage was higher ($P<0.05$) in both the species during growing season than non-growing season and corroborated well with earlier findings of Shinde *et al.* (1998) and Sun *et al.* (2014). DCP intake (g/kg$W^{0.75}$) by both lamb and kids was significantly ($P<0.05$) higher (5.76 vs 5.64) in September as compared to December (2.98 vs 3.14), which might be due to decreased in protein content of available pasture biomass during post growing season. Chaturvedi and Sahoo (2013) however, observed much higher DCP intake in sheep from similar type of ration which might be due to superior quality of supplemented concentrate and roughage fed to the experimental animals. Efficient microbial growth in the rumen requires a balanced supply of nitrogen (amino acids and ammonia) and energy (Das and Singh, 1999). Present study indicated that the N intake per kg DOM intake in kids and lambs during September and December was sufficient for efficient rumen fermentation and did not show any significant difference but availability of energy in terms of ME (KJ/ $W^{0.75}$) decreased significantly ($P<0.05$) during post growing season. Nutritive value in terms of DCP and TDN were comparable in both the species and significantly ($P<0.05$) lower during post growing season as compared to growing season. Similar DCP and ME contents were recorded by Salim *et al.* (2003) in small ruminants under grazing with concentrate supplementation. The quality and quantity of tropical herbage is known to decline markedly after rainy season during onset of winter and causes major constraint for small ruminant production as it was observed in the present study.Daily live weight gain was comparable for both the species, however, both the species showed significant difference in daily gain between growing and non-growing season. Salim *et al.* (2003) also recorded no differences between sheep and goats for live weight gain under grazing with concentrate supplementation. Daily gain (g/d) in both the species in present experiment corroborated with the earlier findings of Dutta *et al.* (2003). Similarly, Mekuriaw and Asmare(2018) also observed a daily gain of 53-5 g/d in Washera lambs fed natural pasture hay supplemented with concentrate and tree leaves. However, Chaudhary *et al.* (2015) reported much higher body weight gain in Sirohi kids which might be due to better quality of pasture and higher rate of supplemental concentrate mixture.

CONCLUSION

It was concluded that nutrient utilization and growth performance were comparable between lambs and kids, however, nutrient intake and utilization in both the species reduced significantly during non-growing season due to deterioration of pasture quality which is reflected from the lowered body weight gain in both the species. Present findings also indicated that *H. binata* based silvipastures under semiarid situation may be utilized for rearing small ruminants for sustainable production.

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