Nutrition of Range Goats in a Shrubland of Western India

Raghavendra Bhatta*, A. K. Shinde, S. K. Sankhyan and D. L. Verma
Division of Animal Nutrition, Central Sheep and Wool Research Institute
Avikanagar 304 501, Rajasthan, India

ABSTRACT : An investigation was made to evaluate the native range of western India in terms of nutrient supply during different physiological stages in goats. One hundred female and 5 male Kutchi adult goats were grazed on a 35 ha plot of native range. They were maintained on sole grazing. Four experiments, one in a defined physiological stage was carried out. Stage I, when maximum number of females were bred; stage II, when bucks were used for breeding purpose; stage III, 3-months old (weaner) kids were allowed to graze on ranges and stage IV, when the goats were in early stage of lactation. During oestrous period, diet contained 15.2% crude protein (CP), 54.0% neutral detergent fibre (NDF), 31.5% acid detergent fibre (ADF) and 12.6% acid detergent lignin (ADL). Digestibility coefficient of dry matter (DM), CP, NDF and ADF was 0.586,0.531, 0.431 and 0.239, respectively. DM, digestible crude protein (DCP) and metabolizable energy (ME) intakes were 82.7, 6.71 g kg^{-1} $W^{0.75}$ and 0.99 MJ kg^{-1} $W^{0.75}$. Diet of buck was constituted by 230 g kg^{-1} DM of grasses and forb and 770 g kg^{-1} DM of tree foliage. CP, NDF, ADF and ADL contents of the diet were 13.6, 57.8, 43.5 and 20.0%, respectively. DM, DCP and ME intakes were 57.9, 4.13 g kg^{-1} $W^{0.75}$ and 0.82 MJ kg^{-1} $W^{0.75}$. Digestibility coefficient of CP, NDF and ADF were 0.496, 0.432 and 0.346, respectively. Diet of kids was constituted by *Prosopis cineraria* (900 g kg^{-1}DM) and *Zizyphus nummularia* (l00 g kg^{-1}DM) leaves. Digestibility of CP, NDF and ADF were 0.456, 0.415 and 0.201, respectively. DM, DCP and ME intakes were 85.8, 6.44 g $kg^{-1}W^{0.75}$ and 1.22 MJ kg^{-1} $W^{0.75}$. Lactation phase of goat fell between October-December and tree foliage formed the major portion of the diet. Diet of lactating goat contained only 6.8% CP and 16.5% ADL. Digestibility of DM, CP, NDF and ADF was 0.567, 0.221, 0.307 and 0.233, respectively. DM, DCP and ME intakes were 108.2, 1.62 g $kg^{-1}W^{0.75}$ and 1.50 MJ $kg^{-1}W^{0.75}$, respectively. Present study establishes that goats on semiarid range with sufficient number of fodder trees were able to meet the nutrient requirement of ewes during oestrous and bucks during breeding season. However, during lactation and active growth phase, only DM requirement is met. Thus, it is recommended to supplement concentrate mixture to goats grazing on range during lactation and growth phase. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 12 : 1719-1724)***

Key Words : Goats, Rangeland, Nutrition

INTRODUCTION

Western region of India is very important for goat production. Goats in this region are primarily dependent on native range for their forage requirement. Browse species found in ranges constitute major portion of food for goats, especially during non-growing season, when it provides essential protein, as grass is dormant. It has been found that constant high grazing pressure and overgrazing are the major constraints for sustainable goat production on ranges in semiarid region. Seasonal changes in the quality and quantity of forage from range often lead to nutritional inadequacy to animals in late winter and summer. In the present study, native range routinely grazed by the goats in a round the year management was evaluated in terms of forage supply, intake and animal performance so as to develop suitable strategies of supplementation if required to optimize the production.

MATERIAL AND METHODS

Rangeland

The study was conducted at Central Sheep and Wool Research Institute, Avikanagar, located at 75° 28'N latitude, 26° 17'E longitude and 320 m above mean sea level. The climate is hot semiarid with mean minimum and maximum temperature of 8°C and 41.5°C respectively. Rainfall in the region is low, erratic and highly inconsistent. During 1999-2000, precipitation was very erratic with 97% of 581 mm (annual rainfall) being received during July to October months, and the remaining 3% in the form of short shower. Native range at the experimental station is occupied by a heterogeneous vegetation type of shrubs with an annual herbaceous under-storey. *Prosopis cineraria* and *Zizyphus nummularia* were the dominant shrub species and their leaves and fruit/pods offer potential source of foliage during winter and summer. The under-storey is occupied by *Melilotus indica*, *Tribulus terrestris*, *Crotolaria burhia*, *Celosia argentea* and *Indigofera cordifolia* grasses and forb species.

