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Effect of Feeding Gram Straw-based Complete Feed Pellets on the Performance, Nutrient Utilization and Rumen Fermentation of Goats

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ABSTRACT

Background: Using crop residues in goat rations is essential to prevent the shortage of fodder for goats in rural areas. To overcome the problems of low acceptability, digestibility, low nutrient contents of crop residues, preparation of crop residue based complete feed pellets is the best way. The aim of this study is to evaluate the effect of feeding gram straw-based complete feed pellets on the growth performance, nutrient utilization and rumen fermentation of goats.

Methods: The goats in groups I and II were fed *ad lib* supernapier hay + 300 gm concentrate daily and *ad libitum* gram straw-based complete feed pellets with roughage to concentrate ratio of 70:30, respectively. The growth performance, nutrient utilization and rumen fermentation study, along with an estimation of hematological and blood biochemical parameters, were carried out in this experiment.

Result: Significantly better growth performance, nutrient utilization, rumen fermentation and low cost of production was found in goats of group II (fed gram straw-based complete feed pellets) with the non-significant difference in body condition score, rumen motility and hematological parameters in goats of group II than group I. The blood glucose values found significantly more in group II as compared to group I. Feeding gram straw-based complete feed pellets improved performance, nutrient utilization and proved to be economical.

Key words: Blood biochemical, Complete feed pellets, Cost of production, Goats, Hematological, Nutrient utilization, Performance, Rumen fermentation.

INTRODUCTION

The Indian economy relies heavily on livestock. India's goat population is estimated to be 148.88 million, accounting for 27.74 per cent of the country's total livestock. India is the world's leading producer of goat milk, as well as the world's second-largest population and meat producer. In India, goat milk accounts for 3% of the total milk production. Goat meat accounts for 14.25% of total meat production in the country.

The main reason for our livestock's low productivity is malnutrition or under-nutrition caused by a wide disparity in demand and supply of feed and fodder in the country (Prajapati *et al*. 2019). The main challenges for goat production in these rural areas are feed shortages, diseases, especially helminthic, poor management and lack of marketing strategies (Gwaze *et al*. 2009). Addressing the problem of restricted forage for goats might have a positive impact in resolution the preceding constraints. There are traditional food crop residues such as paddy straw, wheat straw, groundnut straw, arhar straw and gram straw that could be used to supplement goat feed. But the crop residues have low acceptability, digestibility and low nutrient contents in its original form. Therefore, it is necessary to utilize these crop residues efficiently to satisfy the forage requirement of Indian goats. The best way to utilize the crop residues in the animal rations is by employing a complete feed system. Complete feed is the bled of all components required by the animal body and the proportion of the feedstuffs is variable depending upon the animal's physiological status. The formation of complete feed could improve acceptability, digestibility and nutrient utilization and thereby improves performance of the animals (Patil *et al*. 2021). In view of the availability of gram straw in this region, the present experiment was undertaken to evaluate the performance of goats on feeding gram straw-based complete feed pellets.

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MATERIALS AND METHODS

The one-month experiment was carried out in July 2022 at Goat farm, department of Animal Nutrition, College of

Veterinary Science and Animal Husbandry, Anjora, Durg, Chhattisgarh. All the required ingredients were ground in hammer mill and blended in mixer, mineral mixture, salt was added through medicine hopper. To soften the total complete mash feed and to improve the pellet binding, it was moistened by sprinkling some water and pellets of 8 mm diameter were prepared through the pellet machine. Gram straw-based complete feed pellets were prepared by maintaining 70:30 roughage to concentrate ratio. The pellets were then air dried until they reached optimum moisture and consistency. The concentrate mixture contained maize 36, soya deoiled cake 20, cotton seed cake 17, wheat bran 12, arhar chuni 12, mineral mixture 2 and salt 1 part.

Twelve healthy adult goats of approximate similar body weight (19.22±2.78 kg) were divided into two groups with six goats in each and reared under the same intensive management system. The goats in the control group (group I) were fed *ad lib* supernapier hay and 300 g concentrate mixture to satisfy the nutrient requirement as per ICAR 2013. Whereas goats in the treatment group (group II) were fed *ad lib* complete feed pellets containing 70%-gram straw and a concentrate mixture of 30%.

