METHODS TO IMPROVE UTILIZATION OF RICE STRAW II. EFFECTS OF DIFFERENT LEVELS OF FEEDING ON INTAKE AND DIGESTIBILITY OF UNTREATED AND UREA AMMONIA TREATED RICE STRAW

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Summary

Forty cross bred (168 ± 28 kg) bull calves were offered either untreated (US) or urea ammonia treated (TS) rice straw at five levels of feeding, namely; 60, 80, 100, 120 or 140 % of *ad libitum*. *Ad libitum* level for each animal was estimated over a period of one month, which was followed by a preliminary period of 21 days and a collection period of 15 days. The maximum organic matter intake (OMI-kg/100 kg BW) were 2.08 and 3.35 for US and TS, respectively and urea treatment increased the maximum OMI by 61% than for US. In order to reach maximum intake the amount feed refusal should be 25% for US, but with TS maximum intake was not reached even when the amount of feed refused was 39% of that consumed. The OMD of US significantly decreased with increase in OMI, whereas with TS the decrease was not significant. The inability of animals to select between stems and leaves particularly in TS might be one of the reasons for its constant digestibility. Considering the substantial increases in intake and the negative effect on digestibility of US, further trials are warranted, as well as studies to determine the practical implications.

(**Key Words :** Rice Straw, Urea Treatment, Feeding Level, Intake, Digestibility)

Introduction

It was generally accepted that roughage digestibility decreases with increasing intake (Van Soest, 1982) and thus the net effect of increased intake is marginal. Hence it was suggested that refusals above 15% offered is a wastage of feed, particularly also considering the perceived shortage of feed in some tropical rural areas such as in Bangladesh. However, with the demonstration of the effect of selection on intake and digestibility by stall fed animals (Zemmelink, 1980) interest on the subject of defining the optimum level of refusal on feeding was renewed. Allowing the animals to select increases the digestibility of grasses, legumes and most straws (Zemmelink, 1980; Bhargava et al., 1988; Prabhu et al., 1988; Schiere et al., 1990; Wahed et al., 1990). In case of rice straw, there are also cases of declining digestibility due to the inferior quality of the leaves (Hermanto et al., 1991). The biological optimum of feed rest allowed can range from 15% to 40% depending on the type of feed. Availability of other feeds and the objective of production determines the practical and economic need for level of selection (de Wit et al., 1993). It is evident that a general optimum relationship between intake and digestibility is difficult to establish and that the optimum level of refusal is highly dependent on type of feed, degree of selection and prevailing system of farming. Moreover, the biological and economic or practical optima might not be the same (Schiere and de Wit, 1993). Relationships established for tropical legumes and sheep (Zemmelink, 1980) may not be applicable to rice straw based rations and large ruminants. Therefore, the objectives of the study reported in this paper were:

a) to investigate the biological optimum level of refusal to be allowed for cattle fed on (un) treated rice straw in terms of digestibility and intake

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b) to compare these relationships between untreated and treated rice straw

Materials and Methods

Treatments

The diets used in this study were either untreated rice straw or urea ammonia treated rice straw. The rice straw (variety BG 400-1) was collected from the Seed Paddy Production Station located in the dry zone of Sri Lanka. Urea ammonia treated rice straw was prepared by spraying urea solution (4 kg urea dissolved in 100 litres of water per 100 kg of air dry straw) on to straw. While spraying, the straw was thoroughly mixed and stored under airtight condition in cement pits for 7 days. After 7 days the straw was fed to animals.

The diets consisted of either untreated or urea treated straw at five different levels of feeding. The individual intake of the animals were calculated after feeding for 1 month at 20% refusal of the amount offered. Assuming this intake as 100% (*ad libitum*), the levels of feeding tested were 60, 80, 100, 120 and 140% of *ad libitum*. As such, the treatments tested were:

Untreated rice straw (US)

60% of *ad lib.* (US 60)
80% of *ad lib.* (US 80)
100% of *ad lib.* (US 100)
120% of *ad lib.* (US 120)
140% of *ad lib.* (US 140)

Treated rice straw (TS)

60% of *ad lib.* (TS 60)
80% of *ad lib.* (TS 80)
100% of *ad lib.* (TS 100)
120% of *ad lib.* (TS 120)
140% of *ad lib.* (TS 140)

Allotment of animals

Forty cross-bred (sahiwal × indigenous) bull calves with an average body weight of 163 ± 28 kg were dewormed and divided according to body weight into 4 groups (blocks) of 10 animals each. Then the animals in each group were randomly allocated to the 10 treatments to form a factorial, randomized complete block design. After feeding the animals at these levels for a period of 21 days, measurements were taken for a further period of 15 days.