Animals

One hundred female and 5 male Kutchi adult goats were grazed on 35 ha plot of native range. They were maintained on grazing alone, no supplementation was provided, except for the lopped foliage from the shrub. Kids born from these goats were also allowed for grazing on the same range plot after 3 months of age.

* Corresponding Author: Raghavendra Bhatta. Fax: +91-1437-28163, E-mail: rbhatta@cswri.rai.nic.in
Received December 24, 2001; Accepted July 31, 2002

Experimental procedure

Animal experimentation : Four experiments, one in a defined physiological stage, were carried out. Stage I, when maximum number of females was bred. The stage fell between June-July and was the main growing season with rainfall and hot humid condition. In stage II, bucks were used for breeding. Ambient conditions and forage supply from range was almost similar to that of the oestrus stage. Stage III, when kids were 3 months old and allowed for nibbling on ranges. The period fell between March-April and ground vegetation was almost negligible. Bushes and shrubs were the main source of vegetation and constitute the major portion of the diet. Stage IV, when the goats were in the early stage of lactation (15-45 days post kidding) and forage supply from land deteriorated completely and shrub and bushes form the integral component of the diet.

Digestibility trials

In each stage 6 animals were used to collect representative samples of forage and faeces for estimation of forage intake and nutrient digestibility. Diet samples were collected daily from each animal by snatching 40-50 bites from the mouth before swallowing (Sankhyan et al., 1999). The samples were collected throughout the grazing hours to avoid diurnal variation in diet selection. Each goat was dosed with 1 g chromic oxide in a paper capsule twice daily for 10 days at 08:00 and 17:00 h and at the same time faeces were sampled from the rectum for the last 5 consecutive days. Diet and faeces samples of individual animals were dried separately at 60°C. Individual adult goat was weighed using a spring balance in the morning hours, at fortnightly interval throughout the year. Kids were weighed at birth, 3 and 6 months of age. Milk yield of goat was recorded at weekly interval up to 150 days of lactation period.

Diet sampling

The total number of plants of shrub species present in the grazing area was counted and yield of individual species in the paddock was estimated. Six random quadrates (1 m^2) were clipped close to ground level at uniform height, to determine the quantity of available forage (Papanastasis, 1977). Percentage distribution of individual species on DM basis in grazing area (Holecheck et al., 1982) and chemical composition of forage was also determined.

Chemical analysis

Forage, diet and faeces samples were ground to pass through a 1mm sieve in a Wiley mill and stored in polythene bags for further analysis. Nitrogen was determined by the Kjeldahl method (AOAC, 1984). NDF, ADF and lignin were determined by the method of Van Soest et al. (1991). Nutrient digestibility was estimated by lignin ratio technique (Wallace and Van Dyne, 1970). Metabolizable energy (ME) intake was calculated as

MEI = OMI g×19×0.82 (ARC, 1980)

The chemical composition of the milk was analysed at monthly intervals for milk fat, protein, lactose, solid-not-fat (SNF) and total solids (TS) using standard techniques.

Statistical analysis

Since the objective of the study was to determine the nutrient intake during different physiological stages, only the mean values are presented. The data pertaining to different stages are not compared.

RESULTS

Nutrient content of vegetation

Chemical composition of native herbaceous plant species found in the semiarid range is shown in Table 1. *Vigna sinensis* contained >20% CP, *Tephrosia purpurea, Melilotus indica, Gymnospora spinosa, Phaseolus trilobus, Ceropeagia bulbosa* contained >15% CP. *Dactyloctenium aegypticum, Tribulus terrestris, Ericostema species, Sesamum indicum, Commelina forskalaei, Celosia Argentea, Trianthema portolocastrum* contained >10% CP and *Sorghum helepense* and *Crotolaria burhia* >5% CP. Fibre content of these forage species (cellulose, ADF and lignin) are within normal range of a good quality vegetation. ADL was below 11.0% and ADF 43.0% in almost all the species except in *Trianthema portolocastrum* where ADF was 49%, cellulose 38.5% and ADL 10.6%.

