RESEARCH ARTICLE
JIVA 20 (3) December 2022
https://doi.org/10.55296/JIVA/20.3.2022.38-46

Received: 25-09-2022
Accepted: 03-11-2022

NUTRIENT UTILISATION IN BARBARI GOATS AS AFFECTED BY LEVELS OF FEED INTAKE

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ABSTRACT

To determine the effect of different levels of feed intake on the utilisation of nutrients, eight adult Barbari goat bucks (20.14 ± 0.74 kg mean body wt) were allotted to two sets of 4X4 Latin square design. The animals were fed on diets comprising of concentrate mixture and wheat straw (1:1 ratio) at four fixed levels of voluntary feed intake (95, 80, 60 and 40 per cent) in groups I, II, III and IV respectively. The experiment consisted of four 21-day feeding periods and four feeding levels. A metabolism trial was conducted during the last 8 days of each feeding period. During the study it was observed that lowering the level of feed intake decreased the efficiency of utilisation of dry matter, organic matter and fibre fractions in Barbari goats. Feed restriction also lowered the efficiency of utilisation of absorbed nitrogen and thus increased the proportion of nitrogen excreted in urine. From these results, it is evident that feed restriction adversely affects the nutrient digestibility of Barbari goats.

Keywords: Barbari goats, Levels of feed intake, Nutrient digestibility, Nitrogen balance

INTRODUCTION

In developing countries like India, the small and medium farmers have limited available feed resources for feeding their livestock. Thus, strategies involved in improvement of livestock production require efforts to maximize the utilisation efficiency of available feed resources. The efficiency of microbial fermentation in the fore stomach of ruminants determines the extent of utilisation of poor-quality roughages as feed for ruminants. Incomplete and inefficient utilisation of nutrients especially nitrogen, adds to the cost of production and ultimately leads to environmental pollution (Jayasuriya, 1999).

Therefore, strategies have to be adopted in providing optimum conditions for microbial growth in the rumen to improve animal production by maximising the efficiency of utilisation of available feed resources. Restriction of feed often results in increased digestibility of organic matter (Schneider and Flatt, 1975; Galyean and Owens, 1991). However, this negative relationship between intake and digestibility is not always observed for intakes much lower than maintenance level (Chillard *et al*., 1995). There are reports that one month of feed restriction continued with two months of re-feeding can lead to compensatory growth in goats (Suwignyo *et al*., 2017). So there is a need to optimise levels of feed intake in goats for adequate utilisation of nutrients, without the wastage of feed. Taking these points into consideration the present study was undertaken to see the effect of levels of feed intake on nutrient utilisation in adult Barbari goats.

MATERIALS AND METHODS

Animal experimentation was carried out at Animal Nutrition Division of Indian Veterinary Research Institute, Izatnagar in Uttar Pradesh Province of India. The location is at 170 m above mean sea level ($28^0$22'N and $79^0$24'E) in the northern upper Gangetic plain, having an annual rainfall of 900-1200 mm.

Table 1: Ingredients and chemical composition of the roughage and concentrate supplied to goats

	Concentrate	Roughage
Ingredients (%)		
Wheat straw		100
Maize	38	
Wheat bran	38	
Soybean meal	22	
Vitamin mineral supplement†	2	
Chemical composition (%, DM basis)		
Organic matter	90.88	90.31
Crude protein	18.12	3.07
Ether extract	2.31	1.09
Crude fibre	8.34	37.48
Neutral-detergent fibre	42.70	81.03
Acid-detergent fibre	11.10	51.24
Total ash	9.12	9.69

Abbrevation is: DM = dry matter

† Declared compositon: Ca: 160, Mg: 95, P: 95, S: 27, Mn: 3, Fe: 2.8 (gKg DM^{-1}); I: 77, Co: 15, Se: 5(µgkg DM^{-1}); vitamin A: 40 00000, D_3: 80 000 (IUkg DM^{-1})

Animals and feeding

Eight adult Barbari goat bucks of two year's age (20.14 ± 0.74 kg mean body wt) were used for the study. They were fed *ad libitum* a mixed diet of wheat straw and concentrate (1:1) (Table 1) individually for one week during the preliminary feeding period.

The lowest level of intake recorded during the preliminary period among all animals was set as voluntary feed intake (VFI) to ensure that all animals were able to consume all the feed offered to them during the experimental feeding.

Two sets of 4 x 4 Latin square designs (LSD) were used for this experiment. The experiment consisted of four 21-day feeding periods and four feeding levels. The highest level of intake was 95 per cent of VFI (Group I). The other three levels were 80 per cent (Group II), 60 per cent (Group III) and 40 per cent (Group IV) of the voluntary intake. The experimental animals were weighed (before feeding and watering) in the beginning and end of each feeding period.

