DEGRADATION CHARACTERISTICS OF SOME TROPICAL FEEDS IN THE RUMEN

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Summary

The rumen degradability of rice straw (untreated, urea-sprayed, urea-treated), grasses *(Panicum maximum, Pennisetum clandestinum)* and rice bran was compared. The mean in vivo organic matter digestibility of the untreated (US), urea-supplemented (SS) and urea-ammonia treated (TS) rice straw were 50.9, 53.9 and 57.4%, respectively. Rice bran contained extremely high levels of acid-insoluble ash (25.2% DM), and its OMD was 36.1%. Grasses had OMD values around 66%. Degradability measurements were performed with buffaloes using the nylon bag technique. The organic matter (OM) disappearance data were fitted to an model which was used to describe degradation pattern. The mean potentially degradable fraction for US, SS and TS was 61.5, 61.9 and 69.4%, respectively. Urea-ammonia treatment increased both the amount of OM degraded and the rate at which it was degraded in the rumen. Both grasses had similar values for degradable fraction (around 65%) and for rate constant for degradation (0.04). Rice bran contained high proportions of readily soluble material (23.9%), but the degradable OM fraction was only 13.2%. The low quality of rice bran is attributed to the contamination of rice hulls during processing.

(Key Words: Tropical Feeds, Urea Supplementation, Urea-ammonia Treatment, Rumen Degradability.)

Introduction

The voluntary intake of roughage by ruminants is one of the important parameters in assessing the potential use of a roughage (Raymond, 1969; Van Soest, 1982). This is of special significance when dealing with poor quality roughages such as straw. Since the voluntary intake of a roughage is greatly controlled by its rate and extent of degradation in the rumen, these two parameters would be useful if assessing the nutritional quality of a given type of roughage. Some of the techniques available for measurement of rate of degradation are *in vitro* (Raymond, 1969), Hungate zero time (Hungate, 1966), nylon bag technique (Orskov et al., 1980) and measurement of the activity of particle bound microbial enzymes (Silva, 1986). Out of these techniques, nylon bag technique is considered to be the most convenient and simple technique.

The study reported here was undertaken to assess the nutritive aspects of some commonly fed roughages (straws and grasses) and a concentrate (commercial rice bran), based on their degradability in the rumen.

Materials and Methods

Testfeeds

Nine testfeeds consisting of two untreated rice straws (US1, US2), two urea-sprayed (supplemented) rice straws (SS1, SS2), two urea-ammonia treated rice straws (TS1, TS2), *Panicum maximum* (guinea grass), *Pennisetum clandestinum* (Kikuyu grass) and rice bran (RB) were used. All feeds were obtained from ongoing digestion trials, and the untreated and urea-ammonia treated rice straws were from an experiment designed to test the response of straws to treatment. Urea-sprayed straw was prepared by mixing straw and urea solution (2g urea dissolved in 100 ml water/100g straw DM) and then drying at 70°C. Urea-ammonia treatment was performed by mixing

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straw and urea solution (4g urea dissolved in 100 ml water/100g straw DM) and storing under air-tight conditions for 7 days before drying at 70°C. All testfeeds were ground through a 1.5 mm screen using a laboratory mill.

Animals and diet

Three mature buffaloes (Indigenous x Murrah), weighing on average 400 kg and fitted with permanent rumen canula were used. The animals were fed 8 kg DM of roughage (4 kg rice straw and 4 kg grass) and 0.5 kg of commercial concentrate. The feed was offered in equal meals at 0700 and 1600 h, and animals had free access to drinking water. The bag incubations were done in two successive periods of 21 days each.

Bag incubations

The bags used in this study were made out of nylon cloth having pore size of 41 microns, dimensions 10 x 20 cm, and stitched with polyester thread (10 stitches per cm). The seams were sealed using a silicon based sealant. Five grams (air dried) of the testfeeds were weighed into each bag, and the bags were attached to slits on semi-vinyl tubes (Orskov, 1985). Thick nylon cords 75 cm long was passed through each tube and was anchored to the lid of rumen canula during incubation. In each period and in each animal, all nine testfeeds were incubated in the rumen for 12, 24, 48 and 72 h. Thus, six parallel measurements were made per testfeed per incubation time.

After incubation all bags were washed by hand under running water until the water was clean, gently squeezed to remove excess water and were dried to constant weight at 60°C. After weighing the bags, the dried residues were transferred to porcelain crucibles and ashed at 600°C for 3 h for OM determination. Water soluble fraction and washing losses were determined in duplicate by soaking the bags with testfeeds in warm distilled water at 39°C for five minutes followed by the washing procedure as described before. The residues of these samples were also ashed at 600°C for OM determination. The values for OM degradability at each incubation time were averaged from the three buffaloes and two periods and fitted to the exponential equation (Orskov and McDonald, 1979) given below;

$$P = a + b\,(1-e^{-ct})$$

where; P is the degradation after time 't', a is the intercept of the curve representing the rapidly disappearing component at t=0, b is the portion of feed which will be degraded in time and c is the rate of degradation of b fraction. These constants a, b and c for the different testfeeds were obtained by iteration through computer analysis.

