Effect of Selective Consumption on Intake, Diet Selectivity and Passage Kinetics of Wheat Straw by Barbari Goats

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ABSTRACT : Sixteen adult Barbari bucks were divided into 4 homogeneous groups, each group was offered wheat straw (WS) at levels 75, 100, 125 and 150 per cent of *ad libitum* intake in a factorial randomized complete block design. All goats were uniformly fed a supplement (13.5 g DM/kg $W^{0.75}$) to fulfill their requirement for protein at maintenance level. The experimental feeding of goats at different levels for 21 days was followed by a digestion trial of 6 days and determination of rate of passage of digesta for 144 h duration, respectively. Intake (g/kg $W^{0.75}$) of dry matter (DM), organic matter (OM), digestible DM and digestible OM increased with increase in amount of WS offered. The levels of WS refusals for obtaining upper limit of intake was found to be above 30% of DMO. Concentration of ADF and lignin was significantly lower and CP was higher ($p>0.05$) in food ingested relative to food offered or refused in response to increasing allowance of WS. Dietary means of particulate rate of passage from rumen, transit time and total mean retention time ranged from 0.032 to 0.036/h, 19.10 to 21.72/h and 58.61 to 61.53/h respectively and did not show significant differences ($p>0.05$) irrespective of dietary level of WS. The results suggest that DMI and quality of ingested WS would improve with higher rates of offer and refusals (≥30% of DMO) without any pronounced effect on passage kinetics of digesta, because of the greater opportunity afforded to goats for selective feeding. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 7 : 913-917*)

Key Words : Diet Selectivity, Passage Kinetics, Wheat Straw, Barbari Goats

INTRODUCTION

In most parts of India, the wheat and paddy straws constitute the main source of food for ruminants. It is well recognised that cereal straws are of low nutritive value (Sundstol and Owen, 1984) because of their relatively low digestibility and intake. There had been much research and development into finding ways of alleviating these deficiencies (Doyle et al., 1986). The emphasis has been put mainly on straw upgrading techniques using treatment with chemicals but the extent of their application is not as widespread as one would expect (Owen, 1994), primarily due to lack of resources by the subsistance farmers to purchase and apply the chemicals to crop residues and the general perception that the increase in ruminant production does not justify the cost and effect of treatment. On these grounds, researches from several parts of the world (Owen and Aboud, 1988; Wahed et al., 1990; Rivera et al., 1994; Badurdeen et al., 1994; Rao et al., 1994; Sharma et al., 1997) proposed using high food allowances of heterogenous feeds like straws as a means to increase the dry matter intake and selective consumption by the animals in favour of more digestible fractions. Since no external inputs are required, this approach is attractive for improving the use of crop residues.

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Received June 26, 1999; Accepted September 28, 1999

Further evaluation of this approach calls for a description of the response of animals to increasing levels of food allowance in terms of food intake, proportion of refusal, quality of both the ingested and leftover food and the rate of rumen passage (Robinson et al., 1985; Huhtanen et al., 1995; Rivera et al., 1994). Thus the objectives of this study were to determine the influence of food allowance or selective consumption on intake and extent of diet selection by Barbari goats with wheat straw and its effect on rumen passage kinetics of ingested food.

MATERIALS AND METHODS

Sixteen Barbari bucks of about 18 months of age and average body weight 20.45±194 kg were divided into 4 groups of 4 animal each and fed wheat straw (WS) at 4 different levels of feeding in a factorial randomized complete block design. The individual intake of the animals was calculated after feeding test straw for 21 days at 20% refusals of the amount offered prior to experimental feeding. Assuming this intake as 100% *ad lib.* the levels of feeding straw were 75, 100, 125 and 150% of *ad lib.* (WS 75, WS 100, WS 125 and WS 150). All the goats were offered 13.5 g DM/kg $W^{0.75}$ of a supplement individually which consisted of crushed maize 400, deoiled groundnut cake 420, wheat bran 150, mineral mixture 20 and common salt 10 (g/kg DM) to fulfil the daily requirement of goats for protein during the experiment.

Weighed quantity of chaffed wheat straw at

Table 1. Intake and refusals at different levels of wheat straw (WS) offered

Variables	Treatments				
	WS 75	WS 100	WS 125	WS 150	SEM
Body weight kg $W^{0.75}$	9.24	9.27	9.82	9.52	0.64
DM offered g/kg $W^{0.75}$	30.23^{d}	39.97^{c}	52.96^{b}	58.50^{a}	1.20
DMI g/kg $W^{0.75}$	27.20^{c}	32.38^{b}	37.96^{a}	39.24^{a}	1.28
OMI g/kg $W^{0.75}$	24.69^{c}	29.55^{b}	34.45^{a}	35.60^{a}	1.16
Refusal %	9.90^{d}	18.53^{c}	28.07^{a}	32.80^{a}	2.38
+DDMI g/kg $W^{0.75}$	19.71^{c}	24.30^{b}	28.19^{a}	27.92^{a}	0.95
+DOMI g/kg $W^{0.75}$	18.64^{c}	22.68^{b}	26.52^{a}	26.12^{a}	0.88

