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Nutrient Utilization and Growth Performance of *Jalauni* Lambs Grazed on Three Tier Silvipasture System

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ABSTRACT

Chemical composition of pasture biomass as well as nutrient utilization and growth performance of *Jalauni* lambs were studied under grazing on three tier silvipasture consisting (stocking rate of 2ACU/ha) of grass (*Cenchrusciliaris*), legume (*Stylosanthesseabrana*), shrubs(*Ziziphusxylopyrus, Ziziphusmauritiana, Acacia catechu)* and tree (*Hardiwickiabinata*) during growing (August-October) as wellas post-growing (November-January) periods of pasture in Bundelkhand region along with supplementation (1% ofbody weight) of concentrate mixture. Average dry matter (DM) content of pasture increased with advancement of maturity from 42.89% during growing period to 52.59% in post growing period, with concomitant increase in neutral detergent fiber (NDF) content from 57.67% to 61.36% and reduction in crude protein(CP) content from 11.55% to 8.64%. DM intake of lambs was significantly ($P<0.05$) higher in growing than post growing period. Similarly, digestibility of nutrients namely DM, OM, NDF and CP were higher in growing than post growing period. Intake ($g/W^{0.75}$) of digestible crude protein (DCP) was higher (6.15) in September as compared to December (3.74). Metabolizable energy (ME) intake ($kJ/W^{0.75}$) also followed the same trend.Daily live weight gain (g/d) of *Jalauni* lambs was also significantly ($P<0.05$) higher in growing than post growing period. It was concluded that nutrient intake, nutrient utilization and growth performance of *Jalauni* lambs were significantly ($P<0.05$) affected during post growing period due to deterioration ofnutritive value of available pasture biomass, however, three tier sylvipasture system in the present study could be utilized for rearing of small ruminants for sustainable production.

KEYWORDS: Chemical composition, Growth performance, *Jalauni* lambs, Nutrient utilization, Seasonal variation, Three tier silvipasture

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INTRODUCTION

Silvipasture is the practice of integrating trees, forage, and the grazing of domesticated animals in a mutually beneficial way and is well suited for rearing domesticated animals, particularly small ruminants. Sheep play a significant role in the subsistence economy of farmers in the country. Sheep provides wool, meat and raised generally under grazing on degraded range lands and or offered low quality fibrous feedstuffs like cereal straws and stubbles. The production of meat from sheep play role in the supply of animal protein for human consumption. Small ruminant production in village systems in tropical countries is often characterized by poor growth rates and high mortality (Suresh and Chaudhary, 2015). The productivity of grazing animals can be enhanced by improving the nutrition either through concentrate feeding or by providing additional forage (Salem, 2010).Although the potential of silvipastoral systems in enhancing fodder production is widely known but there is a paucity of information on nutritional aspects of animal grazing freely on such reconstituted silvipasture. The objectives of the present experiment were to assess seasonal variations on intake,nutrient utilization and growth performance of *Jalauni* lambs kept on three tier silvipasture system.

MATERIALS AND METHODS

Twenty *Jalauni* lambs of 9-11 months age (average body weight 25.32± 1.46)were allowed to graze on 1.65 ha (stocking rate of 2 ACU/ha)for 7 hours daily in 6 years old synthesized (3 tier) silvipasture comprising of grass (*Cenchrusciliaris*),

legume (*Stylosanthesseabrana*), shrubs (*Ziziphusxylopyrus, Ziziphusmauritiana, Acaciacatechu)* and tree (*Hardiwickiabinata*), The animals were also supplemented with concentrate mixture (comprising of mustard cake, maize, wheat bran, mineral mixture and common salt; 35: 50: 13: 1: 1)@ 1.0% of their body weight at Central Research Farm, Indian Grassland and Fodder Research Institute, Jhansi during growing (August-October) as well as post growing (November-January) periods. The annual forage production potential of the silvipasture system from ground and above ground vegetations were estimated as per the procedure described by Prajapati, (1980).Body weight of animals were recorded fortnightly. After 50 days of experimental grazing, digestion trial of 6 day duration was conducted in the month of September and December on 6 animals each following lignin as internal marker (Ranjhan,1994). Total faeces voided for 24 hr were collected using faeces collection bags.