Oestrus stage

Maximum number of goats in this part of India is bred in the month of May-July. The vegetation available to animal from range during this period besides tree foliage is shown in Table 2. Goat diet was constituted by 329 g kg^{-1} DM of *Prosopis cineraria* leaves, 357 g kg^{-1}DM of pods, 181 g kg^{-1}DM of *Acacia senegal* leaves. Native species of *Vigna sinensis, Commelina forskalaei, Trianthema portolocastrum* constituted 133.3 g kg^{-1}DM of diet.

Goat diet during oestrus contained 15.2% CP, 54.0% NDF, 31.5% ADF and 12.6% ADL (Table 3). Higher proportion of CP in the diet of goat was associated with consumption of tree pods, as pods contain higher CP than leaves. DM intake of goat during oestrus was 1,224 g day^{-1}, DCP intake was 98.9 g day^{-1} and ME intake was 17.6 MJ day^{-1} (Table 4). DM intake was 3.3% of body weight, which was adequate to meet the requirement of animals, as the quality of diet was better. Digestibility coefficient of DM, CP, NDF and ADF was 0.586, 0.531, 0.431 and 0.239 in goats during oestrus period. Reproductive efficiency in

Table 1. Chemical composition of herbaceous plant species in native ranges of semiarid region

	DM	CP	NDF	ADF	Cellulose	Hemi-cellulose	ADL
Dactyloctenium aegyptium	49.21	12.13	41.87	29.43	14.60	12.40	5.80
Tribulus terrestris	36.08	13.13	44.40	33.70	21.70	10.70	11.10
Tephrosia purpurea	58.53	17.32	54.20	39.10	20.20	15.10	5.40
Enicostema sp.	32.62	13.13	55.40	39.50	30.50	15.90	7.80
Sesamum indicum	39.93	11.38	69.40	32.90	22.30	36.50	4.10
Melilotus indica	49.88	19.70	45.85	33.26	28.20	12.59	5.90
Indigofera cordifolia	54.22	14.52	31.90	22.90	14.50	9.00	5.10
Commelina forskalaei	32.26	12.25	45.90	34.60	27.50	11.30	6.80
Celosia argentea	35.79	12.25	41.50	27.50	19.30	14.00	6.60
Gymnosporia spinosa	29.91	17.50	41.30	27.60	23.30	13.70	7.70
Phaseolus trilobus	37.82	16.10	42.36	30.28	19.30	12.08	10.60
Trianthema portolocastrum	27.85	11.37	58.60	49.00	38.50	9.60	10.60
Vigna sinensis	22.68	23.45	68.50	43.00	36.20	25.50	6.50
Sorghum helepense	24.56	6.13	41.20	29.10	20.30	12.10	5.50
Cocculus pendulus	41.11	10.85	44.50	33.90	22.50	10.60	6.80
Crotolaria burhia	43.92	5.25	33.90	23.60	12.50	10.30	2.40
Ceropeagia bulbosa	25.48	15.75	51.60	37.80	30.40	13.80	7.40

Table 2. Botanical composition of the diet of goats (g kg^{-1} DM) during different stages

Grasses and forbs	Oestrus	Bucks	Kid	Lactation
Achyranthus aspera	-	39.4	-	-
Crotolaria burhia	-	13.1	-	-
Phaseolus trilobus	-	32.8	-	-
Melilotus indica	-	26.2	-	-
Sorghum helepense	-	118.4	-	-
Eriochloa polystachya	38.6	-	-	-
Ceropeagia bulbosa	29.9	-	-	-
Commelina forsklaei	36.7	-	-	-
Trianthema portolocastrum	28.1	-	-	-
Cenchrus catherticus	-	-	-	-
Acacia senegal	181.0	135.2	-	-
Acacia tortolis	-	40.5	-	-
Azardirachta indica	-	9.3	-	286.8
Bauhinia recemosa	-	20.9	-	253.3
Cocculuc pendulus	-	83.1	-	-
Dicrostachys nutans	-	76.1	-	-
Gymnosporia spinosa	-	109.1	-	-
Prosopis cineraria (leaves)	328.8	206.6	900.0	255.7
Zizyphus nummularia	-	88.3	100.0	204.0
Prosopis cineraria (pods)	356.8	-	-	-

Table 3. Chemical composition of goat diet (% DM) during different stages

	Oestrus	Buck	Kid	Lactation
Dry matter	36.5	48.0	48.8	72.3
CP	15.2	13.6	16.5	6.8
NDF	54.0	57.8	55.2	41.2
ADF	31.5	43.5	34.9	30.0
Cellulose	17.5	22.5	14.0	13.6
Hemicellulose	22.5	14.6	20.3	11.3
ADL	12.6	20.0	19.8	16.5

terms of number of animals bred was 98% (Table 6). Out of this 73% of goats gave single kid, 25% gave twins and 1% gave triplet. Kidding rate was 121 during a period of one year.

