In Situ Ruminal Digestion Kinetics of Forages and Feed Byproducts in Cattle and Buffalo

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ABSTRACT : The relative disappearance and rate of degradation of dry matter (DM) and neutral detergent fiber (NDF) of nine different feedstuffs were determined by simultaneously suspending groups of substrates, using the nylon bags, in the rumen of males of Sahiwal cattle and Nili-Ravi buffalo. The digestion kinetics of leguminous forages (Lucerne, berseem and cowpeas) and feed byproducts (cotton seed cake, wheat bran and wheat straw) did not differ between the two species. However, the DM and NDF digestibilities and rates of digestion of grasses and wheat straw were greater in buffalo than in cow bulls, indicating that buffaloes are better converters of poor quality roughages than are Sahiwal. The lag time for DM of grasses did not differ between these two species but the NDF lag time was lower in buffalo than in cows, indicating that both the rate and lag time of digestion may be reliable indicators for assessing the NDF quality.

(Key Words: Rumen, Cow, Buffalo, Bulls, *In Situ*, Grasses, Legumes, Feed Byproducts)

INTRODUCTION

Cattle and buffaloes can utilize poor quality roughages to meet their energy needs for maintenance. However, there is a long debate in the literature about whether cattle or buffaloes are more efficient fiber digesters. Data are equivocal concerning the superiority of either species to digest fibers (Ludhri and Razdan, 1981; Lal et al., 1987 ; Mudgal et al., 1983). Some of the scientists (Pant and Roy, 1971; Bhatia et al., 1980), however, did not find any difference in fiber digestibility in both the species.

Forages do not possess similar nutritional potential because of their variable rates of fibre fermentation (Sarwar et al., 1996). The fermentation rate of fibre is dependent upon the source of feedstuff (Varga and Hoover, 1987), species, maturity and morphology (Cherney et al., 1990; Bowman et al., 1991; Weiss and Shockey, 1991; Cherney et al., 1993). The rate of NDF digestion in negatively related to the NDF contents of forages (Sarwar et al., 1995 ; Nocek and Grant, 1987).

The *in situ* (artificial fibre bag) technique is widely used to determine the rate and extent of digestion of feeds because it is inexpensive (Van Keuren and Heinman, 1962 ; Weekly et al., 1983), simple, rapid and reproducible (Mehrez and Orskove, 1977). The information on the rate and extent of digestion of feedstuffs is used to determine their nutritive value for different animal species. The present study was designed to measure the difference in DM and NDF digestibilities and other related digestive parameters of various feedstuffs using dacron bags, in bovine young bulls.

MATERIALS AND METHODS

Animals and diets

Four young bulls (two each of cow and buffalo), average weight 200 kg and age 18 months, fitted with ruminal cannulae were used to evaluate nine different feedstuffs, in three periods. In each period the animals were given 10 days of adaptation period to the diets at the start of the experiment. This was followed by a four day incubation period for the dacron bags. The animals were fed diets containing ingredients of comparable NDF and CP content to those being tested. In the first period, cotton seed cake, wheat bran and wheat straw were incubated in the rumen. During this period, animals were fed total mixed ration (2 kg concentrate and 2 kg wheat straw) twice daily. The concentrate mixture consisted of 30% cotton seed cake and 70% wheat bran. In the second period, berseem lucerne and cowpeas were incubated in the rumen and animals were fed berseem only at the rate of 2% body weight. In the third period, maize, millet and

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Table 1. Composition of feedstuffs

Items	Cotton seed Cake	Weat Bran	Barseem	Lucern	cowpeas	Maize	Millet	Sorghum	Wheat Straw
	..... % DM								
CP	19.0	15.0	16.0	15.5	17.0	8.0	7.5	8.0	4.0
NDF	56.0	54.0	52.0	54.0	51.0	72.0	73.0	72.6	86.7
ADF	17.0	16.0	38.0	38.0	37.0	45.0	44.0	42.9	54.0
ADL	2.5	2.0	10.5	11.0	9.5	8.12	8.31	7.98	14.0
Cellulose	14.5	14.0	27.5	27.0	26.5	37.0	35.70	35.10	40.0
Hemicellulose	39.0	38.0	14.0	16.0	14.0	27.0	29.0	29.60	32.7

sorghum fodders were incubated in the rumen and the animals were fed maize fodder only at the rate of 2% of their body weight. During each experimental period the animals were housed on a concentrate floor on separate pens and water was offered twice daily.

Sample preparation and analyses.