Botanical composition of the diet

A direct observation and simulation method was used to determine the botanical composition of the diet consumed by the animals. Samples of the ingested species that were being taken by the animals were hand clipped for three consecutive days. The individual animals were observed and forage samples were collected for the entire grazing period from 9 am to 4 pm (Pepeta et al., 2022).

Analysis of samples and data

The representative samples of feeds 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). Mean data were compared over different seasons for statistical differences using Student's t-test (Snedecor and Cochran, 1989)

RESULTS AND DISCUSSION

Chemical composition of silvipasture

Chemical composition of pasture forages in silvipasture system indicated that DM content of different forages varied from 38.25% (*C.ciliaris*) to 47.26% (*A. Catechu*) during growing period and 45.00% (*H.binata*) to 59.53% (*Z.xylopyrus*) in post growing period (Table 1). Similar to present findings, Navaleet al.(2022) also recorded higher DM content (62.50%) in *A. catechu* among different forage species. The total ash contents in all the feeds were similar during both the periods. Similar to the present finding, Dattet al.(2008) also reported an average OM concentration of around 90% in different fodder tree leaves. CP content varied from 15.48% in *A. catechu* to 6.84% in *C.ciliaris* during growing while during post growing period the values range from 13.57% (*A.catechu*) to 3.83% (*C.ciliaris*). Jindal and Satpal,(2020) also reported similar CP and NDF content in different *C.ciliaris* varieties. However, Coelho et al.(2018) reported higher CP content (9.8%) and low lignin content (2.2%) than the present findings which might be due to different stage of harvesting of plant samples.The frequency of harvesting also in general can promote improvement in the quality of the nutritional traits of warm-season grasses.

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

Forage species	Period					
	Growing Period					
	DM	CP	NDF	ADF	Lignin	Ash
Z.xylopyrus	46.96	12.96	47.23	35.44	10.58	7.01
Z.mauritiana	41.08	13.35	49.98	35.49	8.88	7.15
A. catechu	47.26	15.48	51.35	39.09	9.55	6.73
H. binata	44.57	10.20	58.87	38.13	10.84	9.08
S. seabrana	39.22	10.52	61.17	45.99	9.40	6.42
C. ciliaris	38.25	6.84	77.47	50.49	6.55	7.74
	Post growing Period					
Z.xylopyrus	59.53	10.74	50.17	40.88	11.17	7.64
Z.mauritiana	45.75	10.91	52.09	39.60	11.98	6.92
A. catechu	50.65	13.57	54.53	43.04	12.32	8.91
H. binata	45.00	8.14	62.97	45.14	13.4	9.69
S. seabrana	58.74	6.48	69.98	49.59	10.69	5.02
C. ciliaris	55.90	3.83	78.44	54.14	7.26	7.25

NDF contents of browse legume component varied from 47.23% in *Z.xylopyrus* to 54.53% in *A.catechu*. Similarly, Hassen et al.(2017)also reported that almost all browse species had a moderate to high crude protein (CP) content (52.4 - 220 g/kg DM), moderate neutral detergent fiber (283 - 552 g/kg DM) and acid detergent fiber (128 -433 g/kg DM) contents.Higher lignin content was observed in *H. Binata* as compared to other legumes in both the seasons and corroborated with the earlier study of Singh et al.(2016). With the advancement in plant maturity from September to December, the average crude protein content of pasture biomass was decreased by 22.51% whereas on the other hand, NDF and lignin content was increased by 6.40% and 19.57%, respectively during post growing period. Similarly, Singh and Todaria,(2012) reported that the CP contents of MPTs foliage declined as the season proceeded from summer to winter, i.e., from younger to mature leaves. This may be attributed to the dilution effect, which happens when nutrients (particularly N) are redistributed to other plant parts at the end of the growth cycle. Navaleet al.(2022).also reported the highest CP content in the spring season leaves (15.35%) and the lowest in winter (10.75%) and CF (20.58–28.94%) and carbohydrate contents (69.77–75.78%) had an opposite trend. Subhalakshmi et al.(2011) reported that the chemical composition of pasture is influenced by season, type of soil, stocking density, type of 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 growing phase most of the pasture components were in pre-flowering/full bloom stage, during which the nutrient concentration is maximum.The change in nutrient composition could be correlated with stage of maturity.The differences in fiber components between season suggested that less amount of rainfall (Fig. 1) and lower temperature tend to affect the photosynthetic process,caused faster maturation resulting in lower in proximate composition during post growing period and this resulted in higher cell wall contents and lower cell contents than those of growing season (Ravhuhali et al.,2022).

