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Comparative performance of Barbari goats under different rearing system in semi-arid region

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India with 135 million goats has one of the largest goat population and plays a significant role in livelihood and nutritional security as well as providing supplementary income. The country stands first in goat milk production and is the second largest in goat meat in the world by sharing 29% and 12% production respectively. The goat sector contributes 8.4% to the India's livestock GDP. Goat husbandry also generates about 42% rural employment to the small, marginal and landless farmers. Rearing of goat is the major animal husbandry practice prevailing in the rural region of developing countries because of the high fertility and fecundity, low feed and management needs low investment, high feed conversion efficiency, quick pay-off and low risk involved. Goat rearing by grazing method (extensive method) is commonly followed in India. But, due to deforestation and non availability of grazing land, intensive method of goat rearing has its own significance.

Apart from providing supplementary income to marginal farmers, in recent years, commercial goat farming has emerged as a tool to provide substantial income to progressive farmers in peri-urban region of country. In peri-urban region of the country there is problem of land availability for the grazing and cultivation of the green fodder for the feeding of goats. In these areas the green fodder is very much limited or not available for feeding. Commercial farmers from peri-urban region are very much interested to know the production performance of animals with limited access to greens. Keeping these facts in mind, study was conducted to observe the performance of stall fed Barbari goats with no access to green fodder.

The present study was conducted at Barbari goat Farm, ICAR-Central Institute for Research on Goat (CIRG) Makhdoom, Farrah, Mathura (India). The farm is located at an altitude of 163.4 m above the mean sea level, at a latitude of 27.10°′ N and a longitude of 77.9°′ E and the climate is hot and semi-arid.

The present experiment was conducted from October 2017 to March 2018, during the experiment, minimum and maximum ambient temperature ranged from 4.7°C to 18.3°C and 21.6°C to 38.4°C while relative humidity varied from 48.18 to 67.7 with no rainfall.

Thirty growing Barbari goats of average body weight 15.20±0.54 kg of about 6 months of age were divided into 3 groups (Gr 1, Gr 2 and Gr 3) of 10 animals each as per completely randomized design. All the experimental animals were housed in a well-ventilated animal sheds having facility for individual feeding and watering. All the animals were maintained under standard hygienic and uniform management conditions throughout the experimental period with the provision of adequate lighting. Clean drinking water was provided *ad lib.* twice a day. All the animals were housed in individual cage and feeding was done individually. Animals of Gr 3 (under semi intensive system) were allowed to graze in pasture in a group.

Animals of Gr 1 and Gr 2 were fed with common basal diet of concentrate pellet and gram straw with no green/ grazing. They were fed with half of dry matter requirement concentrate pellet first and then *ad lib.* gram straw. The animals of Gr 1 was fed with concentrate pellet having 16% crude protein (CP) while Gr 2 animals were fed with concentrate pellet having 18% crude protein. Goats of Gr 3 were fed with a combination of concentrate pellet (16% CP), gram straw (GS), greens along with 6 h grazing. The feed combination during first 3 months of experiment was 200 g conc. + 200 g GS + 250 g green + 6 h Grazing and from 4–6 months of experiment was 250 g conc. + 300 g GS + 400 g green + 6 h Grazing. The animals were fed to meet their nutrient requirements (NRC, 1981).

Daily intake of concentrate pellet and gram straw were recorded. The representative sample of feed offered and refusal was collected daily and pooled for estimation of monthly dry matter. The DM was estimated by drying samples at 100±2°C in hot air oven to a constant weight. Body weights of each animal in each group were recorded at monthly intervals in the morning before feeding and watering.

Chemical composition of concentrate pellet and gram straw fed to animals was estimated as per AOAC (2006).

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Organic matter (OM) was determined by ashing at 550°C for 5 h. Neutral detergent fibre (NDF) and acid detergent fiber (ADF) were discerned by the methods of Van Soest *et al*. (1991) and AOAC (2006) method 973.18 (A–D), respectively. Crude protein (CP) content (N × 6.25) was measured as per the method described by AOAC (2006), method 984.13 (A–D). Ether extract (EE) was estimated using AOAC (2006) method 920.39 (A).

Blood samples were collected after 120 days of feeding. About 8 ml blood was collected from all the experimental animals in the morning (before feeding) by jugular vein puncture. Out of 8 ml, 6 ml blood was taken into a clean and dry test tube and kept in slanting position for 45 minutes to separate serum; and 2 ml of blood was taken in another clean and dry glass vial containing anticoagulant (EDTA) for hematological analysis. After hematological analysis, blood was used to separate plasma for further analysis of metabolites. The blood samples were brought to the laboratory and centrifuged at 3,000 rpm for 15 min to separate serum collected in small plastic eppendorf tubes (2 ml) and stored at –20°C for further analysis.

The whole blood was analyzed for hematological parameters using hematology analyzer from Melet Schloesing Laboratories, France standardized for goats as per manufacturer protocol.

