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INVESTIGATION OF SOME OF THE PHYSIOLOGICAL FACTORS INFLUENCING INTAKE AND DIGESTION OF RICE STRAW BY NATIVE CATTLE IN BANGLADESH

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Digestion and slaughter trials were conducted with twelve native Bangali cattle, offered either untreated (US) or urea-treated (TS) rice straw ad libitum, to investigate some of the physiological factors influencing voluntary intake. The cattle given TS had higher intakes than the US group although the overall digestibility was depressed, most probably due to a faster rate of passage. The greater daily digestible dry matter intakes of the TS group was associated with a faster rate of liveweight gain. No variation was observed in the eating behaviour of the two groups. The cattle offered the US had significantly greater rumen and total gut contents ($P < 0.01$ and $P < 0.05$ respectively) than those given TS. When expressed on a liveweight basis both groups had gut tissues and total contents weights far greater than those of comparable European cattle. It is concluded that the Bangali cattle have adapted to ingest and process low quality, fibrous roughages and it is suggested that cross breeding with exotic strains may seriously reduce this inherent advantage .

Key words: cattle, rice straw, urea, intake, digestion

Bangladesh is one of the poorest countries in Asia, with a very high population density (600 persons/km^2) and little or no land allocated to fodder cultivation. Thus livestock production has to be based on the maximum use of crop residues, and by-products from the production of food for human consumption. These are supplemented to a limited extent by grasses and legumes that can be grazed on river embankments or by the roadside, aquatic weeds and other more exotic plant species such as leguminous trees.

Of the crop residues, rice straw is by far the most important, contributing over 90% of the feed energy available to cattle (Bangladesh Agricultural Census 1977 1980)). Untreated, unsupplemented rice straw has a fairly low dry matter (DM) digestibility, 45-50% (Jackson 1978), but when chemically treated using either caustic soda (NaOH), calcium hydroxide ($Ca(OH)_2$) or urea, the digestibility of straw DM, as well as the daily gain and food conversion efficiency can all be increased (Saadullah et al 1982), Of equal interest is the comparatively good performance by Bangali cattle when given untreated, unsupplemented rice straw . Saadullah et al (1982) reported that these cattle, when offered rice straw ad libitum, showed a daily liveweight gain of 35 g, while Ørskov et al (1981) found that Friesian heifers which received untreated barley straw ad libitum lost weight at the rate of 447 g/head/day. The Bangali cattle consumed more straw, about 3% their liveweight as DM/day (Saadullah et al 1982), while comparable European cattle when offered barley straw could only ingest about 1.5% (Andrews et al 1972).

The difference in intake may be due to a number of factors: there could be marked differences in the nutritive values of rice and barley

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straws, or in their respective rates of microbial degradation, or that some form of natural selection may have occurred in Bangladesh cattle giving them the ability to ingest large amounts of low energy - density feeds. To this end the following work was conducted to examine some of the physiological factors influencing the intake of rice straw by native cattle in Bangladesh.

Materials and Methods

Animals: Twelve native Bangali cattle (11 bulls and 1 heifer) all about 2 years old, with a mean liveweight of 127 kg were used.

Treatments: The cattle were allocated at random to two treatments, either untreated rice straw (US), or urea treated rice straw (TS). The straw had been treated by soaking it with an equal amount of water to which 4% urea and 1% lime (CaO) had been added, in an earthern pit for 10 days. The straw was then removed, drained and sun dried, before soaking prior to use.

Diet: The basal diet of straw was supplemented with 1 kg fresh grass and 150 g fishmeal/head/day. The untreated straw group received 1.5% urea (on a straw DM basis) at the time of feeding, to make the diets isonitrogenous, while both groups received 0.32% Na_2SO_4(straw DM basis).

Feeding: The straw was offered ad libitum (5 kg air dry weight which was about 10% more than the daily DM intake), in two equal meals at 0700 and 1430 h. Residues were collected each day at 0700 h, sun- dried, weighed and subsampled for DM estimation. Water was freely available.

Housing: The cattle were penned in concrete stalls in pairs, but were tethered to facilitate individual feeding and faecal collection.

Liveweight estimation: The cattle were weighed on two consective days at the beginning of the experimental period and the mean was taken as the initial liveweight. This procedure was repeated each week throughout the experimental period.

Faecal collection: A digestibility trial was conducted over a seven day period, with faeces being collected every four hours from the concrete floor of the pen. This method of collection was simpler, and avoided the problems associated with the use of faecal collection bags. The fresh weights of material excreted was recorded and a subsample taken for DM analysis.

Rate of particulate outflow: This trial was conducted at the same time as the digestibility trial with chromium-mordanted ground barley straw being used as the inert marker. The straw was prepared by first grinding it in a laboratory hammer mill (through a 2.5 mm screen)and then washing it in tap water to remove the soluble component (Mould et al 1982). The residual material was then mordanted by treating with 18% sodium dichromate (DM basis) using the procedure of Uden et al (1980). Three cattle from each group were offered 100 g DM/head of the mordanted straw; this was mixed with the protein supplement and entirely consumed within 10-15 minutes, at which point the faecal collection was started. The faeces were subsampled, dried and ground, and the chromic oxide concentration estimated using the method of Stevenson and Clare (1963).