The legumes (berseem; *Trifolium alexandrium*; lucerne; *Medicago sative*; and cowpeas; *Vigna sinensis*,) used in this experiment were havested at mid bloom stage; the grasses (maize; *Zee mays*, millet: *Pennisetum americanum* and sorghum; *Sorghum vulgra*) were havested at early heading stage, and the byproducts (cotton seed cake, wheat bran and wheat straw) were purchased from the local market. The legume and grass sample were first coarsely chopped and dried at 55℃ in a forced-air oven. All the samples were then ground through a Wiley mill to have an average lenght of 2 mm. Ths samples were analyzed for DM, Nitrogen (AOAC, 1984), NDF and ADF (Van Soest et al., 1991). Chemical composition of feed samples is presented in table 1.

Incubation procedure

Nylon bag measuring 13 × 21 cm, with an average pore size of 5o μm, were used to determine the rate and extent of DM and NDF disappearance *in situ*. For each time point, 10 grams of each feed sample was weighed into bags (approximately 18.3 mg/cm^2 bag surface area), in triplicate. Two bags were used for determination of DM and NDF disappearance and the third one served as blank (for calculation of loss or gain, if any, of nylon bag during incubation). The bags were closed and tied with braided nylon fishing line. Before incubation in the rumen, the bags were soaked in running tap water for 15 minutes. This was done to remove the soluble material and particales of $\leq$ 50 μm from the feed samples. Weight loss due to soaking was expressed as pre-ruminal disappearance of DM. On day 11 of each experiment, the bags were suspended in the rumen at 08:00 hours for 0, 1, 2, 4, 6, 10, 24, 26, 48, and 96 hours, in reverse order and removed all at the same time. After removal from the rumen, the bags were washed in running tap water until the rinse was clear. The bags were then dried at 55℃ in a forced-air oven for 18 hours. The bags were equilibrated with air for 8 hours to have constant weight in the presence of air. The bags were weighed and the residues were transferred to 100-ml plastic cups and stored for later analysis of DM and NDF. Digestibility coefficients of DM and NDF were calculated at 48 hours of incubation (an average time for feed to stay in the bovine rumen during passage from the gastro-intestinal tract). Lag time of digestion and rate and extent of DM and NDF disappearance was calculated according to the procedure of Sarwar, et al., (1991).

Statistical analysis

The data collected on different parameters (lag time of digestion, rate and extent of DM and NDF digestion) were analyzed according to Randomized Complete Block Design; using cow and buffalo bulls as blocks. The difference in means were tested using Duncan's Multiple Range test (Steel and Torrie, 1981).

RESULTS

Grasses

The DM and NDF digestibilities (at 48 hours) of grasses were higher in buffaloes than in cow bulls (table 2). Rate of digestion of DM and NDF were higher and the lag time of NDF digestion was lower in the buffalo bulls than in cow bulls.

Extent of digestion of DM and NDF (at 96 hours) and lag time of DM digestion were not different among the two species.

Table 2. Comparative *in situ* dry matter digestibility (DMD), neutral detergent fibre digestibility (NDFD), lag time, rate and extent of digestion of grasses in buffalo and cow calves

	Buffalo calves	Cow calves	SE[1]	Probability
No.	2	2		
DMD (%[2])	55.29	45.95	7.82	0.05
Lag (h)	2.95	3.03	0.07	NS
Rate (%/h)	4.17	3.08	0.90	0.01
Extent (%[3])	67.17	67.49	1.12	NS
NDFD (%[2])	53.21	45.68	1.43	0.01
Lag (h)	3.15	3.55	0.01	0.01
Rate (%/h)	3.91	2.98	0.14	0.05
Extent (%[3])	69.01	66.85	1.42	NS

[1] SE, standard error.
[2] Digestibility was determined at 48 hours of incubation.
[3] Extent of Digestion was determined at 96 hours of incubation.

Table 3. Comparative *in situ* dry matter digestibility (DMD), neutral detergent fibre digestibility (NDFD), lag time, rate and extent of digestion of wheat straw in buffalo and cow male calves

	Buffalo calves	Cow calves	SE[1]	Probability
NO.	2	2		
DMD (%[2])	41.16	32.55	2.76	0.05
Lag (h)	3.95	3.70	0.08	NS
Rate (%/h)	3.60	3.10	0.07	0.05
Extent (%[3])	46.01	46.15	1.45	NS
NDFD (%[2])	39.56	30.25	1.98	0.01
Lag (h)	4.15	4.50	0.24	NS
Rate (%/h)	3.40	2.80	0.05	0.05
Extent (%[3])	44.89	43.10	1.51	NS

[1] SE, Standard error.
[2] Digestibility was determined at 48 hours of incubation.
[3] Extent of Digestion was determined at 96 hours of incubation.