Table 4. Nutrient intake by goats on native range of semiarid region during different stages

	Oestrus	Buck	Kid	Lactation
Nutrient intake				
DMI (g/day)	1,224±94.0	1,214±35.9	691±28.5	1,585±19.1
DMI (g/kg BW)	33.7±2.89	32.5±1.65	42.78±1.91	43.6±5.6
DCPI (g/kg $W^{0.75}$)	82.7±6.86	57.9±3.1	85.76±3.68	108.2±13.5
DCPI (g/day)	98.9±8.91	84.6±8.71	51.91±1.89	23.5±4.60
DCPI (g/kg BW)	2.74±0.28	2.54±0.26	3.21±0.11	0.67±0.14
DMI (g/kg $W^{0.75}$)	6.71±0.65	4.13±0.52	6.44±0.22	1.62±0.34
MEI (MJ/day)	17.6±1.38	16.7±0.84	9.83±0.41	22.1±2.70
MEI (MJ/kg BW)	0.49±0.04	0.45±0.03	0.61±0.03	0.60±0.08
MEI (MJ/kg $W^{0.75}$)	0.99±0.09	0.82±0.04	1.22±0.05	1.50±0.19
Digestibility of nutrients				
Dry matter	58.6±2.44	55.8±3.65	51.98±0.33	56.7±0.60
CP	53.1±1.37	49.6±3.73	45.59±0.60	22.1±3.70
NDF	43.1±3.20	43.2±5.90	41.48±0.72	30.7±0.80
ADF	23.9±2.30	34.6±5.29	20.11±1.54	23.3±4.20
Cellulose	54.9±1.68	54.9±3.91	55.97±2.34	55.0±2.30
Hemicellulose	56.2±1.73	57.0±6.89	58.42±1.58	59.8±4.60

Bucks

Male goats (bucks) were maintained with females on range throughout the year. Breeding season of goat in this region fell somewhere between May-July. Bucks are used for breeding in this season. Thus, the level of nutrition was assessed to suggest any supplementation to improve reproductive efficiency. Diet of buck was constituted by 230 g kg^{-1} DM grasses and forb and 770 g kg^{-1} DM tree foliage. Predominant grasses in the diet were *Achyranthus aspera* 39.4, *Phaseolus trilobus* 32.8 and *Sorghum helepense* 118.4 g kg^{-1}DM. *Acacia senegal, Gymnospora*

Table 5. Growth performance of kids on native ranges

Item	Male	Female
Birth weight (kg)	3.42±0.10	3.25±0.08
Weaning weight (kg)	10.51±0.35	10.47±0.40
Six month weight (kg)	15.03±0.46	14.00±0.58
Daily gain (0-3 m) (g)	79	80
Daily gain (3-6 m) (g)	50	39

Table 6. Reproductive efficiency of goat on native ranges

Item	Values
Tupping per cent	98
Does kidded	
Single	73
Twin	25
Triplet	1
Breeding efficiency	123
Kidding percent	97
Kidding rate (litter size)	121

Table 7. Milk yield and composition of lactating goats

Item	Values
Milk yield (kg)	
90 days	57.51±1.39
150 days	81.51±2.20
Daily milk yield (g)	543.00
Milk composition (%)	
Fat	4.5±0.2
Protein	3.0±0.1
Lactose	3.8±0.1
SNF	7.8±0.1
Total solids	12.4±0.2

spinosa and *Prosopis cineraria* constituted 135, 109, and 207 g kg^{-1}DM of diet (Table 2). Higher content of browse species in the diet contributed to 13.6% CP and 20.0% lignin (Table 3). NDF, ADF and cellulose content of diet were 57.86, 43.46 and 22.46%. DM intake of buck was 1,214 g day^{-1} or 32.5 g kg^{-1} BW. DCP intake was 84.6 g day^{-1} or 2.54 g kg^{-1} BW (Table 4). ME intake was 16.7 MJ day^{-1} or 0.45 MJ kg^{-1} BW. Digestibility coefficient of CP was 0.496, NDF 0.432, ADF 0.346 and cellulose 0.549. Average body weight of animal was 55.0 kg, which was maintained throughout the year, except for a slight decline in summer with deterioration of forage supply from range.