Mean values bearing different superscripts are significantly different ($p<0.01$); + Calculated on the basis of per cent digestibility of composite ration (WS and concentrate).

respective levels of feeding was offered individually in two portions in the morning and evening. Daily dry matter intake (DMI) was recorded by weighing refusals 24 h post feeding. After the experimental feeding of the animals at different treatment levels for 21 days, a digestion trial of 6 days duration was conducted. During the trial, feeds, faeces and feed leftovers were weighed and sampled daily for the determination of proximate principles (AOAC, 1990) and fibre fractions (Goering and VanSoest, 1970). Diet selectivity by goats was assessed by weekly estimation of ADF, lignin and CP content of straw leftovers relative to food offered during the experimental feeding.

A rate of passage study of 144 h duration was undertaken on 12 goats (3 from each treatment) immediately after the digestion trial. To determine the rate of passage of digesta, Chromium (Cr) mordanted wheat straw was prepared by the method of Uden et al. (1980) with modifications (Beauchemin and BuchanenSmith, 1989). Single dose of 10 g Cr-mordanted fibre was fed orally by mixing it with small portion of concentrate mixture. Rectal grab-samples were collected after 8 h post dosing and then at 4 h interval until 24 h, every 6 h between 24 and 48 h, every 8 h between 48 to 96 h and finally with time interval of 12 h between 96 to 144 h of post dosing. The samples were stored at -20°C until analysed. Chromium concentration in faecal samples was estimated by Diphenylcarbazide method (Sandell, 1950).

The data were subjected to analysis of variance according to complete factorial randomized block design (Snedcor and Cochran, 1967). The difference between the treatment means were tested applying Duncans' multiple range test (Duncan, 1955). Rate of passage of digesta through digestive tract was calculated by the mathematical model suggested by Grovum and William (1973).

RESULTS AND DISCUSSION

Dry-matter intake

DMI per unit metabolic body weight of WS by goats increased upto the level of WS 125 and there was a proportional increase in the amount of refusals (table 1). The increase in DMI at higher levels of DMO ($p<0.01$) followed a curvilinear relationship and agrees well ($R^2=0.62$) with the model of Zemmelink (1980). The results support the hypothesis that intake of WS would increase if the amount offered and proportion refused were allowed to be higher than the normal rate of refusal (10 to 15% of DMO) adopted when feeding *ad lib.* (Minson, 1990).

In this experiment, a leftover: allowance ratio of 0.15 would be obtained at WS allowance of 36.21 g DMO/kg $W^{0.75}$. The consumption of DM at this level of offer would be 26.7 g which was only 0.68 of the theoritical maximum intake (38.93 g) estimated with the Zemmelink model (Zemmelink, 1980). Increasing the food allowance to 58.5 g/kg $W^{0.75}$, the critical level of DMO, would result in a leftover: allowance ratio between 0.30 and 0.34. Further increase in food allowance did not result in increased DMI because intake can not be expected to increase beyond a certain maximum limit of animal (Zemmelink, 1980, 1986). As expected, OMI from WS and DDMI/DOMI from composite diet (WS+Conc) followed the trend of DMI in this experiment. Since intake and composition of supplementary concentrate mixture was uniform at all the levels of straw offered during the experiment, any variation in nutrient intake by goats has to be attributed to the differences in the level of straw offered. In terms of animal production, the amount of DDM/DOM that the animal consume is most important (Badurdeen et al., 1994).

The intake response to offering more straw was of a magnitude comparable with that usually achieved in treating straws with alkali or Urea (Hossain and Rehman, 1981; Saadullah et al., 1981 and Wahed et al., 1990). Thus, it appears desirable to report food allowance and levels of excess refusals when intake data are published to facilitate comparisons among studies.

Diet selection

Chemical composition in terms of ADF, CP and lignin of WS offered and left uneaten by goats at

Table 2. Chemical composition of wheat straw (offered, ingested and leftovers) at different levles

Attributes % DM	Wheat straw							
	Offered	Leftover				Ingested			
		WS 75	WS 100	WS 125	WS 150	WS 75	WS 100	WS 125	WS 150
ADF	A 42.26[a]	50.58[a]	48.78[b]	49.28[b]	47.79[c]	41.32[AB]	40.76[B]	39.48[C]	39.52[C]
CP	C 4.25[c]	3.21[a]	3.58[b]	3.61[b]	3.63[b]	4.36[B]	4.40[B]	4.50[A]	4.56[A]
Lignin	A 6.54[b]	8.01[a]	9.54[a]	9.63[a]	9.20[a]	6.30[A]	5.86[AB]	5.29[B]	5.30[B]

Means marked with unlike small and capital superscripts are significantly different ($p<0.05$) for leftovers and ingested treatments respectively.