Wheat straw

The DM and NDF digestibilities of wheat straw were higher in buffalo bulls than in cow bulls (table 3). Rate of digestion of DM and NDF was also higher in buffalo bulls than in cow bulls. However, the lag time and extent of digestion of DM and NDF were not different among the two species.

Table 4. Comparative *in situ* dry matter digestibility (DMD), neutral detergent fibre digestibility (NDFD), lag time, rate and extent of digestion of leguminous forages in buffalo and cow male calves

	Buffalo calves	Cow calves	SE[1]	Probability
NO.	2	2		
DMD (%[2])	75.08	75.10	1.25	NS
Lag (h)	1.38	1.38	0.11	NS
Rate (%/h)	6.08	5.66	0.21	NS
Extent (%[3])	79.18	78.38	2.01	NS
NDFD (%[2])	52.30	51.54	1.19	NS
Lag (h)	1.67	1.75	0.11	NS
Rate (%/h)	5.33	5.16	0.19	NS
Extent (%[3])	57.47	56.82	1.10	NS

[1] SE, Standard error.
[2] Digestibility was determined at 48 hours of incubation.
[3] Extent of Digestion was determined at 96 hours of incubation.

Table 5. Comparative *in situ* dry matter digestibility (DMD), neutral detergent fibre digestibility (NDFD), lag time, rate and extent of digestion of feed by products in buffalo and cow male calves

	Buffalo calves	Cow calves	SE[1]	Probability
NO.	2	2		
DMD (%[2])	73.08	72.09	1.06	NS
Lag (h)	0.10	0.12	0.01	NS
Rate (%/h)	6.87	7.50	0.42	NS
Extent (%[3])	76.07	75.14	0.80	NS
NDFD (%[2])	55.31	55.76	1.19	NS
Lag (h)	0.15	0.17	0.01	NS
Rate (%/h)	6.38	6.88	0.44	NS
Extent (%[3])	60.20	60.74	1.22	NS

[1] SE, Standard error.
[2] Digestibility was determined at 48 hours of incubation.
[3] Extent of Digestibility was determined at 96 hours of incubation.

Legumes and feed byproducts

The digestive parameters (DM and NDF digestion) of leguinous forages and feed byproducts were similar in both the cow and buffalo bulls (table 4, 5).

DISCUSSION

The DM and NDF digestibilities of wheat straw and grass forages were better in buffalo than in cow bulls. The DM and NDF digestion rates of grass forages were also higher in buffalo than in cow bulls. Bhatia et al. (1994) reported higher digestibility of DM, NDF, ADF, cellulose and hemicellulose in buffalo than in cows fed wheat straw, ground nut cake and berseem hay. In a later study. They (Bhatia et al., 1995), reported that DM and NDF digestion of berseem hay was higher in buffaloes than in cows. Langar et al., (1984) reported that cellulose and ADF digestibilities of urea treated wheat straw were higher in buffaloes than in cows. Kennedy et al., (1992a) reported a higher rate of DM digestion of rice straw in buffaloes than in cattle. The greater digestibility and lower lag time of digestion of NDF in buffaloes than in cattle may be due to higher cellulolytic bacterial population (Singh et al., 1992), or due to greater fibrolytic activity of adherent microbes in the former than in the later (Kennedy et al., 1992b). Pradahan, (1991) reported that rumen digesta from buffalo contained a greater microbial population and ruminal ammonia concentration than in cattle. The ruminal protozoal ($\times 10^8$ ml) were 1.59, 1.15 and 16.2 and 13.2 in buffaloes and cattle, respectively. The rumen NH_3 concentration was higher in buffaloes (12.8 mg/100 ml) than in cattle (10.1 mg/100 ml). Bhatia et al., (1992) reported that proteolytic and amyloytic bacterial count was 5 to 7 times higher in buffaloes than in cattle.

The digestion kinetics of leguminous forages and feed byproducts were similar in both species of animals. Gilani et al., 1991, 1992) found no difference in digestibility of crude fibre of a mix diet (containing 50% cotton seed cake and 35% wheat bran) in the two species. On the other hand, Bhatia et al., (1995) have reported a higher NDF digestion rate of berseem hay in buffaloes than in cows. The lack difference in the digestion kinetics or extents of digestion of the leguminous forages and the byproducts between the two species of animals suggests that both the species can diest high quality forages and byproducts equally well.

CONCLUSION

The digestion kinetics of the leguminous forages and feed bypoducts were similar in both species of animals. The rates and extents of digestion of DM and NDF of wheat straw and grasses were higher in buffalo bulls than in cow bulls. No definite conclusions can be drawn from these data. Further studies are required to prove which is better utilizer of roughages.

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