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Effect of supplementation of concentrate mixture or barley grain to grazing goats on nutrient utilization during summer at semiarid region

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ABSTRACT

Thirty local female goats available in Bundelkhand region grazed under 2 paddocks @ 1.0 ACU/ha (paddock A) and 2.0 ACU/ha (paddock B) in a shrub infested grassland were selected. To nullify the effect of stocking rates half of the goats from each paddock were supplemented with crushed barley grain (group 1) and remaining animals were supplemented concentrate mixture (group 2) during April to July. The goats under both the paddocks primarily selected 6 species of shrub and less (3.42-7.76% of total forages) quantity of grasses. Digestibility of nutrients was similar in both the groups. N intake/kg DOM intake was higher ($P<0.05$) in group 2 than in group 1, however, other nutrients intake were similar in both the groups. DCP and ME intake in both the groups were sufficient for maintenance. The protein as well as energy availability in grazing goats as calculated using CNCPS model was comparable to the conventional digestibility trial and the model can be used to calculate the nutrient requirement of grazing goats.

Key words: CNCPS Model, Goats, Grazing, Supplementation

The cornell net carbohydrate and protein system (CNCPS) is an application model which can provide more precise and accurate data on feeding values of feeds, forage and animal requirements (NRC 1989). In general browse is the most important forage class for goats ranging from 51 to 90% of their diet (Papachristou 1997). Due to higher selectivity goats select diets with a higher crude protein and lower fibre content than sheep (Rutagwenda *et al.* 1990, Garcia *et al.* 1995). During December to June when good quality pasture is not available, DCP and TDN supplementation double the growth rate of heifers (Ahuja 1978). Pfister *et al.* (1983) indicated that nutritional stress on goats and sheep during dry season is responsible for high weight losses and periodic mortality. This requires provision of supplementary feeding particularly energy supplement in the form of barley or maize grains for maintaining optimum productivity of goats during dry summer. The present investigation has therefore been taken up to study the effect of supplemental feeding of barley or concentrate mixture to grazing goats on nutrient utilization and application of CNCPS model for calculation of nutrient availability.

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MATERIALS AND METHODS

Thirty female local goats of Bundelkhand region of India were selected at 1.5 to 2.5 years of age and were randomly distributed in to 2 groups according to their body weight. The experiment was conducted during April to July. Due to high ambient temperature (42°C) the grazing period of all the animals was restricted to 6 hr daily from 7.00 AM to 1.00 PM in a shrubs-infested grassland at 2 stocking rates i.e. @1.0 ACU/ha (paddock A) and @ 2.0 ACU/ha (paddock B). Therefore under paddock A and B there were 10 and 20 goats respectively. During the experiment the availability of green forage was scanty therefore, half of the animals from each stocking rate were supplemented @ 200 g crushed barley grain per animal (group 1) and remaining half of the animals under both the paddocks were supplemented with equal amount of concentrate mixture (group 2) containing maize grain 20, rice polish 5, deoiled rice bran 25, wheat bran 4, deoiled groundnut-cake 20, deoiled mustard-cake 15, molasses 8, salt 2, mineral mixture 1 kg/100 kg and nutrisac 150 g/100kg to *nullify the effect of stocking rates on supplementation.* Supplementation was done once in a day in the stall about half an hour after grazing. Potable drinking water was made available to all the animals before and after the grazing. All the animals were de-wormed at the start of the experiment, housed in well-ventilated stall. A digestion trial on grazing goats was conducted selecting 6 animals from each group using lignin as an internal marker (Ranjhan 1994). Fortnightly body weight changes of all the animals were recorded.

Botanical composition of diet

A direct observation and simulation method was used to determine the botanical composition of the diet consumed by the animals. Two goats from each group were used for this study. Samples of the ingested species that were being taken by individual goats were hand clipped for consecutive 3 days. The individual animal was observed and forage samples were collected for the entire grazing time from 7.00 AM to 1.00 PM.

