Influence of Food Allowance on Nutrient Utilization of Oat (*Avena sativa*) Hay by Goats and Feeding Value of Leftovers from High Levels of Offer in Sheep

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ABSTRACT : Two experiments were conducted to determine the effect of feeding levels on intake and nutrient utilization of oat (*Avena sativa*) hay (OH) by goats and potential feeding value of leftovers from high levels of offer in sheep. In experiment 1, the goats (15) were offered OH at three levels of feeding to give leftovers of about 20% (T-1), 35% (T-2) and 50% (T-3) of DM offered. A marked effect of refusal rate of OH on intake and digestibility of nutrients was evident. Allowing selective consumption at higher levels (T-2 and T-3), the intake of DCP and TDN from OH was found not only to meet the maintenance requirement but provided surplus nutrients for moderate production. In experiment 2, sheep (3) were offered one of the three dietary treatments viz OH, refusals left uneaten by goats in T-2 and T-3 (OHR) and 3% urea treated oat hay refusals (UTR) in a 3×3 latin square design. Though the potential feeding value of leftovers (OHR and UTR) was lower than OH, the results confirm the possibility of their effective use. It was concluded that feeding above the conventional *ad libitum* level could be an alternative to improve the performance of ruminants fed feeds like oat hay. The potential impact of the strategy would, however, depend on the effective reutilization of leftovers for feeding other animals. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 5 : 723-727*)

Key Words : Oat Hay, Food Allowance, Intake, Digestibility, Leftovers, Goat

INTRODUCTION

High level of food excess has been proposed as a means to increase the performance of ruminants fed crop residues (Owen and Aboud, 1988). Since no external inputs are required, this approach appears to be attractive in improving the use of grasses, legumes and most straws. Species such as goats that display selective feeding behaviour are able to pick out more digestible fractions of a feed if offered in abundance (Zemmelink, 1980; Schiere et al., 1990; Wahed et al., 1990). Further evaluation of this approach may, however, require quantification of the response of animals to increasing levels of food allowance, in terms of food intake, proportion of food left uneaten and quality of both the ingested food and the leftovers (Rivera et al., 1994). To this end, the purpose of the research described here was to determine the influence of food allowance on diet selectivity, intake and nutrient utilization of oat (*Avena Sativa*) hay by Barbari goats and to evaluate the potential feeding value of refed food leftovers in sheep.

MATERIALS AND METHODS

The experiments were conducted at Animal Nutrition Division of Indian Veterinary Research Institute in 1995/96 for the evaluation of some nutritional implications of feeding oat hay at higher levels.

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Experiment 1

It analysed the effect of feed amount offered on selection, intake and *in vivo* digestibility of oat hay (OH) by goats. Forage oats were harvested from Institute's Agriculture Farm at about 50% flowering stage, shndried and chaffed prior to feeding. 15 adult Barbari male goats weighing 13.5±2.6 kg were used in this trial. The goats were offered oat hay *ad libitum* at three levels (5 goats/treatment) to give leftovers of about 20% (T1), 35% (T2) and 50% (T3) of DM offered. The amount of oat hay offered was adjusted daily on the basis of the previous day's intake during entire feeding period of 60 days, followed by 7 day digestibility trial. A fixed amount of commercial mineral mixture was provided to all the goats in order to meet their mineral requirements. The goats were provided free access to water and weighed at weekly intervals in the morning before offering the feed. The dry-matter intake (DMI) of each animal was determined by carefully measuring the amount of oat hay offered and refused each day (Wahed et al., 1990).