Kids

Kids were born in October-November and after weaning at 3 months of age, were sent for nibbling in the ranges. Most of the native vegetation sprouted in monsoon season was in the withering stage and major vegetation cover is constituted by bushes, shrubs and tree foliage. Diet of kids was constituted by *Prosopis cineraria* (900 g kg^{-1} DM) and *Zizyphus nummularia* leaves (100 g kg^{-1} DM) in Table 2. Greater proportion of leaves along with twig in kid diet contributed for higher CP and lignin content of 16.5% and 19.9% (Table 3). NDF and ADF content of diet were 55.20 and 34.90%. DM intake of kids was 691 g day^{-1} or 4.3% of BW, DCP intake was 51.9 g day^{-1} or 3.2 % of BW (Table 4). ME intake was 9.8 MJ day^{-1} or 0.61% of BW. Digestibility coefficient of DM, CP, ADF and NDF was 0.519, 0.456, 0.201 and 0.415. Growth performances of kids are shown in Table 5. Birth weight of male and female kids was 3.42 and 3.25 kg. Weaning (3 month) and 6 month weight in male and female was 10.51, 15.03 and 10.47, 14.00 kg respectively. Average daily gain in both the sexes between 0-3 and 3-6 month of age was 80 and 45 g respectively.

Lactating goats

Lactation phase of goats on ranges fell between October-December. During this phase goat diet was constituted by 287 g kg^{-1} DM *Azardirachta indica,* 253 g kg^{-1} DM *Bauhinia racemosa,* 256 g kg^{-1} DM *of Prosopis cineraria* and 204 g kg^{-1} DM of *Zizyphus nummularia* (Table 2). Diet of goat contained 6.8% CP and 16.5% lignin (Table 3). Higher proportion of lignin and lower proportion of protein in lactating goats was due to consumption of twig, as twig contains less protein and more lignin than leaves. NDF and ADF content of goat diet were 41.2 and 30.0% respectively. Dry matter intake of goat was 1,585 g day^{-1} or 4.4 % of BW (Table 4). Higher intake was associated with higher demand for lactation. Low intake of CP and poor digestibility of diet resulted in poor intake of DCP and it was 23.5 g day^{-1} or 0.67 g kg^{-1} BW. ME intake was 22.1 MJ day^{-1} or 0.60 MJ kg^{-1} BW. Digestibility of protein was severely depressed to 0.221 because of greater proportion of twig and presence of tannin in the diet. Milk yield of goat in 90 and 150 days of lactation was 57.5 and 81.5 kg, respectively. Daily milk yield of goat was 639 g during 0-90 days post kidding. Fat, protein, lactose, solid-not-fat (SNF) and total solids (TS) content of milk were 4.5, 3.0, 3.8, 7.8 and 12.4 per cent, respectively.

DISCUSSION

Native ranges in semiarid region are occupied by various species of grasses, forb and shrubs. These plant species sprout during June-July with the onset of first monsoon shower, remain green up to August-September, then wither off with the onset of winter. Short life cycle of these species often impose restriction on forage availability to grazing goats during late winter and summer. Although these species are rich in crude protein and energy content (Table 1), because of their availability for a short period renders the goats to low plane of nutrition for most part of the year. Rehabilitation of these native ranges by perennial grasses, legumes and tree fodder could extend the availability of forage for longer period.

Goats maintained on these ranges pass through different

stages like growth, lactation and breeding. The nutrient requirement of goats during these stages varies widely and is affected to a great extent by the forage supply from the range.