Analysis of samples

Dry matter (DM), ash, ether extract (EE) of various samples were determined according to AOAC (1995). The dried samples were analysed for neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin (Van Soest *et al.* 1991). Total nitrogen was determined by macro Kjeldahl method (AOAC 1995). Nitrogen insolubility was measured using borate-phosphate buffer of pH 6.8 (Krishnamoorthy *et al.* 1982). The difference between the total N and buffer insoluble N was considered as the buffer soluble N. Nitrogen that is insoluble in neutral detergent (NDIN) and acid detergent (ADIN) were estimated as per Van Soest *et al.* (1991). Non protein nitrogen (NPN) was estimated as per Licitra *et al.* (1996). Estimation of starch in dried samples was followed as per (AOAC, 1995). Nonstructural carbohydrate (NSC) was computed directly (Van Soest 1991): 100-[(NDF-NDFP) +protein + fat + ash)]. Nutrient availability in goats in terms of TDN and metabolizable protein (MP) were calculated using CNCPS model and were compared with the present study. Data obtained were statistically analyzed (Snedecor and Cochran 1967).

RESULTS AND DISCUSSION

The forages that were selected by goats under both the paddocks primarily consisted of 6 species of shrubs and very little quantity of grasses (Table 1). The major shrub species selected under paddock B were *Helicteris isora* (30.14±1.56%) followed by *Securinega virosa* (19.38±5.18%) whereas, under paddock A, *Securinega virosa* (18.80±1.61%), *Acacia catechu* (18.03±2.43%) and *Flacourtia indica* (16.38±1.90%). Proximate as well as cell wall constituents of forage selected by both the groups were similar (Table 2). The percentage of a species in the diet is always positively related with its abundance on the range (Kababya *et al.* 1998).

Carbohydrate and protein fractions of total ration presented in Table 3, revealed that in both the groups rapidly degradable true protein (PB1) was higher and the values were 57.36±1.21 and 42.85±1.60% in groups 1 and 2, respectively. A considerable amount of protein in both the ration was present as NPN (PA) and the value was higher ($P<0.01$) in group 2 (37.99±1.81%) than in group 1 (23.75±0.91%). Higher ($P<0.01$) levels of intermediately degradable fraction (PB1)

Table 1. Botanical composition of diet

Name of feed	Paddock 'B'	Paddock 'A'
Helicteres isora	30.14±01.56	14.59 ± 02.04
Ziziphus xylophyrus	08.90 ± 01.93	12.57 ± 00.72
Acacia catechu	10.79 ± 03.54	18.03 ± 02.43
Flacourtia indica	13.56 ± 02.00	16.38 ± 01.90
Securinega virosa	19.38 ± 05.18	18.80 ± 01.61
Carissa spinarum	15.94 ± 01.38	13.80 ± 00.90
Mixed grasses	07.76 ± 03.04	03.42 ± 01.32

Table 2. Chemical composition of forage selected by the animal during trial, barley grain and concentrate mixture (% DM basis)