Measurements and laboratory analyses

The dry matter (DM) intake of each animal was determined by measuring the amount of straw offered and refused each day. The DM content of straw offered and refused was determined by drying in a force draft oven at 100℃ for 24 hours. During the collection period sub samples of the feed offered, refused and grab samples of the faeces were collected daily and stored at −4℃. At the end of the collection period the sub samples were thawed, thoroughly mixed and representative samples were oven dried at 70℃ for 48 hours. The dried samples were ground to pass through a 1 mm sieve and analyzed for DM, organic matter and acid insoluble ash (AIA). Organic matter was determined by ashing at 550℃ for 24 hours, and AIA was determined using the method described by Van Keulen and Young (1977). Feed samples were also analyzed for crude protein (AOAC, 1981) and for neutral detergent fibre (Goering and Van Soest, 1970). Organic matter digestibility (OMD%) was calculated using AIA as the marker.

Statistical analyses

The data obtained were fitted to the regression models listed below:

(a) $Y = \beta_0 + \beta_1 X$
(b) $Y = \beta_0 + \beta_1 X + \beta_2 X^2$

where;
Y = dependent variable (intake, digestibility)
X = independent variable (amount offered)
β_0, β_1, β_2 are constant

The best fitting model was selected based on correlation coefficient and residual mean squares. The maximum organic matter intake value (OMI) was calculated from the first derivative of the best fit regression model.

Results and Discussion

The chemical composition of untreated and urea treated rice straw is presented in table 1.

The level of organic matter offered (OMO) as a percentage of body weight (kg/100 kg BW) ranged from 1.1 to 3.1 and 1.8 to 5.0 for US and TS groups, respectively. The OMI (kg/100 kg BW) increased with increasing supply of feed within the range studied (figure 1). The relationship between OMO and OMI is non-linear for US ($r = 0.91$; $p < 0.05$) and linear for TS ($r = 0.91$; $p < 0.001$). The intake of US reached the maximum at the level of 2.9 kg of OMO, but OMI of TS increased continuously upto the maximum level of OM offered. The results clearly indicate that with TS the OMI did not level off even at the 140% *ad libitum* level tested in the study. In more recent studies conducted in Indonesia (de Jong and van Bruchem, 1993), chopped untreated or urea treated rice straw was fed to sheep at 40, 65, 90, 115 and 140 g DM/kg$^{0.75}$. They reported that both intake and digestibility continuously increased with the increase in feed offered.

TABLE 1. CHEMICAL COMPOSITION (DRY MATTER BASIS) OF UNTREATED AND UREA TREATED RICE STRAW

%	Untreated	Urea treated
Dry matter	89.1	54.6
Organic matter	85.0	84.1
Acid insoluble ash	11.9	12.8
Neutral detergent fibre	75.9	74.6
Crude protein	5.2	7.7

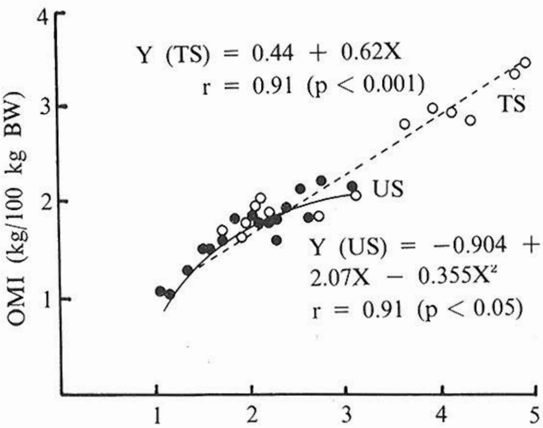

Figure 1. Effect of organic matter offered (OMO) on organic matter intake (OMI) of (un) treated rice straw.

The results reported in this paper supports the hypotheses that intake of straw would increase if the amount offered and proportion refused were allowed to be higher than the conventional rate of 10-20% refusal adopted when feeding straw *ad libitum*. Zemmelink (1980) clearly demonstrated the effects of selective consumption on voluntary intake and digestibility of tropical forages. In that thesis and later work he concludes that obtaining meaningful data on intake and digestibility of tropical forages arise from the fact that they consist of coarse plants with large differences in quality between morphological components, not only between leaves and stems, but also between different fractions of the stem. The major plant parts in rice straw are the leaf blades (25-31%), the leaf sheath (32-37%) and the stem (29-43%), and their digestibilities range from 20-60%, 24-56% and 18-77%, respectively as reviewed by Doyle et al. (1986). Results from stall feeding experiments with goats and sheep fed barley straw (Wahed et al., 1990), sheep fed rice straw (de Jong and van Bruchem, 1993), and cattle fed finger millet straw (Prabhu et al., 1988) or Kikiyu grass (Schiere et al., 1990) clearly indicate that the amount consumed steadily increase with the increase in amount offered. Of the above studies, the maximum intake was reached only in the study reported by Prabhu et al. where refusal levels of over 30% was required to achieve maximum intake. The optimum amount of feed that should be offered to maximise intake is likely to be influenced by animal factors (species, physiological state/production performance) and food factors (species, cultivar/variety, pretreatment/processing, roughage to supplement ratio). The influence of one of these factors mentioned above (urea treatment) on the amounts that should be offered in order to achieve maximum intake is well demonstrated in our study. To our knowledge, no other experiments has been conducted to study the response of feeding different levels of rice straw to cattle.