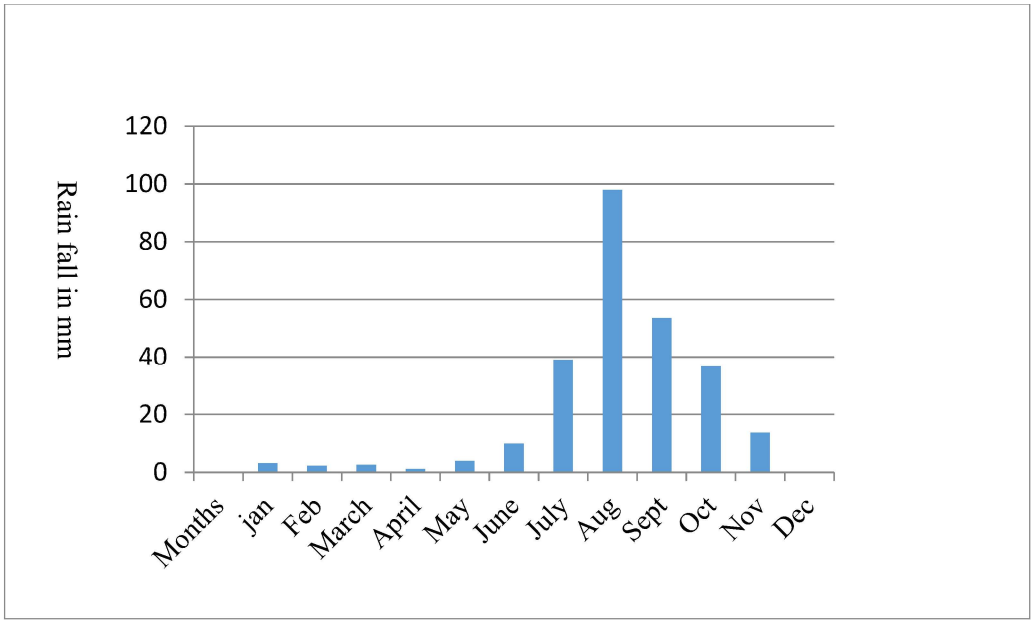

Fig-1.Rainfall pattern during the growing and post growing season

Nutrient intake and digestibility

The forage biomass that was consumed by the animals under grazing were primarily consisted of grass (*C. cilliaris)*, legume (*stylosanthesseabrana)* shrubs (%(*Z. xylopyrus, Z.mauritianaA. catechu* and trees *(H. binata)*.The present finding on dry matter intake from grazing during digestion trial indicated that daily DM intake (kg/100 kg body weight) in sheep was decreased from growing to non growing period of pasture biomass (Table 2). Das et al.(2021) also reported that pasture DM intake by the growing lambs was 3.15% during August to September and reduced to 2.45% during November to January while grazed on *H.binata* based sylvi-pasture system.

Table 2.Nutrient intake in *Jalauni* lambs from grazing in three-tier silvipasture system