Particulars	Group 1	Group 2	t value	Barley	Conc. mix.
DM	34.16 ± 01.13	34.42± 01.00	0.1771^{NS}	92.34	91.51
CP	13.00 ± 00.27	12.97 ±00.51	0.2955^{NS}	12.35	18.73
CF	21.41 ± 00.67	20.16 ±00.64	1.1021^{NS}	06.71	06.12
EE	04.68 ± 00.21	04.09 ±00.26	1.1317^{NS}	05.41	04.41
NFE	53.59 ± 00.53	54.79± 00.94	1.0828^{NS}	71.98	57.79
Ash	07.16 ± 00.12	07.33 ±00.15	0.8991^{NS}	03.55	12.95
NDF	46.89 ±00.47	47.52± 01.83	1.0999^{NS}	25.27	27.25
ADF	35.64 ± 02.50	32.96± 02.04	2.1835^{NS}	14.18	08.78
Hemicellulose	16.75 ± 00.43	16.38± 00.37	0.6509^{NS}	15.08	18.28
Cellulose	16.22 ± 00.34	16.76 ±00.59	0.7897^{NS}	07.29	06.89
Lignin	15.51±00.64	13.98±00.43	0.9846^{NS}	02.00	02.46
Starch % of NSC	42.15 ± 0.55	40.57 ± 1.89	0.9633^{NS}	57.83	78.74
NSC	46.22 ± 0.75	45.79 ± 2.10	0.1907^{NS}	60.82	38.66
S.P. % of CP	80.40 ± 1.48	80.18 ± 0.84	0.0955^{NS}	87.29	85.85
AD IP % of CP	09.90 ± 0.91	10.73 ± 0.45	0.7060^{NS}	6.40	9.28
NPN % of SP	33.88 ± 1.94	32.20 ± 1.31	0.9133^{NS}	22.15	66.41
ND IP % of CP	12.38 ± 0.98	12.61 ± 0.54	0.2051^{NS}	7.41	4.00

NS, Nonsignificant.

Table 3. Fractions of protein and carbohydrates of total ration

Protein fractions	Group 1	Group 2	t value
PAJ (% CP)	23.75 ± 0.91	37.99 ± 1.81	7.0246**
PB1 (% CP)	57.36 ± 1.21	42.85 ± 1.60	6.4116**
PB2 (% CP)	3.27 ± 0.13	3.05 ± 0.11	0.2368^{NS}
PB3 (% CP)	6.27 ± 0.59	5.70 ± 0.53	0.7279^{NS}
PC (% CP)	10.00 ± 0.43	9.21 ± 1.21	0.6116^{NS}
Carbohydrate fractions			
CHO (% DM)	446.02 ± 17.59	471.37 ± 56.97	0.4252^{NS}
CA (% CHO)	60.38 ± 2.31	64.89 ± 6.16	0.6929^{NS}
CB1 (% CHO)	133.10 ± 4.10	125.29 ± 13.67	0.3998^{NS}
CB2 (% CHO)	106.94 ± 4.43	104.57 ± 12.31	0.1813^{NS}
CCJ (% CHO)	153.62 ± 13.31	160.89 ± 25.16	0.2554^{NS}

NS, Nonsignificant, **, significant (P< 0.01).

was observed in group 1 (57.36±1.21) than in group 2 (42.85±1.60) due to the presence of higher quantity of soluble true protein content in concentrate mixture. However, all other protein fractions and different fractions of carbohydrate were similar in both the groups.

The average digestibility coefficient for dry matter, organic matter and crude protein were higher in group 2 than in group 1 (Table 4), however, variations between the groups were not significant. Ether extract, NDF, ADF and NFE digestibility were also found similar under both the groups.

The data on dry matter and organic matter intake of grazing goats during digestion trial in both the groups in Table 4 showed that daily DM intake (kg/100kg body weight) in group 1 (2.92±0.22) and group 2 (2.87±0.23) was similar. Organic matter intake per 100 kg body weight was also similar in both the groups as reported earlier (Holecheck and Vavra 1982, Hakkila *et al.* 1987, Pfister and Malecheck 1986, Gihad 1976).

Digestible DM, OM, CP as well as TDN intake per 100 kg body weight were similar in both the groups (Table 4). ME intake per 100 kg body weight was slightly higher in group 2, however, variation between the groups was not significant. N intake per kg DOM intake (g) was higher (P<0.05) in group 2 (35.84±4.91) than in group 2 (24.52±1.09). In our study daily ME intake (M cal) was 1.53±0.02 in group 1 and 1.62± 0.14 in group 2 and the corresponding values for DCP intake (g/d) was 45.94±1.84 and 62.29±8.17. Daily ME and DCP requirement of 20 kg goat under tropical range condition is 1.20 M cal and 32 g, respectively (NRC 1985). In this study under both the groups ME and DCP intake were higher than NRC requirement suggested that availability of protein and energy were sufficient to the animals.