Table 3. Effect of selective consumption (level of feeding) on passage kinetics

Feed	Sampling site	Marker	Parameters	Treatments					
				WS 75	WS 100	WS 125	WS 150	SEM	Significant level
Wheat straw	Rectum	Cr-mordant	K_1/h	0.032	0.035	0.034	0.036	0.0016	NS
			K_2/h	0.139	0.089	0.103	0.10	0.0224	NS
			TTh	20.13	19.53	19.10	21.72	0.0089	NS
			TMRTh	61.53	59.53	58.61	59.87	1.70	NS

K_1=Rumen outflow rate, K_2=Hindgut out flow rate, TT=Transit time, TMRT=Total mean retention time.
NS=Non-significant.

different levels was compared with that of offered and ingested straw in table 2. The goats left uneaten WS with a higher ($p<0.01$) concentration of ADF than that of straw offered. However, the ingested food had significantly ($p>0.01$) lower concentration of ADF except those in WS 75 relative to offered WS. At lowest levels of food excess (WS 75), goats ingested WS with an ADF value (41.32±0.12%) not different from that of the straw offered and left refusals with a significantly ($p<0.01$) higher ADF concentration. WS refusals from all treatments were of lower ($p<0.01$) CP content than straw offered, however, ingested WS contained higher CP values relative to offered straw (table 2). Similarly, though the ADL content of refusals was significantly higher than that of offered straw, the goats ingested WS of lower ADL values except those on WS 75.

The analytical approach used in this study (concentration of ADF, CP and lignin in refusals relative to those of food offered) allowed for the description of the response in the quality of both the ingested food and the food leftovers to varying food allowances. The results showed goats to be selective feeders as straw refused by them contained more fibre (ADF and lignin) and less CP than that of offered WS. The results also support the other hypothesis namely that quality of ingested straw would improve with higher rates of offer and refusals because of the greater opportunity afforded for selective feeding. This effect is in agreement with the results obtained with barley straw (Bhargava et al., 1988; Wahed et al., 1990), sorghum stover (Aboud et al., 1991) and oat hay (Sharma et al., 1997). This response to offering more straw has been attributed to an increased leaf: stem ratio (Bhargava et al., 1988; Aboud et al., 1991). In WS the leaf components have been reported to be more digestible than stem (Wales et al., 1990; Flackowsky et al., 1991). In this study, morphological fractionation of the offered and refused straw was not attempted. Nevertheless, it is likely that the differences observed between offered and refused straws in contents of ADF, CP and lignin were reflecting differences in their relative content of leaf and stem (Wales et al., 1990).

The intake and food selection response was to the increasing amounts of straw offered were diminishing one in our study. This is understandable if we accept that above a given level of allowance, animals may not consume nodose straws and the constraining factor was the amount of straw available from which to select the more leafy parts. Intake by small ruminants can be greater for the straws with more leaves (Wales et al., 1990) and these animals select when an opportunity exist (Wahed and Owen, 1986). To our knowledge, no other experiment has been conducted to study the response of feeding different levels of wheat straw to goats. The effect of increase DM intake as a consequence of selective consumption on average body weight of animals was not pronounced. It may be due to the use of adult animals and relatively short period

of feeding trial at maintenance level.

Passage kinetics

Dietary means of particulate rate of passage from rumen (K_1), transit time (TT) and total mean retention time (TMRT) values are presented in table 3. The K_1, TT and TMRT in total tract of goats fed different levels of WS did not show significant ($p>0.05$) difference. The K_1, TT and TMRT values ranged from 0.032 to 0.036/h; 19.10 to 21.72 and 58.61 to 61.53 h respectively (table 3). TMRT values are slightly higher, although the values of K_1 are closely in agreement with the results reported by Garcia et al. (1995). The rate of passage increases with increase in intake in order to maintain a constant amount of fill in the gastrointestinal (G.I.) tract. It appears that intake levels achieved by goats at various dietary levels of WS in the present study were not limited by the space occupied within G.I. tract of goats, which resulted in no feedback control through rate of passage. These findings indicate that the passage of WS diet irrespective of their intake/kg $W^{0.75}$ in the adult goats as measured by using Cr- mordanted straw as a marker follows a fairly constant pattern.

The whole pattern of excretion in this experiment was found to be much more slow and the possible reason attributed is that Cr-mordant straw might be excreted at slower rate than from feeds like hay and silage used by Beauchenin and Buchanan Smith (1989). This difference could be due to longer retention of straw, because of its lower digestibility compared to hay and silage. This trend of slow rate of passage and longer mean retention time of the digesta found in the present study is supported by the results of Dominque et al. (1991).

CONCLUSIONS

It may be concluded that intake of WS is markedly increased when goats are allowed to refuse around $\geq 30\%$ of the amount offered instead of the conventional 10 to 15% normally allowed. Voluntary intake measured over the traditional refusal range would thus result in underestimation of the potential of straws. Increased intake of wheat straw as a consequence of selective consumption was due to animals apparent selection in favour of more nutritious fractions and did not have any pronounced effect on rate of passage of digesta.

ACKNOWLEDGEMENT

We thank the Director of the Institute for providing facilities. The first author is indebted to ICAR for the financial support in the form of Junior Research Fellowship.

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