Goats' initial and weekly live body weights were recorded on digital weighing balance. Daily feed intake was recorded by subtracting the feed left over from the feed offered to each goat. Initial body condition score and body condition score every fortnight was recorded. Scoring is done by using the hand to feel for the fullness of muscling and fat cover over and at lumbar region, brisket region, ribs and into the vertebrae in the loin region. FCR was calculated by dividing weight gain by feed intake.

At the middle of the trial, rumen liquor was collected at 4 hours post feeding by using stomach tube having a 0.15 mm internal diameter and 150 cm long plastic tube. The stomach tube was moistened and animal's mouth was opened by placing a thumb in the region without teeth. The tube was then passed over the back of the tongue and entered the oesophagus. A 50 ml syringe was used to apply suction to draw ruminal fluid. The fluid was obtained by lowering the animals head until the fluid ran from the tube. Approximately, 50 ml of rumen liquor was collected from individual goats. The sucked fluid was filtered through the cheesecloth and pH was immediately measured. The filtered rumen liquor was immediately taken for digestion to estimate total nitrogen. 15 ml of rumen liquor was frozen and stored at -20°C for determination of TVFA. TVFA was determined using the Markham apparatus as described by Bernett and Reid (1957). The total nitrogen was analyzed as per AOAC (2007). The total bacterial and protozoan count was carried out by the direct method given by Smith and Baker, 1944.

About two and five milliliters of blood samples were collected separately for haematological and biochemical analysis from each animal in clean plain tubes at the start and end of the experiment. Blood samples were subjected to haematological analysis (Hb, PCV, TEC and TLC) and the serum was separated as per the standard procedure. It was analyzed in a semi-auto analyzer using diagnostic kits for various biochemical parameters (blood glucose (mg/dl), total protein (g/dl), albumin (g/dl), globulin (g/dl), total cholesterol (mg/dl), ALT, AST and creatinine).

The metabolic trial was conducted with all 12 goats. A 21-day preliminary period and two days adoption period was followed by a four-day collection period. The goats were kept in individual metabolic cages having provision for feeding and watering. The goats were offered respective rations and daily dry matter intake, feed refusal, total faeces and urine passed were recorded and collected individually. The samples of supernapier hay, concentrate mixture, gram straw-based complete feed pellets and dried faeces were analysed for proximate analysis (AOAC, 1995) and ADF and NDF by Van Soest, 1991. Urine was analyzed for nitrogen as per AOAC (2007).

The cost of each experimental diet was calculated considering the prevailing market price of individual feed ingredients and supplements during the experiment. The cost per kg live body weight of goat reared under different feeding regimens was calculated based on feed consumption data for 0-28 days.

The data of the study was analysed by an independent T-test. Overall data were analyzed as per the standard procedure (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Chemical composition of concentrate mixture, supernapier hay and gram straw-based complete feed pellets is shown in Table 1.

Performance parameters

The daily DMI and weight gain in goats (Table 2) during the study period were significantly higher (P<0.01), with better FCR in treatment group fed gram straw-based complete feed pellets than the control group. DMI of crop residue-based complete feed pellets was higher due to more acceptability of complete feed in processed form. Grinding crop residues reduces particle size and pelleting with concentrate mixture leads to lower bulk density. Therefore, to fulfill bulk requirement, DMI intake of complete feed could be improved (Nagalakshmi and Reddy, 2011). High DMI of crop residue-based complete processed feed was also reported by Reddy

Table 1: Chemical composition of concentrate mixture, supernapier hay and gram straw-based complete feed pellets.