Oestrous stage

Goats grazing on ranges remain under low level of nutrition during summer months because of poor availability of vegetation. The first monsoon showers drops the ambient temperature considerably with simultaneous sprouting of ground vegetation. At the same time, pods of *Prosopis cineraria, Acacia nilotica* and *Acacia tortolis* are also available to the goats. These pods are very rich in crude protein (12-15%) and energy. All these conditions flush the goats and induce them into oestrous. Sankhyan et al. (2001) also reported that pods consumption induces oestrous in grazing goats. Average DM, DCP and ME intakes of goats were 82.7, 6.71 g kg^{-1} $W^{0.75}$ and 0.99 MJ kg^{-1} $W^{0.75}$. Protein and energy intakes of these goats were well above the requirements (Kearl, 1982). Thus, goats on these ranges did not require any supplementation during oestrous period.

Bucks

Breeding bucks were maintained with the females throughout the year. It has been suggested that bucks should be provided with extra allowances during breeding season (Ranjhan, 1980). Nutrition of these bucks was evaluated to ascertain whether supplementation is required or not. DM, DCP and ME intakes of breeding bucks were 57.9, 4.13 g kg^{-1} $W^{0.75}$and 0.82 MJ kg^{-1} $W^{0.75}$. Ranjhan (1980) has recommended 85.0 g DCP and 15.4 MJ ME as the requirement for breeding bucks. Nutrient intake of bucks was optimum as per the recommendation. The ratio of male to female in this study was 1:20 and the bucks were under moderate activity. If more number of females is to be bred, extra allowances @ 300 g d^{-1} concentrate mixture is recommended. With this level of nutrition, 98% tupping was recorded in goats (Table 6) with 26% twinning. The breeding efficiency of goats was 123 with kidding per cent and kidding rate of 97 and 121, respectively. The reproduction data depicts that goats were under optimum nutritional state.

Kids

Maximum number of kids were born in October-November and moved to ranges after weaning at 3-months of age. At this period most of the ground vegetation was matured and lignified. Kids diet was constituted by *Prosopis cineraria* and *Zizyphus nummularia*. DM, DCP and ME intakes of kids were 85.8, 6.44 g kg^{-1} $W^{0.75}$ and 1.22 MJ kg^{-1} $W^{0.75}$. These intakes were sufficient for an average daily gain of 55-65 g day^{-1}. Lower growth rate in these kids is due to the presence of tannin contained in tree leaves. Although low levels of natural tannins are beneficial for ruminants because of favourable alteration of rumen fermentation and improvement in the efficiency of microbial protein synthesis (Bhatta et al., 2000, 2001), however in this study the tannin consumption by the goats was very high. The adverse effect of tannin can be annihilated by feeding kids with polyethylene glycol-6000, either by drenching or by incorporation in small quantity of concentrate mixture (Bhatta et al., 2002a). Sankhyan et al. (1996) reported 665 g DM intakes in kids grazing on silvipasture with a growth rate of 98 g day^{-1}. Grazing of kids on Cenchrus pasture and supplemented with concentrate @ 1.5% of body weight, attained growth rate of 96 g day^{-1} (Shinde et al., 1995). These results suggest that the growth performance of these kids can be improved by supplementation.

Lactation stage

Lactation phase of goats fell between October-November. During this period tree leaves and bushes constitute the major portion of the diet, since ground vegetation is negligible. Higher proportion of twig consumption increased the DMI to 4.0% of the body weight but reduced the CP content as twigs contain more proportion of lignin and less proportion of CP. Poor CP digestibility of lignified diet resulted in lower DCP intake. Thus, goats during lactation on such ranges remain on low level of protein intake. Bhatta et al. (2002b) also reported sizeable reduction in CPI of lactating goats during these periods, because of the negative effect of tannin on protein utilization.

Daily nutrient requirement of lactating goat is 72.0 g DCP and 11.2 MJ ME (Ranjhan, 1980). The DCP and ME intake of lactating goats in the present study was 23.5 g and 22.1 MJ ME day^{-1}. Present study suggests that DCP intake in goats was grossly inadequate, thus necessitating supplementation. Singh (1996) supplemented lactating Kutchi goats with 0, 150, 300 and 450 g day^{-1}concentrate mixture in addition to browsing on range. Total milk yield in the above groups was 94.4, 93.2, 110.0 and 101.1 kg, respectively. It was concluded that milk yield significantly increased with the increasing levels of supplementation up to 300 g day^{-1}concentrate in does.