Parameters	Growing period	Post growing period	*SEM*	*P Value*
Pasture intake(kg)	0.832	0.802	0.05	0.537
Concentrate intake(kg)	0.283	0.342	0.02	0.003
Total DM intake(kg)	1.114	1.144	0.06	0.585
DMI%BW	3.90^{b}	3.41^{a}	0.12	0.004
Pasture intake, % B W	2.91^{b}	2.39^{a}	0.12	0.003
Pasture intake,% DMI	74.38	71.10	2.03	0.064
DMI g/kg $W^{0.75}$	89.57^{b}	79.93^{a}	4.01	0.043
CPI (g)/kg $W^{0.75}$	10.61^{b}	8.15^{a}	0.49	0.001
DCPI (g)/kg $W^{0.75}$	6.15^{b}	3.74^{a}	0.28	0.000
TDNI (g/kg $W^{0.75}$)	59.19^{b}	45.96^{a}	0.83	0.002
MEI (kJ/ kg $W^{0.75}$)	863.16^{b}	695.26^{a}	13.19	0.015
N intake (g/kgDOMI)	32.34	31.21	0.87	0.230

*Means bearing different superscript in a row differ significantly (P<0.05)

A rapid increase in the herbage fiber, namely the ADF content, over time from the growing to post growing season and the maturity-driven decline in forage quality negatively affects forage DMI (Van Soest, 1994). Xiao et al.(2020) also reported that the change of grazing season (from warm season to cold season) had a negative effect on DMI. This is because there were of higher ADF and NDF concentrations, harder stems, and fewer leaves in pasture biomass in the cold season, therefore, Tibetan sheep had lower DMI in the cold season. Similarly, Askar et al.(2014) also reported that increased forage lignin and consequent decline in digestibility have negative effects on voluntary intake. The grazing season can also indirectly affect DMI. It can reduce the bite weight and thus the DMI. Nitrogen content and cell wall constituents are important factors which determine feed intake. N content has a significant influence on microbial activity in the rumen, and the cell wall content affects the outflow rate of rumen contents (Weston, 2002).Mir et al.(2018) and Amiri et al. (2012) reported that due to increase in fibre and lignin content and decreasein CP content of the feed with maturity directly affects the intake by decreasing the palatability. Similarly, Carvalho et al.(2022) also reported greater DMI during the rainy seasonby the experimental ewes, due to better forage nutritive value relative to other seasons. Pasture intake depends upon digestibility of pasture, rumen fill, metabolic factors, chemical and physical properties of concentrate and stage of growth. DM intake(g) per kg metabolic body weight in *Jalauni* lambs ranged from 89.57 to 79.93, respectively, in different seasons. However, Shinde and Mahanta,(2020) reported lower DM intake (g/ $kgW^{0.75}$) values ranging from 49.6 in monsoon to 43.7 in winter in sheep grazed on range land which might be due to lower biomass availability from such pasture. Similar with the present findings, DM intake levels of 40-90(g/ kg $BW^{0.75}$) have been reported as normal for grazing ruminants (Cordova et al.,1978).

Digestibility of DM, OM,CP and NDF were significantly ($P<0.05$) higher in growing than in post growing period (Table 3). This indicates the impact of seasonality on forage nutritive value and, consequently, nutrient utilization by the lambs.

Table 3.Nutrient utilization and growth performance of *Jalauni* lambs grazed on tree-tier silvipasture system

Apparent digestibility(%)	Growing period	Post growing period	*SEM*	*Pvalue*
DM	61.28^{b}	52.85^{a}	0.96	0.000
OM	64.95^{b}	57.36^{a}	0.69	0.000
CP	58.04^{b}	46.01^{a}	1.45	0.000
NDF	56.49^{b}	51.10^{a}	1.10	0.004
ADF	51.21^{b}	44.53^{a}	1.11	0.000
Cellulose	70.26^{b}	66.28^{a}	1.98	0.078
Nutritive value(%)				
DCP	6.97^{b}	4.72^{a}	0.24	0.000
TDN	65.61^{b}	57.41^{a}	0.92	0.000
ME(Mcal/kg)	2.35^{b}	2.01^{a}	0.09	0.004
Initial body weight(kg)	25.32^{b}	30.99^{a}	0.72	0.000
Final body weight(kg)	30.99^{b}	34.54^{a}	0.71	0.000
Gain in body weight(kg)	5.67^{b}	3.55^{a}	0.09	0.000
Average daily gain (g/d)	61.63^{b}	38.59^{a}	1.16	0.000

*Means bearing different superscript in a row differ significantly ($P<0.05$)