Application of the data of feed fraction in CNCPS model gave values (g/d) of structural carbohydrate fermenting bacteria (SCBACT) production in group 1 was 10.08±0.40 and in group 2 was 9.73±1.03 (Table 5). The non-structural carbohydrate fermenting bacteria (NSCBACT) production was much higher than SCBACT and the values for groups 1 and 2 were 73.96±2.05 and 73.07±7.65 respectively. In the present study the forage selected by the grazing goats as well as supplemental feed contain less quantity of CF and relatively higher amount of non-structural carbohydrate, therefore NSCBACT production was more. The protein available from bacteria as bacterial true protein (REBTP) was maximum

Table 4. Intake and digestibility of nutrients

Particular	Group 1	Group 2	t value
Body weight (kg)	20.27 ± 2.53	21.97 ± 2.73	0.4675^{NS}
DMI (g)	507.90 ± 29.97	625.18 ± 70.51	0.8734^{NS}
DMI /100 kg b.wt	2.92 ± 0.22	2.87 ± 0.23	0.8095^{NS}
OMI / 100 kg b.wt	3.09 ± 0.21	2.63 ± 0.02	1.4947^{NS}
Digestibility coefficient (%)			
DM	56.15 ± 1.24	61.16 ± 2.02	2.0465^{NS}
OM	60.45 ± 1.52	64.71 ± 1.80	1.8070^{NS}
CP	61.58 ± 1.86	69.60 ± 3.83	1.8840^{NS}
EE	54.78 ± 2.67	52.06 ± 2.49	0.7432^{NS}
NDF	43.70 ± 2.48	38.32 ± 2.75	1.4422^{NS}
ADF	31.58 ± 2.25	28.16 ± 2.59	1.2817^{NS}
NFE	75.73 ± 2.66	79.22 ± 2.58	0.9417^{NS}
DOMI (g/ 100 kg b.wt)	3.24 ± 0.21	2.63 ± 0.22	1.7812^{NS}
DCP intake g/d	45.94± 1.84	62.29± 8.17	1.9522^{NS}
DCP intake /100 kg b.wt	239.02 ± 23.53	281.18± 16.49	1.4673^{NS}
N intake g/ kg DOMI	24.52 ± 1.09	35.84 ± 4.91	1.9522^{NS}
TDN intake g/ d	422.98 ± 6.48	446.96± 38.25	0.6182^{NS}
TDN intake kg/100 kg b. wt	2.22 ± 0.23	2.12 ± 0.22	0.3956^{NS}
ME intake (M cal) / day	1.53 ± 0.02	1.62 ± 0.14	0.6402^{NS}
ME intake (M cal) / 100 kg b.wt	8.05 ± 0.83	7.66 ± 0.80	0.3385^{NS}

NS, Nonsignificant.

Table 5. Nutrient availability from bacteria and intestine of host animal (g/d)

Bacterial synthesis	Group 1	Group 2	t value
SCBACT	10.03±0.40	9.73±1.02	0.2678NS
NSCBACT	73.96±2.05	73.07±7.65	0.0198NS
REBTP	31.48±0.90	31.02±3.23	0.1398NS
REBCW	13.11±0.37	12.91±1.35	0.1468NS
REBNA	7.87±0.22	7.75±0.81	0.5707NS
REBCHO	17.64±0.50	17.37±1.81	0.1422NS
REFAT	10.08±0.28	9.93±1.03	0.1447NS
REBASH	3.70±0.10	3.64±0.38	0.6181NS
Protein			
DIGFP	3.77±0.35	4.34±0.68	0.9739NS
DIGBTP	31.48±0.90	31.02±3.23	0.1449NS
DIGBNA	7.73±0.22	7.42±0.71	0.0158NS
DIGP	43.02±1.45	42.77±4.55	0.0517NS
Carbohydrate			
VFA	271.07±7.98	265.99±27.64	0.1751NS
DIGFC	597.86±32.28	611.69±94.37	0.1396NS
DIGBC	422.13±17.04	447.88±54.06	0.4543NS
DIGC	1291.06±56.13	1325.53±174.10	0.1884NS
Fat			
DIGFFAT	25.25±0.63	23.81±2.93	0.5037NS
DIGBF	24.08±0.60	22.62±2.79	0.5128NS
DIGF	49.43±1.23	46.42±5.72	0.5137NS

NS, Nonsignificant.