Sample collection and analysis

During last 8 days of each period, goats were placed in individual metabolism cages and the daily output of urine and faeces was recorded. The metabolism cages were having facility to collect urine and faecal samples separately. To ensure clean separation of faeces and urine, the screens were cleaned daily and also the angle and position of the collector was suitably adjusted. Representative samples of feed offered, residue left, faeces voided and urine excreted were brought daily to the laboratory and preserved as per the methods of Schneider and Flatt (1975) for further chemical analysis.

The proximate composition of feed and faecal samples was determined (AOAC, 1995). The contents of neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analyzed (Van Soest *et al*., 1991). Nitrogen content (N) in feed, faeces and urine were determined by micro-Kjeldhal method and crude protein calculated as N x 6.25.

Statistical analysis

The various data sets were subjected to Analyses of variance (ANOVA) procedure according to a Latin square design using the General Linear Model (GLM) of the SAS system for windows. Treatment means was compared by using Duncan's New Multiple Range Test. The statistical model is shown below:

$Y = \mu + \alpha + \beta + \gamma(\alpha) + t + \varepsilon,$

where μ is the overall mean, α is the random effect of the square, β is the random effect

of period, $\gamma(\alpha)$ is the random effect of goat within the square, t is the fixed effect of treatment, and ε is the random error.

RESULTS AND DISCUSSION

Intake and digestibility

Prior to experimental feeding goats were fed *ad libitum* wheat straw and concentrate mixture (1:1) for one week to determine the lowest level of feed intake. The observed lowest level of feed intake was 484.47±0.05 g/day (DM basis), which was termed as voluntary feed intake (VFI). On the basis of VFI, the quantities of feed to be offered to animals at different levels were decided. In the feeding trial, good quality diets were used uniformly by maintaining a constant ratio of wheat straw and concentrate (1:1) so that the desired level of feed intake could be achieved. Intake (gd^{-1}) and digestibility (%) of nutrients at various levels of feed intake are presented in Table 2.

The significant variation ($P < 0.05$) observed in the intake of nutrients among groups was due to the feeding levels maintained for animals under different groups as envisaged by the experimental design. It indicated significant difference in the nutritional status of animals among the treatment groups. Digestibility of a feed is not a fixed trait but is modified by various factors such as the level of feed intake, fodder variety (Avornyo, 2020) water consumption (Hussein *et al*., 2020), age and state of animal production. Restriction of feed intake often results in enhanced OM digestibility owing to higher retention time in the rumen (Galyean and Owens, 1991). The decrease in feed intake did not induce increased DM and OM digestibility in the present study, which would be expected. This is probably due to lower availability of energy under restricted feeding conditions, which limits the growth of microorganisms (Dehority and Orpin, 1988). In a study in Corriedale lambs (Fujihara *et al*., 2005) digestibility of OM tended to increase significantly ($P < 0.05$) with an increase in dietary energy. Moreover, decreased digestibility of DM and OM at very low intake observed in the present study might be owing to increased proportion of endogenous materials in faeces especially with straw based diet which could have had an abrasive effect on gut mucosa. A similar type of variation of digestibility related to feed intake was earlier observed by Liu and McMeniman, (2006) in Merino sheep and Soejono *et al*. (1999) in Bali and Ongole cattle. On contrary, absence of change in digestibility of DM and OM, at intakes lower than maintenance, was recorded by some workers (Keenan *et al*., 1969; Agabriel *et al*., 1995).

Table 2. Intake (gd^{-1}) and digestibility (%) of nutrients at various levels of feed intake

Parameters	Group I (L-95)	Group II (L-80)	Group III (L-60)	Group IV (L-40)	SEM
			Dry matter		
Intake	459.50^{a}	385.98^{b}	294.08^{c}	192.99^{d}	0.90
Digestibility	59.80^{a}	58.59^{a}	57.65^{ab}	54.95^{b}	1.60
			Organic matter		
Intake	416.28^{a}	349.67^{b}	266.42^{c}	174.84^{d}	0.81
Digestibility	63.74^{a}	62.59^{a}	61.70^{ab}	59.18^{b}	1.38
			Crude protein		
Intake	48.48^{a}	40.72^{b}	31.02^{c}	20.36^{d}	0.09
Digestibility	70.23	69.95	70.73	70.20	1.38
			Ether extract		
Intake	7.79^{a}	6.55^{b}	4.99^{c}	3.28^{d}	0.01
Digestibility	62.87	63.52	63.05	61.57	1.87
			Crude fibre		
Intake	105.68^{a}	88.77^{b}	67.64^{c}	44.39^{d}	0.33
Digestibility	54.76^{a}	53.24^{ab}	52.75^{ab}	51.01^{b}	1.34
			Neutral detergent fibre		
Intake	284.81^{a}	239.24^{b}	182.28^{c}	119.62^{d}	0.70
Digestibility	50.98^{a}	49.16^{ab}	48.73^{ab}	47.52^{b}	1.54
			Acid detergent fibre		
Intake	143.79^{a}	120.78^{b}	92.03^{c}	60.39^{d}	0.45
Digestibility	41.95^{a}	41.67^{ab}	39.87^{ab}	39.22^{b}	1.30