The serum samples were analyzed for different biochemical constituent's, viz. glucose, total protein, albumin, cholesterol and triglycerides using diagnostic commercial kits (Autospan, Span diagnostic Ltd.). Concentration of glucose, total protein, albumin, triglycerides and cholesterol were quantified using end-point assay using double beam spectrophotometer (UV-Vis spectrophotometer, Labtronics, LT-2700, Panchkula, India). The procedure provided by the company on kits leaflet was strictly followed for analysis.

Commercial ELISA kits were used for quantitative determination of cortisol (Calbiotech, Austin drive, Spring valley CA 91978, USA) and testosterone (DRG, International, Inc, USA) concentration in plasma samples in duplicate following the instructions of the manufacturers. Analytical sensitivity of immunoassays for plasma cortisol and testosterone were 20 ng/ml, and 0.083 ng/ml, respectively.

The data collected during study were statistically analyzed using generalized linear model (GLM) procedures of analysis of variance (ANOVA). The means of the treatments were compared using Duncan's Multiple Range Test (DMRT) as per Snedecor and Cochran (1989). All the analysis was performed using SPSS 1995 software package.

The chemical composition of concentrate pellet and gram straw fed to experimental animals is presented in Table 1.

The chemical composition of concentrate pellet 1 and concentrate pellet 2 was similar. While concentrate pellet 1 was having 16.57% crude protein and concentrate pellet 2 was having 18.13% crude protein. Gram straw was having 6.11% crude protein. Total ash content (%) was 6.54, 6.78 and 8.24 for concentrate pellet 1, concentrate pellet 2 and gram straw respectively.

Table 1. Chemical composition of the feed (DM basis)

Nutrients (%)	Concentrate pellet 1 (C1)	Concentrate pellet 2 (C2)	Gram straw
Crude protein	16.57	18.13	6.11
Ether extract	3.21	2.02	0.42
Acid detergent fibre	10.56	11.01	47.44
Neutral detergent fibre	36.23	35.54	63.24
Cellulose	6.68	5.92	34.42
Hemicellulose	25.67	24.52	15.80
Total Ash	6.54	6.78	8.24

Initial mean body weight (kg) was in 15.24 in Gr 1,15.24 in Gr 2 and 15.04 in Gr 3 which finally changed to 29.70, 31.13 and 27.55 respectively in Gr 1, Gr 2 and Gr 3 respectively in 192 days of experimental feeding. Total body weight gain was highest (15.89 kg) in Gr 2 followed by Gr 1 (14.46) and Gr 3 (12.51). Average daily gain (g) was 75.28 in Gr 1, 82.77 in Gr 2 and 65.14 in Gr 3. Daily gain was highest in Gr 2 fed with high CP concentrate pellet but statistically similar to Gr 1 but significantly higher than the Gr 3 kept on grazing with supplementation of concentrate pellet, gram straw and greens. The average daily gain of goats was in agreement with 50–100 g per day reported by Ranjhan (1998). Animals kept on grazing pasture also lost some energy in browsing and grazing. Barbari goats are more suitable breed for stall feeding and the performance is better in intensive system as compared to semi-intensive system of rearing. Weight gain of goats was in range of other studies (Kumar *et al.* 2014 and Kumar *et al.* 2015) where animals were fed with complete pellet diet. Pal *et al*. (2010) also reported similar body weight gain in non-descript goats. They reported an average daily gain (g) of 51.56 and 62.22 in control and treatment groups, respectively and showed no significant difference ($P > 0.05$). Control group was fed with concentrate mixture while in treatment group concentrate mixture was replaced with leaf meal mixture. Patil *et al.* (2014) also reported significantly higher overall weight gain in stall fed group (7.90 kg) as compared to grazing group (5.30 kg) in Osmanabadi goats. Miah and Alim (2009) also reported higher increase in body weight of black Bengal goats under intensive system compared to semi-intensive system though non-significant. The daily feed intake was measured in Gr 1 and Gr 2 by feeding with weighed quantity of concentrate pellet and *ad lib.* gram straw. The refusal of gram straw was also measured and their dry matter was estimated monthly to calculate the average dry matter intake of feed during whole of experimental period. Feed intake was not measured in animals of Gr 3. Daily feed intake was similar in Gr 1 and Gr 2. Feed intake was in the range 3.8 to 4.6% of body weight in growing goats as suggested (NRC 2007) for tropical environment.

The blood Hb, RBC, PCV, WBC, lymphocyte, monocyte and granulocyte were comparable ($P>0.05$) among the different groups (Table 2). All the values were within the

Table 2. Hematology and blood metabolites in different groups of Barbari goats during experimental feeding