Experiment 2

This experiment investigated the potential feeding value of the oat hay left uneaten by goats in group T-2 and T-3 of the previous experiment. Three adult male sheep (avg. body weight 22.5 kg) were assigned to one of the three dietary treatments consisting *ad libitum* fresh oat hay (OH) oat hay refusal (OHR) or 3% urea treated oat hay leftovers (UTR) in a 3×3 latin square switch-over design. The oat hay refusals

Table 1. Chemical composition of oat hay (offered, ingested and leftovers) at different levels (%, DM basis)

Feed components	Oat hay							
	Offered	Left overs				Ingested			
		T-1	T-2	T-3	SEM	T-1	T-2	T-3	SEM
CP	10.50	4.77^{B}	7.06^{A}	7.78^{A}	0.41	11.78^{b}	11.94^{b}	12.96^{a}	0.32
ADF	40.31	51.00^{A}	47.19^{B}	45.73^{C}	0.21	36.79^{a}	34.57^{b}	33.32^{b}	0.68
NDF	60.25	72.65^{A}	68.29^{B}	68.54^{B}	0.91	55.07^{a}	53.34^{ab}	51.29^{b}	1.10
Cell contents	39.75	27.35^{B}	31.70^{A}	31.46^{A}	0.91	41.96^{b}	42.61^{b}	45.93^{a}	0.73

[a,b,c] Means with different superscripts small & capitals are significantly different ($p<0.05$) for ingested and leftover treatments respectively.

were sundried for 2–3 days before commencement of their feeding to different groups. The refusals treated with urea (UTR) were covered with polythene sheet for a period of at least 21 days before the onset of experimental feeding. A commercial mineral mixture was given to all the animals in order to meet their mineral requirements. The animals were fed for a 30 days preliminary period to adjust to the diet followed by a 7 days collection period with free access to water twice daily during each trial.

Analytical procedure

Samples of feed offered, residues and faeces for each animal were taken daily during the digestibility trial of Expt. 1 and 2, and oven dried for analysis of proximate composition (AOAC, 1981) and fibre fractions (Goering and Van Soest, 1970).

Analysis of variance for completely randomized design (Expt. 1) and latin square design (Expt. 2) ignoring the period effect was carried out. Treatment means were compared for statistical differences using Duncan's multiple range test (Snedecor and Cochran, 1980).

RESULTS

Experiment 1

The chemical composition of oat hay offered, refused and ingested remained relatively constant (table 1). All animals ingested food with a lower concentration ($p<0.05$) of ADF and NDF and left uneaten food with a higher concentration of cell wall constituents. However, the concentrations of crude protein and cell contents were higher in ingested food irrespective of treatment as compared to leftovers of offered oat hay. The difference in composition of the food offered with respect to the food ingested increased while that between leftovers and the food offered decreased as more food was given in excess (table 1).

DMI, kg/100 kg BW or g/kg $W^{0.75}$ by Barbari goats increased ($p<0.01$) with the level of feed offered and there was a proportional increase in the percentage of refusals (table 2). At 20% refusal level (T-1), the estimated DMI, g/kg $W^{0.75}$/d of oat hay was 37.83 which increased to 58.96 at 36% residue in T-2. The animals in group T-3 consumed 71.20 g with 48% residue. DMI, % body weight of goats varied considerably from nearly 1.96% in T-1 to 3.58% in T-3. The digestibility of different nutrients of oat hay was significantly ($p<0.05$) affected by the level of feed offered (table 2). Digestibilities of DM, OM, NDF and ADF increased initially when level of refusal was increased from 20% (T-1) to 35% and thereafter decreased with further increasing the level of feeding

Table 2. Intake, digestibility and nutrient content of oat hay at different levels

Variables	Treatments			SEM
	T1	T2	T3	
Body weight (kg $W^{0.75}$)	7.11	7.46	7.30	-
DMO** (g/kg $W^{0.75}$)	44.66^{c}	87.16^{b}	131.30^{a}	1.65
DMI** (g/kg $W^{0.75}$)	37.83^{c}	58.96^{b}	71.20^{a}	0.85
DMI** (kg/100 kg body wt.)	1.96^{c}	3.01^{b}	3.58^{a}	0.08
Refusals** (%)	19.90^{c}	36.44^{b}	47.93^{a}	1.70
Digestibility (%)				
DM*	62.24^{c}	74.01^{a}	68.33^{b}	0.72
OM*	65.37^{c}	77.57^{a}	70.60^{b}	0.70
EE*	69.17^{b}	75.95^{a}	75.46^{c}	0.63
CP*	62.28^{b}	74.71^{a}	72.41^{a}	0.61
NDF*	48.07^{c}	62.78^{a}	57.22^{b}	0.81
ADF*	41.01^{c}	59.42^{a}	54.98^{b}	1.08
Nutrient content (%)				
DCP*	5.71^{b}	7.26^{a}	7.81^{a}	0.40
TDN*	60.15^{c}	74.95^{a}	68.26^{b}	1.30
Nutrient intake (g/kg $W^{0.75}$)				
DCP*	2.16^{c}	4.27^{b}	5.75^{a}	0.30
TDN*	22.75^{c}	44.19^{b}	48.60^{a}	1.25
DOM*	21.64^{c}	42.03^{b}	46.24^{a}	1.24