Nutrients	Concentrate mixture	Supernapier hay	Complete feed pellets
Dry matter %	91.26	89.38	90.45
Crude protein %	21.78	8.07	11.54
Ether extract %	3.14	1.69	2.75
Crude fiber %	9.0	37.6	24.6
Total ash %	9.04	6.98	8.4
Nitrogen free extract %	56.93	45.66	52.71
NDF %	23.01	68.41	50.3
ADF %	11.04	39.3	32.68

and Reddy (1985) in calves; Nagalakshmi and Reddy (2011) in lambs and Devasena and Prasad (2014) in goats.

The higher DMI in the treatment group might have resulted in higher body weight gain in goats of the treatment group. Feeding complete feed leads to a proportionate intake of roughage and concentrate, giving an optimum rumen environment; therefore, the animal shows better performance. Islam *et al*. (2017); Venkateswarlu *et al*. (2013) and Dhuria *et al.* (2009) also reported a significant effect of feeding crop residue-based complete ration on growth rate than the traditional ration.

Fortnightly body condition score was non-significant between the groups with similar faecal consistency scores.

A non-significant difference was found in ruminal motility count (Table 3) between the control and treatment groups, indicating no side effect on the rumen function of both the rations given to the control and treatment groups.

Rumen fermentation

The rumen liquor profile (Table 4) revealed significant variations (P<0.01 and P<0.05) between the control and treatment group for TVFA, total nitrogen, total bacterial and protozoan count except for the pH of rumen liquor. The significant variations for TVFA and total nitrogen might be due to the better adaptation of ruminal microbes to the pelleted complete feed. The values of TVFA found in this experiment were higher and the total nitrogen value was lower than that recorded by Rekhate *et al*. (2005), with similar pH values.

Nutrient utilization

The digestibility of DM, CP, CF, EE, NFE, ADF and NDF (Table 5) was significantly higher in the treatment group fed with gram straw-based complete feed pellets than in the control group, indicating the better utilization of gram straw by the goats. It noted that the better utilization of nutrients from the complete feed pellets might be due to a uniform supply of nutrients at regular intervals, which helps maintain a steady and healthy rumen environment. Gupta *et al*. (2006); Nagalaxmi and Reddy (2012); Kishore *et al*. (2014); Mudgal *et al*. (2014) and Rashid *et al.* (2016) found higher nutrient digestibility in animals fed complete rations in pelleted or block form than the conventional ration.

The nitrogen balance-related data is presented in Table 6. The mean retention of nitrogen (gm/head/day) in goats fed gram straw-based complete feed pellets was significantly higher than the goats fed conventional ration. It can be inferred that gram straw can be incorporated into

Table 2: Performance parameters and faecal consistency score of goats in control and treatment groups.

Sr. No.	Parameters	Ist week	IIndweek	IIIrd week	IVth week	Significance
Daily DM intake (g)	Control	700.55±17.33^{b}	717.14±13.93^{b}	730.74±10.97^{b}	738.33±6.14^{b}	(P <0.01)**
	Treatment	776.24±47,76^{a}	796.95±67.29^{a}	813.33±40.82^{a}	818.33±45.46^{a}	
ADG (g)	Control	60.54±0.85^{b}	61.43±0.90^{b}	60.72±1.75^{b}	62.14±0.78^{b}	(P <0.01)**
	Treatment	102.86±0.00^{a}	104.29±1.27^{a}	108.33±0.58^{a}	110.00±0.00^{a}	
FCR	Control	12.83±0.27^{a}	12.96±0.33^{a}	13.37±0.42^{a}	13.20±0.22^{a}	(P <0.01)**
	Treatment	8.34±0.26^{b}	8.45±0.31^{b}	8.29±0.30^{b}	8.29±0.32^{b}	
Faecal consistency score	Control	1	1	1	1	NS
	Treatment	1	1	1	1	
Fortnightly body condition score	Control	2.75±0.22		3.00±00		NS
	Treatment	2.63±0.14		3.17±0.41		

NS-Non-significant, Means bearing different superscripts in rows differ significantly (P<0.01)**.

Table 3: Rumen motility/5 minutes in control and treatment groups.