Values with different superscripts in a row differ significantly: ($P < 0.05$)

In the present study digestibility of CP and EE was not affected by level of feed intake. In studies conducted in Merino crossbred wethers Liu and McMeniman (2006) observed that CP digestibility was not affected even when the animals were fed at 50 per cent of the maintenance requirement. Malik *et al*. (1998) reported that digestibility of CP in crossbred heifers was not affected by higher levels of CP intake (44% more than the NRC recommendation) while, Krishnamohan and Ranjhan (1984) observed a decrease in digestibility of CP as energy level of ration increased. Baruah (1983) reported that energy levels had no significant effect on CP and EE digestibility in adult buffaloes.

The digestibility of CF and fibre fractions were significantly ($P < 0.05$) higher at enhanced levels of feed intake. Increased availability of energy at higher levels of feeding might have resulted in

enhanced enzymatic activity of cellulolytic bacteria (Kabre *et al*., 1994). This is in agreement with the findings of Malik *et al*. (1998) who reported that when crossbred heifers fed at 140, 120 and 100 per cent of NRC recommendations, digestibility coefficient of CF was higher at increased levels of feed intake. Likewise, in a study conducted in non-lactating dairy cows (Grimaud and Doreau, 1995) the fibre digestibility (NDF and ADF) was more at higher plane of nutrition even though the differences were not significant.

Nitrogen balance

Nitrogen retention is considered as the most common index of the protein nutrition status of ruminants (Owens and Zinn, 1988). In this study, a positive nitrogen balance was observed up to 60 per cent of VFI (Table.3).

Faecal excretion of nitrogen (gd^{-1}) decreased ($P < 0.01$) with reduction in the level of feed intake. The differences in the quantity and routes of nitrogen excretion with consequent influences on nitrogen retention reflected the influence of levels of feed intake in nitrogen metabolism. In a related study in Saanen goats (Paengkoum *et al*., 2006), the urinary excretion of nitrogen was lower ($P < 0.05$) in goats fed high energy than in those fed low energy. The negative nitrogen balance of group IV in the present study may be due to higher endogenous losses of nitrogen that have exceeded the dietary nitrogen supply. In a similar study in Merino crossbred wethers Liu and McMeniman (2006) observed a negative nitrogen balance when animals were fed at half the maintenance requirement. Comparable findings were recorded in studies with crossbred cattle

Table 3. Nitrogen balance at various levels of intakes

Parameters	**Group I (L-95)**	**Group II (L-80)**	**Group III (L-60)**	**Group IV (L-40)**	**SEM**
N intake (gd^{-1})	7.76^{a}	6.51^{b}	4.96^{c}	3.26^{d}	0.01
N excretion (gd^{-1})					
Faecal loss	2.31^{a}	1.96^{b}	1.45^{c}	0.97^{d}	0.08
Urinary loss	2.10^{b}	2.47^{a}	2.37^{a}	2.37^{a}	0.10
N balance					
gd^{-1}		3.34^{a}	2.09^{b}	1.14^{c}	-0.08^{d}
As % intake	43.11^{a}	32.06^{b}	23.09^{c}	-2.39^{d}	1.68
As % absorbed	61.22^{a}	45.86^{b}	32.77^{c}	-3.47^{d}	2.13

Values with different superscripts in a row differ significantly: ($P < 0.05$).

(Singh, 2004) and Murrah buffaloes (Dipu *et al*., 2008). Results of the present study revealed that nitrogen absorption and thereby retention was reduced ($P < 0.05$) at lower levels of feed intake

CONCLUSION

The study concludes that decreasing the level of feed intake lowered the efficiency of utilisation of dry matter, organic matter and fibre fractions in Barbari goats. Moreover, feed restriction also lowered the efficiency of utilisation of absorbed nitrogen and thus increased the proportion of nitrogen excreted in urine.

ACKNOWLEDGEMENT

The authors are grateful to the NATP (CGP-III), ICAR, New Delhi for providing assistance for this study. The first author is thankful to UGC, New Delhi for providing assistance in the form of senior research fellowship.

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