[a,b,c] Means in a row with different superscripts are different; * $p<0.05$, ** $p<0.01$.

from T-2 to T-3. There was, however, no significant difference in EE and CP digestibility of oat hay in groups T-2 and T-3 whereas the values were higher ($p<0.05$) than in T-1. Similarly, the nutrient density in terms of TDN was higher in T-2 than in T-3 and T-1. There was no apparent difference in the values of DCP obtained in T-2 and T-3, whereas they were significantly higher than the corresponding value of T-1. As the level of food excess increased the animals significantly improved ($p<0.05$) their intake (g/kg $W^{0.75}$) of DOM, TDN and DCP (table 2).

Experiment 2

Chemical composition of experimental diets (table 3) show that CP content of OHR was lower than OH, but after 3% urea treatment CP content of UTR improved from 7.56 to 10.17%. The original food (OH) had lower concentration of NDF (676 vs. 758 g/kg DM) and ADF (407 vs. 494 g/kg DM) than the refed leftover.

Table 3. Chemical composition of fresh and leftovers of oat hay (% DM basis)

Attributes	OH	OHR	UTR
DM	92.42	92.37	85.46
CP	10.46	7.56	10.17
EE	2.00	1.91	1.80
Ash	10.36	9.28	10.81
NDF	67.62	75.82	71.99
ADF	40.75	49.40	50.66

OH-Fresh oat hay, OHR-Oat hay refusals, UTR-Urea treated oat hay refusals.

The DMI (g DM/kg $W^{0.75}$) was significantly ($p<0.01$) higher for OH followed by OHR and UTR. No difference was, however, evident in the digestibilities of DM, OM, CP and EE (table 4) between the groups fed leftovers (OHR and UTR) and that given the original food. Digestibility of NDF and ADF was comparable in sheep fed OH and UTR but these values were significantly ($p<0.05$) higher than those given only OHR.

The nutrient content in terms of DCP was higher ($p<0.05$) on control (OH) followed by UTR and OHR. However, TDN content (% DM) was higher in UTR to its relative values in OH or OHR. The intake of nutrients (DCP/TDN/DDM) was the greatest ($p<0.05$) for sheep given OH diet followed by animals fed OHR and UTR.

DISCUSSION

Diet selectivity (concentration of NDF, ADF and CP of oat hay ingested and the leftovers relative to those of the food offered), DMI and digestibility of food, all increased in response to increasing food allowance or levels of food excess. The effect is in agreement with results obtained with barley straw (Bhargava et al., 1988; Wahed et al., 1990), sorghum stover (Aboud et al., 1993), pearl millet (Rivera et al., 1994), finger millet (Subba Rao et al., 1994) and Kikuyu grass (Schiere et al., 1990). The various responses to offering more straw or a heterogenous feed has been attributed to an increased leaf: stem ratio in the food ingested (Aboud et al., 1993). It is likely that the proportion and quality of the morphological fractions of leaf in oat hay (not measured in this study) determine to a large extent the consumption and quality of food ingested by ruminants. The results support the hypothesis that intake of roughages would increase if the amount offered and proportion refused were allowed to be higher than those conventional leftover allowance ratios as low as 0.05 or 0.10 (Minson, 1990). In the present study, intake of oat hay was still increasing even at the highest offer level (T-3) studied, thus a wider range of offer level is imperative to obtain a reliable estimation of the relationship between feed offered and intake. Nonetheless, these findings suggest that potential DMI of oat hay and possibly other roughages should be determined at a food allowance or excess much higher than those traditionally recommended. If intake values are to be extrapolated to practical situations where high levels of leftovers are not affordable, lower levels of allowance could be used experimentally, but the values obtained should not be considered as the maximum or potential intake (Rivera et al., 1994). The tendency for the increased digestibility of oat hay at the higher levels as compared to lower level of refusal might be due to quality difference between the selected material. The goats apparently preferred leaves and inflorescence portion of oat hay which are more digestible than stem portion (Bhargava et al., 1988). These findings are in conformity with the earlier reports which demonstrate that increase in DMI does not depress digestibility when it is associated with selective consumption (Schiere et al., 1990; Wahed et al., 1990; Prabhu et al., 1995).