(about 60%) and nucleic acid fraction (REBNA) was minimum (about 15%) in both the groups. Protein availability in intestine from bacteria (DIGBTP) was maximum (about 73%) followed by feed and nucleic acid in both the groups and variation between groups were nonsignificant. Carbohydrate available in intestine as feed carbohydrate (DIGFC) was maximum (about 46%) in both the groups. A considerable amount (33%) of available carbohydrate in intestine was from bacterial carbohydrate (DIGBC). The carbohydrate available as VFA was lower than DIGFC or DIGBC and the daily availability in group 1 was 271.07±7.98 g and in group 2 was 265.99±27.64 g. The lower value of VFA in both the groups might be due to the lower intake of carbohydrate fraction A which is quickly degradable as well as intermediately degradable protein fraction B_1 (Table 5).

The total faecal DM losses in group 1 (121.57±4.40) and in group 2 (131.18±12.67) were similar and losses were highest as carbohydrate followed by ash, protein and fat (Table 6). Similar findings were also observed by Jeya Prakash (1999) in working buffaloes fed complete ration. Daily TDN availability from the given feed was predicted from the model as 533.43±19.78 g in group 1 and 555.47±65.53 g in group 2 and the variation between the groups was not significant (Table 6). When daily TDN intake was calculated through the conventional digestibility trial, it was 422.98±6.48 g in group 1 and 446.96 ±38.25 g in group 2. Therefore, TDN availability as calculated by CNCPS model was 26.11% higher in group 1 and 24.27% higher in group 2 as compared to conventional digestibility trial. Daily metabolizable protein (MP) intake (g) calculated from the CNCPS model was 35.29±1.24 in group 1 and 35.36±3.87 in group 2 (Table 6). DCP intake (g/d) calculated from conventional digestibility trial was 45.94±1.84 and 62.29±8.7, respectively, in groups 1 and 2. Metabolizable protein of feed in group 1 was about 77% of DCP intake and in group 2 the corresponding value was 57%.

Table 6. Nutrient utilization from total ration by CNCP system

	Group 1	Group 2	t value
Faecal losses (g/d)			
Protein			
FEPROT	23.60±0.5	26.58±2.83	1.0311NS
Carbohydrate			
FECHO	51.02±2.77	53.39±7.58	0.2995NS
Fat			
FEFAT	1.72±0.04	1.62±0.20	0.5171NS
Ash			
FEASH	45.33±2.94	47.62±4.38	0.4858NS
Total	121.57±4.40	131.18±12.67	0.7164NS
Nutrient availability			
TDNAPP (g/d)	533.43 ± 19.78	555.47 ± 65.53	0.3292NS
ME			
MEa (M cal/d)	1.93±0.07	2.00 ± 0.24	0.2134NS
MEC (M cal / d)	3.38 ± 0.05	3.19 ± 0.06	2.5648*
Metabolizable protein (g/d)			
MP	35.29 ± 1.24	35.36 ± 3.87	0.04281NS

NS, Nonsignificant; *, significant ($P < 0.05$).

It can be concluded that at semiarid region during lean summer months, goats can be maintained on poor quality forages with the supplementation of only energy source in the form of crushed barley grain. Nutrient availability as calculated using CNCPS model was comparable to the conventional digestibility trial, therefore, conducting such trial the model may be adapted for computation of nutrient availability in grazing goats.

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