Group	Initial	Ist week	IIndweek	IIIrd week	IVth week
Control	6.17±0.41	6.17±0.41	6.50±0.55	6.50±0.55	6.33±0.52
Treatment	6.17±0.41	6.33±0.52	6.83±0.41	6.83±0.41	6.83±0.41
Significance	NS	NS	NS	NS	NS

NS- Non-significant.

Table 4: Rumen fermentation parameters of goats in control and treatment groups.

Group	pH	Total nitrogen (mg/100 ml SRL)	TVFA (mEq/100 ml SRL)	Microbial count	
				Bacterial count × 10^{10}/ml of SRL	Protozoan cou × 10^{6}/ml of SRL
Control	6.58±0.20	74.67±3.39^{b}	8.14±0.35^{b}	0.96±0.01^{b}	1.50±0.08^{b}
Treatment	6.58±0.20	80.27±2.89^{a}	9.60±0.85^{a}	1.09±0.11^{a}	1.75±0.12^{a}
Significance	NS	(P<0.05)*	(P<0.01)**	(P<0.05)*	(P<0.01)**

NS- Non-significant, Means bearing different superscripts in rows differ significantly (P<0.01)** and (P<0.05)*.

the ration of goats with a positive nitrogen balance and with better nutrient utilization. The comparatively higher nitrogen retention in the treatment group was due to better utilization of nitrogen by the microbes at comparably lower nitrogen intake. The nitrogen balance reported by Wadhwani *et al*. (2010) is similar to findings in the present experiment.

Table 5: Nutrient utilization of goats in control and treatment groups.

Nutrient	Digestibility %		Significance
	Control	Treatment	
Dry matter	57.92±0.24[b]	62.89±0.27[a]	(P<0.01)**
Crude protein	62.58±0.69[b]	65.34±0.60[a]	(P<0.01)**
Crude fibre	58.29±1.34[b]	60.02±0.71[a]	(P<0.05)*
Ether extract	68.14±1.14[b]	71.23±0.62[a]	(P<0.01)**
Nitrogen free extract (NFE)	62.50±1.46[b]	67.66±0.69[a]	(P<0.01)**
NDF	59.96±0.94[b]	62.48±0.65[a]	(P<0.01)**
ADF	52.24±0.71[b]	53.35±0.48[a]	(P<0.01)**

Means bearing different superscripts in columns differ significantly (P<0.01)** and (P<0.05)*.

Haematological parameters

Table 7 indicates the data regarding haematological parameters. At the end of an experiment, the haematological values have a non-significant difference between the groups. All the haematological values were in the normal range. Ramulu *et al.* (2015) reported non-significant difference in haematological values in buffalo calves fed complete diet with sorghum stover plus concentrate with and without supplementation of Zn.

Blood biochemical parameters

The blood biochemical profile is presented in Table 8, indicating no significant difference found for the biochemical parameters between the control and treatment groups except for the blood glucose level. Blood glucose level was significantly higher in goats in the treatment group than in the control group. Higher blood sugar levels in the treatment group might be due to better nutrient utilization from the complete feed pellets than the conventional ration. The glucose level findings agree with Behera *et al*. (1993) reported in black Bengal goats and Delany *et al*. (2010) in cows. Sharma *et al*. (2010) reported non-significant

Table 6: Nitrogen balance in goats in control and treatment groups.

Group	Nitrogen intake (g)	Nitrogen excreted in faeces (g)	Nitrogen excreted through urine (g)	Nitrogen retained in body (g)
Control	15.52±0.12[a]	5.81±0.14[a]	2.57±0.58	7.14±0.13[b]
Treatment	15.20±0.23[b]	5.27±0.17[b]	2.51±0.48	7.43±0.23[a]
Significance	(P<0.05)*	(P<0.01)**	NS	(P<0.05)*

Means bearing different superscripts in rows differ significantly (P<0.01)**.
NS- Non-significant.

Table 7: Hematological parameters of goats in control and treatment groups.