The daily TDN and DCP requirements for maintenance of goats were 28.35 g and 2.5 g/kg $W^{0.75}$ respectively (Kearl, 1982). The average intake of TDN and DCP was below maintenance in the case of animals fed in T-1 group (table 2). However, goats in T-2 and T-3 had TDN and DCP intakes of 44.2~48.6 and 4.27~5.75 g/kg $W^{0.75}$ respectively which are adequate for maintenance and moderate production.

High food allowances would be practical only if there was a surplus of residues or if leftovers could be reutilized for feeding other animals (Rivera et al., 1994). The lower consumption of leftovers by sheep in

Table 4. Intake and nutrient utilization of fresh and refed leftovers of oat hay by sheep

Variables	Treatments			SEM
	OH	OHR	UTR	
DMI (g/kg $W^{0.75}$)	51.90[a]	42.40[b]	37.39[c]	2.19
Digestibility (%)				
DM	58.75	58.40	61.12	1.47
OM	60.84	62.45	66.46	1.64
CP	52.83	50.30	54.49	1.21
EE	53.47	55.28	51.33	2.10
NDF	66.45[ab]	62.27[b]	70.88[a]	1.74
ADF	64.29[ab]	61.38[b]	66.95[a]	1.24
Nutrient content (%)				
DCP	7.74[a]	4.36[c]	5.86[b]	0.35
TDN	57.26[b]	56.16[b]	62.24[a]	1.27
Nutrient intake (g/kg $W^{0.75}$)				
DCP	4.02[a]	1.95[b]	2.19[bc]	0.33
DDM	30.50[a]	24.89[b]	22.85[bc]	1.26
TDN	29.72[a]	23.81[b]	23.27[b]	1.25

[a,b,c] Means with different superscripts in the same row differ ($p<0.05$).

OH-Fresh oat hay, OHR-Oat hay refusals, UTR-Urea treated oat hay refusals.

general relative to that of the original food (table 4) could be due to a lower palatability and/or a higher NDF concentration. The depression in DMI of UTR was, however, more pronounced probably due to taste and odour of added urea (Kenney and Black, 1984; Orr et al., 1985). Inspite of higher ADF concentration of the leftovers, no difference was evident in the digestibilities of major nutrients between the groups fed leftovers (OHR and UTR) and that given the original food (table 4) possibly owing to a decreased passage rate resulting from the lower intake in the former groups. The higher digestibility of NDF and ADF observed in UTR relative to OHR confirm the general observation that ammonia treatment act mainly on the linkages among cell-wall components (Chesson and Monro, 1981) and thus increase the accessibility for rumen microorganisms (Lindberg et al., 1984). The intake of DCP by sheep given leftovers was well above their recommended maintenance requirement (Kearl, 1982). However, potential intake of TDN was slightly lower than their requirement of 27.0 g/kg $W^{0.75}$/d. These results confirm the hypothesis that farmers could benefit from feeding oat hay at high food allowance to stall fed goats of high economic value and give leftovers to less valuable or less selective stock. The economic impact of this strategy would, however, depend not only on the response of animals given original food but also on the response of those given the leftovers. The studies also indicate the desirability of reporting food allowance or levels of food excess while publishing intake and digestibility data to facilitate comparisons among studies.

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