Attributes	Gr 1	Gr 2	Gr 3	P value
WBC (m/mm^3)	13.40±0.96	13.21±0.94	13.90±0.58	0.576
RBC (M/mm^3)	14.36±0.36	13.05±0.32	13.07±0.30	0.951
HCT (%)	21.73±0.57	19.88±0.43	19.44±0.57	0.813
MCV (fl)	15.13±0.39	15.32±0.23	14.88±0.26	0.709
Hb (g/dl)	8.19±0.18	8.61±1.16	7.37±0.22	0.576
THR (m/ mm^3)	382.70±27.98	326.00±21.36	361.50±19.52	0.397
MCH (pg)	5.69±0.09	5.73±0.07	5.58±0.07	0.719
MCHC (g/dl)	37.68±0.35	37.62±0.40	37.87±0.45	0.675
RDW (%)	16.59±0.44	16.38±0.22	17.17±0.44	0.153
Lymphocytes (%)	43.21±2.35	45.48±1.81	49.47±2.02	0.746
Monocytes (%)	6.28±0.45	7.62±0.24	7.07±0.43	0.075
Granulocytes (%)	50.51±2.57	46.96±1.96	43.46±1.66	0.276
Glucose (mg/dl)	83.08± 3.07	81.33±2.48	82.35±1.55	0.407
Total protein (g/dl)	5.69±0.05	5.59±0.05	5.58±0.10	0.122
Albumin (g/dl)	3.99±0.11	3.20±0.13	3.13±0.11	0.159
Total cholesterol (mg/dl)	50.93±0.98	50.99±1.23	56.90±1.87	0.241
Triglycerides (mg/dl)	77.28±5.88	79.29±2.75	80.04±3.85	0.357

normal reference range for goats. The mean hemoglobin (g/dl) was 8.19, 8.61 and 7.37 in Gr 1, Gr 2 and Gr 3 respectively. Hemoglobin is an indicator of erythrocytic normality and general well being of the animal (Radostits *et al.* 1994). Hemoglobin level was within the normal range (8–12 g/dl) as reported by Kaneko (1997). This suggests that the general health of goats given different diets remained similar. There was no significant difference in the Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC) and Red cell distribution width (RDW) of different group of goats indicating no anemic condition in goats. This means the animals were getting all the nutrients sufficiently to meet their physiological need of growth and different body function under this feeding regimen. However Patil *et al.* (2014) reported that blood parameters (average Hb , PCV and RBC count) were higher in stall feeding group compared to grazing group in Osmanabadi goats but no significant difference was reported in different leukocytes counts.

Serum biochemical profile gives important information concerning clinical status, deficit condition, treatment monitoring and also nutritional balance. The data pertaining to the general metabolism of experimental goats revealed that the mean values of glucose, total protein, albumin, triglycerides and cholesterol obtained in the present study was within normal physiological range (Kaneko 1997). There was no significant (P>0.05) difference in blood biochemical parameters, viz. glucose, total protein, albumin, triglycerides and cholesterol among different groups suggesting that the diet had no adverse effect on these blood parameters in growing Barbari goats. This may be due to accomplishment of minimum nutritional requirements in all the groups.

Plasma cortisol and testosterone level were significantly (P < 0.05) higher in Gr 3 compared to Gr 1 and Gr 2. However, the concentrations of plasma cortisol and testosterone were similar in Gr 1 and Gr 2.

Higher testosterone concentration in Gr 3 might be due to grazing of animals in group compared to individual housing of animals in Gr 1 and Gr 2. This might lead to expression of more sexual activity in animals of Gr 3 compared to Gr 1 and Gr 2. Serum cortisol level is an indicator of stress level to the animals. Animals in Gr 3 were subjected to stress during grazing condition, which may be reason of higher cortisol level in Gr 3. Level of cortisol is similar in Gr 1 and Gr 2 of animals.

From present study, it may be concluded that performance of Barbari goats is better in stall fed system as compared to semi intensive system of rearing. Under stall fed condition the performance of goats can be maintained without green fodder.

SUMMARY

This study was undertaken to compare the performance of Barbari goats under grazing system and stall feeding system. Thirty growing Barbari goats of average body weight 15.20±0.54 kg of about 6 months of age were divided into three equal groups (Gr 1, Gr 2 and Gr 3) of ten animals each as per completely randomized design. The animals of Gr 1 was fed with concentrate pellet having 16% Crude protein (CP) while Gr 2 animals were fed with concentrate pellet having 18% crude protein. Goats of Gr 3 were fed with a combination of Concentrate pellet (16% CP), Gram straw, greens along with 6 h grazing. Total body weight gain was highest in Gr 2 followed by Gr 1 and Gr 3. Duration of experimental feeding was 192 days. Average daily gain (g) was 75.28 in Gr 1, 82.77 in Gr 2 and 65.14 in Gr 3. Average daily gain was highest in Gr 2 fed with high CP concentrate pellet and statistically similar to Gr 1 but significantly higher than the Gr 3 kept on grazing with supplementation of concentrate pellet, gram straw and greens. The blood Hb, RBC, PCV, WBC, lymphocyte, monocyte and granulocyte were comparable (P>0.05)

among the different groups. Upon DLC analysis, different leukocytes were in the normal range in the stall fed group compared to the grazing group. However, plasma cortisol and testosterone level was significantly ($P < 0.05$) higher in Gr 3 compared to Gr 1 and Gr 2. But the concentrations of plasma cortisol and testosterone were similar in Gr 1 and Gr 2.

Present study concluded that the performance of Barbari goats was better under stall feeding system and farmers can gain more profit in stall feeding system of goat rearing compared to grazing system.

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