With sheep (de Jong and van Bruchem, 1993) and with our present study on cattle, eventhough intake increased with the increasing level of feed offered there is insufficient evidence to show the phenomenon of selective consumption on rice straw based diets. In the study reported by de Jong and van Bruchem, the composition of the feed offered and refused was similar (leaves to stem ratio was the same), and also the in sacco degradation characteristics of the feed offered and refused were similar. Such measurements were not performed in our study.

Figure 2 demonstrates that the digestibility of US tends to decline with increasing levels of OMO (r = −0.59; b = −3.44), whereas TS shows no prominent reduction (r = −0.51; b = −0.13). On the contrary, in the study reported by de Jong and Bruchem (1993) with sheep, the digestibility of both untreated and urea treated rice straw steadily increased with the increase in straw intake. Similar positive response was reported in feeding barley straw to sheep and goats (Bhargava et al., 1988; Wahed et al., 1990). If we presume that ruminants prefer leaves, then at higher levels of rice straw offered the digestibility will be lower. This is because, as compared to grasses and other cereal straws, with rice straw the leaf blade and leaf sheath is less digestible than the stem (Winugroho, 1981; Sannasgala and Jayasuriya, 1984). More recent information (Hermanto et al., 1992) reveals that the stem fraction has a faster rate of degradation (3.2 to 4.6 %/h) as compared to leaf blade and sheath (1.9 to 3.0 %/h). In the study reported by de Jong and van Bruchem (1993), even though no effect was found on the ratio of leaves to stems ingested, the variation in straw digestibility between animals was rather high and was related to their preference for leaves. A tendency for declined digestibility at higher intakes was also observed when feeding finger millet straw to cattle (Prabhu et al., 1988). This could reflect the comments of Hogen and Weston (1971) and Robinson et al. (1985), that increased intake affects the rate of rumen passage, i.e. the so called push effect.

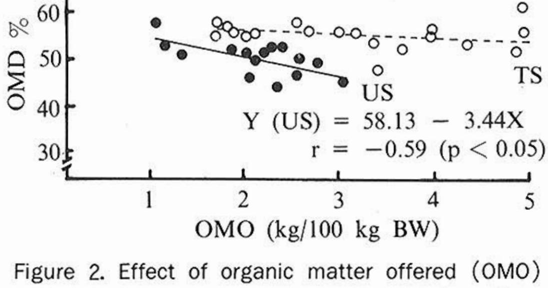

Figure 2. Effect of organic matter offered (OMO) on organic matter digestibility (OMD) of (un) treated rice straw.

The digestible organic matter intake (DOMI) showed a positive and linear correlation with OMO (figure 3) for both US (r = 0.86) and TS (r = 0.90). The DOMI increased with increasing level of feeding, and the rate of increase in TS ($p < 0.001$) was greater than US ($p < 0.05$). With US, at the highest level of OMO the DOMI was 1 kg/100 kg BW. In terms of animal production, what is most important is the amount of DOMI the animal consumes.

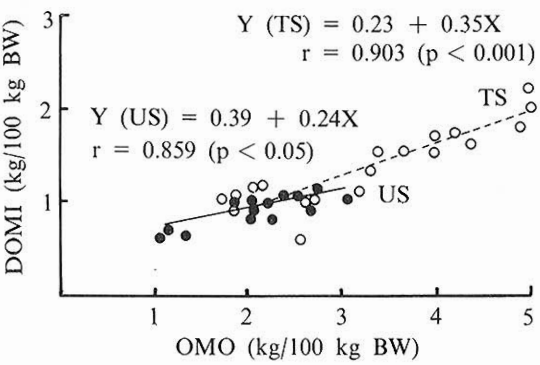

Figure 3. Effect of organic matter offered (OMO) on digestible organic matter intake (DOMI) of (un) treated rice straw.

The information obtained from this experiment does not entirely explain the reasons for the different effect of increased selection and intake on OMD. More work on rumen parameters like flow rate and microbial growth might further explain the effects observed. The intake levels observed for TS are high indeed when comparing with the reviews of Doyle et al. (1986) and Schiere and de Wit (1993), but most common experiments never use such high levels of excess feed. The absence of a flattening intake curve for TS indicates that the levels of excess feed required are easily underestimated. The practical implications of these effects require further study.

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