As the season shifts towards dry season, the plants in the pasture grow old increasing the lignin and fibre content and thereby decreasing the digestibility (Mayouf and Arbouche,, 2015). Moreover, encrustation of lignin with cellulose, hemicelluloses and proteins of the cellwall render them inaccessible to microbes thereby decreasing their digestibility. Similarly, Sun and Zhou,(2007) also reported that metabolizable energy content and digestibility of DM, GE,OM, CP, NDF and ADF in sheep grazed on *Leymuschinensis* induced pasture were significantly greater (P<0.05) in spring and summer than in winter and autumn. With the decrease of CP and the increase of ADF and NDF in the diet of grazing lambs during the month of December, DM digestibility was decreased, which indicated a negative relation between the DM digestibility and the maturity of forage. Mertens, (1987) reported that diets with lesser DM digestibility during dry period, can restrict ruminant intake as a result of rumen fill limitations, with consequent negative effects.In the present study the digestibility of organic matter was reduced by 11.7% from growing to non growing period and corroborated with the earlier findings of Carvalho et al.(2022) where it was reported that rainy season diet OMD was 28.8 % higher than during the dry season in sheep indicating the association between organic matter digestibility and season.Greater OM digestibility in diets selected by lambs during the growing season indicates greater energy availability compared to post growing season which was reflected by higher intake of TDN or ME by the grazing lambs during growing season.

DCP intake (g/100 kg body weight) in lambs were in close agreement with the suggested values of ICAR(2013). DCP intake (g/kg $W^{0.75}$) was higher (6.15) in September than in December (3.74), which might be due to decrease in protein content of pasture biomass. 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.However,Shinde and Mahanta, (2020) reported lower DCP intake in sheep because of inferior quality of the pasture.ARC (1980) states that rumen microbes require 30 g of N from dietary sources per kg of OM apparently degraded for efficient rumen microbial activity and growth. In present study the N intake (g)values per kg DOM intake in lambs during both the periods indicatedits sufficiency for efficient utilization of energy by the rumen microbes and its optimum growth.TDN intake (g/kg$W^{0.75}$) was significantly higher (P<0.05) during growing period as compared to post growing period and sufficient for achieving a live weight gain of 60 g daily (ICAR, 2013).

Nutritive value in terms of DCP and TDN (%) were significantly (P<0.05) lower during post growing season as compared to growing season. Similar DCP and TDN contents were recorded by Das et al. (2021) in small ruminants under grazing on *H. binata* based sylvipasture system with concentrate supplementation. Sun et al.(2014) also recorded reduced energy content from autumn (9.04 MJ/kg) to winter season(7.94 MJ/kg) in cashmere goats grazing on *L. chinensis* pasture. The quality and quantity of grazing biomass is known to decline markedly after rainy season during onset of winter and imposes major constraint for small ruminant production as it was observed in the present study.

Average daily live weight gain showed significant difference for growing and non growing periods .Das et al.(2021) reported a daily gain of 53 g in *Jalauni* lambs grazed on *H. binata* based silvopasture system along with supplementation. Pent et al.(2020) also recorded a daily gain of 63 g in crossbred lambs gazed on black walnut (*Juglansnigra* L.)-based or honey locust (*Gleditisiatriacanthose* L.)-based silvopasture systems. A live weight gain of 20-22 kg with average daily gain (head/day) of 56-61 g and 93-102g in lambs and kids, respectively were recorded on two tier (*Cenchrusciliaris* + *A. excelsa*) and three tier (*C. Ciliaris* + *D. cinerea* + *A. excelsa*) silvopastoral systems with stocking density of 14 animals/ha (Ramana et al., 2000).Rao et al. (2013) however, reported higher body weight gain in sheep grazed on *L. leucocephala* based sylvipasture which might be due to better availability of nutrients to the animals.The average body weight and average daily gain varied (P<0.05) parallel to the level of protein availability as it is evident in different season in the present study.

CONCLUSION

It was concluded that nutrient intake and nutrient utilization of *Jalauni* lambs were affected significantly during post growing period due to deterioration of pasture quality.Results also indicated that three tier sylvipasture system under semiarid situation could be utilized for rearing of small ruminants for sustainable production.

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