Results and Discussion

The chemical composition and the *in vivo* organic matter digestibility of the feeds used (Navaratne, 1986) are given in table 1. As indicated earlier the untreated rice straws (US) and the urea-sprayed (SS) rice straws obtained from different digestion trials, as such the response to urea supplementation cannot be compared. Nevertheless, the average OMD values of 50.9%, 53.9% and 57.4% for untreated, urea-sprayed and urea-treated straws, respectively, are within the range of values published in literature (Doyle et al., 1986). With both untreated straw (US1 and US2), treating with urea (TS1 and TS2) increased the OMD, but the increase in CP content due to treatment was marginal. The total and acid-insoluble ash contents were extremely high, as a result its

TABLE 1. CHEMICAL COMPOSITION AND *IN VIVO* ORGANIC MATTER DIGESTIBILITY(OMD) OF TESTFEEDS

Feed	Ash	Crude protein	Neutral Detergent Fibre	OMD %
	g/kg DM			
Untreated straw				
US 1	130	41	736	48.0
US 2	121	47	774	53.8
Urea-sprayed straw				
SS 1	108	74	744	57.2
SS 2	124	64	745	50.5
Urea-ammonia treated straw				
TS 1	128	52	749	55.3
TS 2	119	55	761	59.4
Guinea grass	100	96	–	66.4
Kikuyu grass	58	178	760	66.7
Rice bran	295 (25.2)	95	–	36.1

TABLE 2. ORGANIC MATTER LOSS (OML) AT VARIOUS INCUBATION PERIODS, WASHING LOSS AND PARAMETERS OF THE MODEL[1] USED TO DESCRIBE THE DEGRADATION OF FEEDS IN THE RUMEN

Feed	Soaking and washing loss (g/100g DM)	OML at different incubation times (h)				Parameters of model			RSD
		12	24	48	72	a	b	c	
Untreated rice straw									
US 1	9.0	14.2	25.5	40.1	51.7	−1.3	60.9	0.025	1.27
US 2	8.0	15.5	29.1	47.7	57.6	−0.7	64.2	0.028	1.92
Urea-sprayed									
SS 1	8.1	16.8	32.2	53.3	65.4	−5.0	70.2	0.036	3.53
SS 2	8.9	14.8	28.2	47.8	58.4	−5.9	64.5	0.036	3.00
Urea-ammonia treated									
TS 1	9.4	16.3	30.7	53.0	63.5	1.8	68.3	0.026	3.30
TS 2	7.8	21.8	35.7	55.5	68.7	4.7	64.1	0.032	3.94
Guinea grass	14.8	35.2	49.7	65.2	72.7	15.7	64.1	0.041	0.66
Kikuyu grass	16.5	37.8	53.8	65.6	71.2	17.8	66.2	0.040	0.98
Rice bran	13.4	28.6	31.9	34.9	36.7	23.9	13.2	0.039	0.26

[1] See text for description of constants a, b and c

OMD was only 36%. The poor quality of rice bran is due to contamination/adulteration with rice hulls during commercial milling processes (Ibrahim, 1986).

There are no published data from literature about the degradation characteristics of rice straw, and also information available on other tropical feeds are limited (Playne et al., 1972 and 1978). The organic matter (OM) disappearance at various incubation periods, and the parameters (constants a, b and c) of the model used to describe degradation are given in table 2. The results indicate that the OM disappearance of all the straw samples are closer to each other at shorter incubation periods (12 and 24 h), and are also less than those obtained for the grasses and rice bran. However, the OM disappearance of different straws were clearly different at longer incubation periods. This is evident in figure 1, which illustrates the degradation curves along with the scatter points for different feeds.

The degradation curve of RB is clearly different from the roughage curves (figure 1), having the largest intercept a of 23.9 and smallest "b" value (13.2) which denote the rapidly disappearing component and rumen degradable component, respectively. Comparison of RB degradation curve with curves of roughages shows that RB reaches its maximum degradation or the potential degradation faster than roughages. The summative degradation of RB was higher than straws at shorter incubation (12 h) but at longer incubation, it was less. This is probably because, of the poor quality of RB sample which has a very high acid insoluble ash content of 25.2%. On the other hand, none of the roughages reached the asymptote even at 72 h, which suggests that measurements at 72 h incubation period is not long enough for the determination of maximum degradability of these roughages. The results obtained here are somewhat different to those reported for barley straw (Orskov et al., 1980) and for grasses and legumes (Hopson et al., 1961; Chenost et al., 1970; Cizek, 1970; Playne et al., 1972 and 1978). In these studies incubation periods of 12, 24, 48 and 72 h were found to be adequate to describe degradation. However, with tropical grasses a considerable portion of dry matter could be released if the incubation time in the rumen is increased from 72 to 168 h (Playne et al., 1978). In a more recent study with straws, grasses and legumes (Ibrahim et al., unpublished), it was found that a considerable proportion of organic matter and cell wall components were removed between 72 and 240 h in