Parameter	Start of experiment		Significance	End of experiment		Significance
	Control	Treatment		Control	Treatment	
Hb mg%	8.18±0.15	8.15±0.14	NS	8.22±0.10	8.22±0.08	NS
PCV%	22.40±0.44	22.38±0.52	NS	22.48±0.37	23.42±0.76	NS
TEC × 10^6/µl	8.32±0.12	8.30±0.14	NS	8.35±0.14	8.37±0.16	NS
TLC × 10^3/µl	7.9±1.19	9.3±2.02	NS	7.95±1.12	10.28±1.50	NS

NS- Non-significant.

Table 8: Blood biochemical profile of goats in control and treatment groups.

Parameter	Start of experiment			End of experiment		
	Control	Treatment	Significance	Control	Treatment	Significance
Blood glucose mg%	48.17±2.59	52.13±4.31	NS	48.40±2.63[b]	53.28±4.47[a]	(P<0.05)*
Total protein g%	6.54±0.19	6.61±0.26	NS	6.53±0.18	6.65±0.27	NS
Serum creatinine mg%	0.92±0.10	0.92±0.10	NS	0.92±0.10	0.94±0.10	NS
Total cholesterol mg%	60.97±4.76	59.12±2.96	NS	60.83±4.55	59.09±2.97	NS
SGOT U/L	197.10±10.52	196.43±8.80	NS	196.05±10.34	195.45±9.57	NS
SGPT U/L	18.65±0.42	18.63±0.47	NS	18.60±0.49	18.60±0.27	NS
Serum albumen g%	3.02±0.36	3.15±0.29	NS	3.02±0.37	3.16±0.26	NS
Serum globulin g%	2.81±0.08	2.91±0.26	NS	2.80±0.09	2.99±0.29	NS

NS-Non-significant, Means bearing different superscripts in columns differ significantly (P<0.05) *

Table 9: Cost of production per goat in control and treatment groups.

Feed stuff	Control	Treatment
Average supernapier hay intake (Kg)	14.09 kg in 28 days	-
Average concentrate intake /goat	8.35 kg in 28 days	-
Average gram straw-based complete feed pellet intake/goat	-	24.79 Kg in 28 days
Cost of feedstuffs	Hay=Rs. 6/Kg Concentrate=Rs. 34.22/kg	Complete feed pellets =Rs. 15.87/Kg
Cost of feeding	Hay=Rs. 84.54/- Concentrate= Rs. 285.74/-	Complete feed pellets = Rs. 393.42/-
Cost of processing	-	Rs. 1/Kg of complete feed =Rs. 24.79/-
Total feeding cost	Rs. 370.28/-	Rs. 418.21/-
Average total weight gain/ goat	1.71 Kg	2.96 Kg
Cost of feeding per Kg of weight gain	Rs. 216.54/Kg	Rs. 141.29/Kg

difference in serum glucose, total protein, albumin and globulin concentrations whereas significantly lower values of serum total cholesterol and SGPT ($p<0.05$) and alkaline phosphatase ($p<0.01$) in calves fed complete feeds in mash or block form compared to those fed the diet in conventional form.

Cost of production

The total cost of feeding (Rs. /animal) for experimental goats (Table 9) was estimated to be Rs. 370.28/- and 418.21/- in the control and treatment groups, respectively. The goats in the control group with conventional ration have a lower cost of production (Rs. 370.28/animal) than the treatment group. The average total weight gain in four weeks was higher in the treatment group (2.96 Kg/ animal) with the lower cost of per Kg of weight gain than in the control group (1.71 Kg/ animal). The present findings are more or less comparable with Saiyed *et al*. (2003); Wadhwani *et al*. (2010) and Chaudhary *et al*. (2017) reported lower cost of production per Kg weight gain in animals fed crop residue-based complete feeds than conventional ration.

CONCLUSION

Feeding gram straw-based complete feed pellets with 70:30 roughage to concentrate ratio positively affects goats' performance parameters with better utilization of nutrients by maintaining a healthy rumen environment. Further, it has no adverse effect on haematological and blood biochemical parameters. Feeding of gram straw-based complete feed pellets proved economical due to reducing the per kg cost of production.

Conflict of interest: None.

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