CONCLUSION

Present study suggests that goats on semiarid ranges are able to meet the nutrient requirement during oestrous and breeding season (males). Since these stages coincide with the maximum availability of forage on ranges. Thus, supplementation is not required. However, during lactation and active growth phase the ground vegetation withers off and tree foliage constitute the major portion of the diet. The

DM requirement is however met with this foliage. But, since these top feeds contain polyphenolic compounds like tannins, adversely affect the protein utilization. Thus, two remedial measures can be adopted, a. supplementation of concentrate mixture, b. ameliorating the effect of tannin by PEG.

The milk yield of does (450 g d^{-1}) and growth rate of kids (55-65 g ADG) observed in this region are on the lower to moderate level. These production traits could be improved by following the supplementation especially during lactation and growth phase to achieve desired production as was also recommended in earlier studies.

REFERENCES

AOAC. 1984. Official Method of Analysis. 13th edn. Association of Official Analytical Chemists. Washington, DC.

Agricultural Research Council. 1980. The Nutrient Requirement of Ruminant Livestock., Commonwealth Agricultural Bureaux, Farham Royal, UK, pp. 121-166.

Bhatta R., U. Krishnamoorthy and F. Mohammed. 2001. Effect of tamarind (*Tamarindus indica*) seed husk tannins on *in vitro* rumen fermentation. Anim. Feed Sci. Technol. 90:143-152.

Bhatta, Raghavendra, A. K. Shinde, S. Vaithiyanathan, S. K. Sankhyan and D. L. Verma. 2002a. Effect of polyethylene glycol-6000 feeding on nutrient intake, and digestion as well as growth of kids browsing *Prosopis cineraria*. Anim. Feed Sci. Technol. (in press).

Bhatta, Raghavendra, A. K. Shinde, S. K. Sankhyan, D. L. Verma and S. Vaithiyanathan. 2002b. Effect of feeding tree foliage on milk yield and composition of lactating goats on semiarid rangeland. Ind. J. Anim. Sci. 72(1):84-86.

Bhatta, R., U. Krishnamoorthy and F. Mohammed. 2000. Effect of feeding tamarind (*Tamarindus indica*) seed husk as a source of tannin on dry matter intake, digestibility of nutrients and production performance of crossbred dairy cows in mid-lactation. Anim. Feed Sci. Technol. 83:67-74.

Holecheck, J. L., M. Vavra and R. D. Pieper. 1982. Methods for determining the nutritive quality of range ruminant diets: a review. J. Anim. Sci. 54:363-375.

Kearl, L. C. 1982. Nutrient Requirement of Ruminants in Developing Countries, International Feedstuffs Institute, Utah Agricultural Experimental Station, Logan.

Papanastasis, P. V. 1977. Optimum size and shape of quadrate for sampling herbage weight in grassland of Northern Greece. J. Range Manage. 30:446-448.

Ranjhan, S. K. 1980. Nutrient Requirement and Nutrition of Goats for Meat and Milk Production. Animal Nutrition in the Tropics. pp. 296-309.

Sankhyan, S. K., A. K. Shinde, R. Bhatta and S. A. Karim. 1999. Comparison of diet and faecal collection methods for assessment of seasonal variation in dry matter intake by sheep maintained on a *Cenchrus ciliaris* pasture. Anim. Feed Sci. Technol. 82:261-269.

Sankhyan, S. K., A. K. Shinde, R. Bhatta and D. L. Verma. 2001. Utilization of tree pods for flushing of goats in semiarid ranges. Conference on 'Impact of activities on Thar desert environment, 15-17. February, CAZRI, Jodhpur, India. p. 122(Abstr.).

Sankhyan, S. K., A. K. Shinde, S. A. Karim, J. S. Mann, N. P. Singh and B. C. Patnayak. 1996. Plane of nutrition and growth response of lambs and kids maintained on two and three tier silvipasture. Ind. J. Anim. Sci. 71:1194-1197.

Shinde, A. K., S. A. Karim, N. P. Singh and B. C. Patnayak. 1995. Growth performance of weaner lambs under intensive and semi-intensive feeding management. Ind. J. Anim. Sci. 65:830-833.

Singh, N. P. 1996. Supplementary feeding of goats during lactation. Ind. J. of Small Rumin. 2(1):7-10.

Van Soest, P. J., J. B. Robertson and B. A. Lewis. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74:3583-3597.

Wallace, J. D. and G. M. Van Dyne. 1970. Precision on indirect method for estimating digestibility of forage consumed by grazing cattle. J. Range Manage. 21:424-430.

.