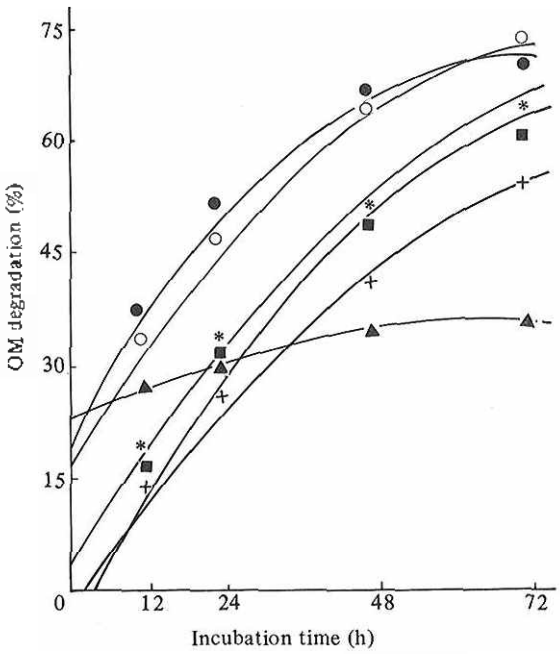

Figure 1. Relationship between organic matter disappearance (%) and incubation time (h) in the rumen.
+——+ untreated straw;
■——■ urea sprayed straw;
—— urea-treated straw;
○——○ Guinea grass;
●——● Kikuyu grass;
▲——▲ rice bran.
(For straws, each point represents mean of 2 values)

TABLE 3. THE DIFFERENCE BETWEEN RAPIDLY DISAPPEARING FRACTION (a) AS DETERMINED BY THE MODEL AND THE ZERO HOUR INCUBATION PERIOD (Do)

Feed	a	Do	a Do
Untreated rice straw			
US 1	−1.3	9.0	−10.3
US 2	−0.7	8.0	− 8.7
Urea-sprayed			
SS 1	−5.0	8.1	−13.1
SS 2	5.9	8.9	−14.8
Urea-ammonia treated			
TS 1	1.8	9.4	− 7.6
TS 2	4.7	7.8	− 3.1
Guinea grass	15.7	14.8	0.9
Kikuyu grass	17.8	10.5	7.3
Rice bran	23.9	13.4	10.5

the rumen. The behavior of the rice bran curve is more or less similar to those reported for concentrates. On the other hand, with roughages any measurement involving longer incubation periods (beyond 72 h) may not hold any practical significance, nevertheless are important in curve fitting, and also in distinguishing between digestible and indigestible components in feeds.

Among the roughages, rapidly disappearing fraction (a) is small in straws, where the untreated and urea sprayed straw showed negative intercepts indicating a lag phase in degradation. When the disappearance at zero hour incubation (Do) in warm water at 39°C and the value "a" of the respective curves are compared, a passive loss of material (fine particles) was indicated in all the straw samples, as Do is larger than "a" (table 3). With RB and both grass samples, the Do values are smaller than their respective "a" values, which indicates the presence of a readily available cell soluble material fraction. Another difference in grass samples is their comparatively high rate constant (c) which denotes a rapid degradation of "b" fraction.

Comparing the untreated rice straws (US1 and US2) with their respective treated straws (TS1 and TS2), it could be seen that both the degradable fraction and the rate constant of degradation were improved by urea-ammonia treatment. The mean increase in degradable fraction (62.6 versus 69.4) and rate constant of degradation (0.026 versus 0.029) obtained here for urea-ammonia treatment are of similar magnitude to those reported with ammonia treatment of cereal straws (Tuah et al., 1986).

With the roughages used in this study, the incubation periods of 12, 24, 48 and 72 h are not adequate to build up complete degradation curves, and also the inclusion of more incubation periods at the lower time scale might be helpful in curve fitting. It is of interest to note the presence of a lag phase, especially with straws, which indicate delay in initiation of degradation. Appropriate models which takes into account the lag phase has been recently developed (Robinson et al., 1986). However, nylon bag technique could still be used to identify the different fractions in the feed dry matter (cell soluble, ruminal degradable), in order to classify their nutritive value. As for the screening of roughage samples based on

their degradability, the selection of proper incubation period may be important. On the other hand, the nylon bag technique could be used to identify the aspects on which the feeds differ in their degradability (rate, extent etc.) and the mode of effect of pretreatments.

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