Behavioural studies: All the cattle were observed at five minute intervals from 0600 to 1800 h, half an hour after and before dawn and dusk respectively, on three consecutive days and their behaviour recorded as either eating/drinking, ruminating or at rest. The number of chews (i.e. jaw movements)/bolus and chews/minute were also measured, on two occasions each day during this period.

Slaughter details: All six animals from the US group and five from the TS group were slaughtered over a three day period;the heifer was retained for breeding purposes. The gastrointestinal tract was removed entire and ligated so as to divide the gut into four sections, viz. the reticulorumen, omasum-abomasum, small intestine and large intestine. The empty weight of each section was recorded, as was the weight of contents. Subsamples of the contents were taken for DM analysis. The weight of the fat deposits around the kidneys, heart and mesenteric tissue and the yield of saleable carcass was recorded.

Results

DM intake and DM digestibility: The two supplements (grass and fishmeal) were always consumed, so that the residues produced consisted entirely of straw. With reference to Table 1, it can be seen that the

Table 1:

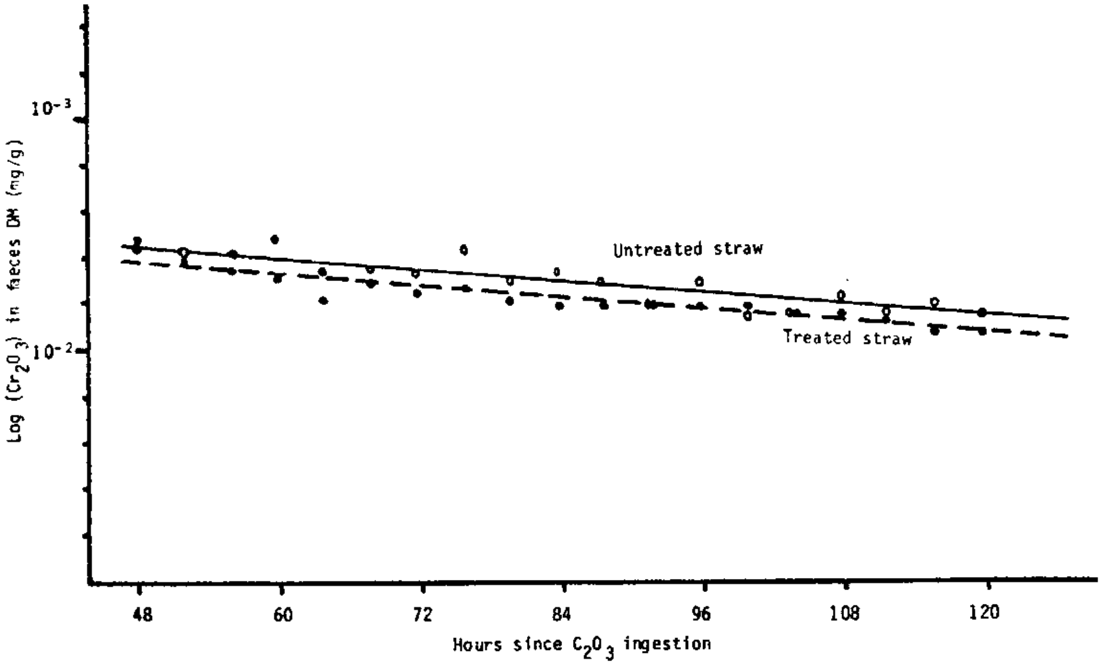
Dry matter intake (DMI), % dry matter (DM) digestibility and daily digestible dry matter (DMD) intake as influenced by the diet offered

Diet	DMI/day (kg)	% DM Digestibility	Daily DMD intake (kg)
Untreated straw	4.28	65.2	2.79
Treated straw	4.54	63.9	2.90
SE Means	0.06	1.00	0.05

TS group ate slightly more/day than the US group, 4.54 and 4.28 kg/animal/day respectively, of which 0.41 kg was contributed by the supplements. The DM digestibilities of the two straws were similar and resulted in nearly equal digestible dry matter (DDM)intakes, for the US and TS groups respectively.

Rate of outflow: The concentrations of chromic oxide (Cr_2O_3) present in the faecal DM of the cattle receiving either US or TS, expressed on a logarithmic scale, are plotted against time (Figure 1). These values were then used for the regression analysis and to obtain the regression coefficients (k or rate constants) for the outflow of Cr_2O_3. The k values were identical for both groups, and although the concentration of Cr_2O_3in the faeces of the group receiving US was slightly higher than that of the TS group, the difference was not significant.

Figure 1:
The concentrations of chromic oxide in the faeces against time after ingestion

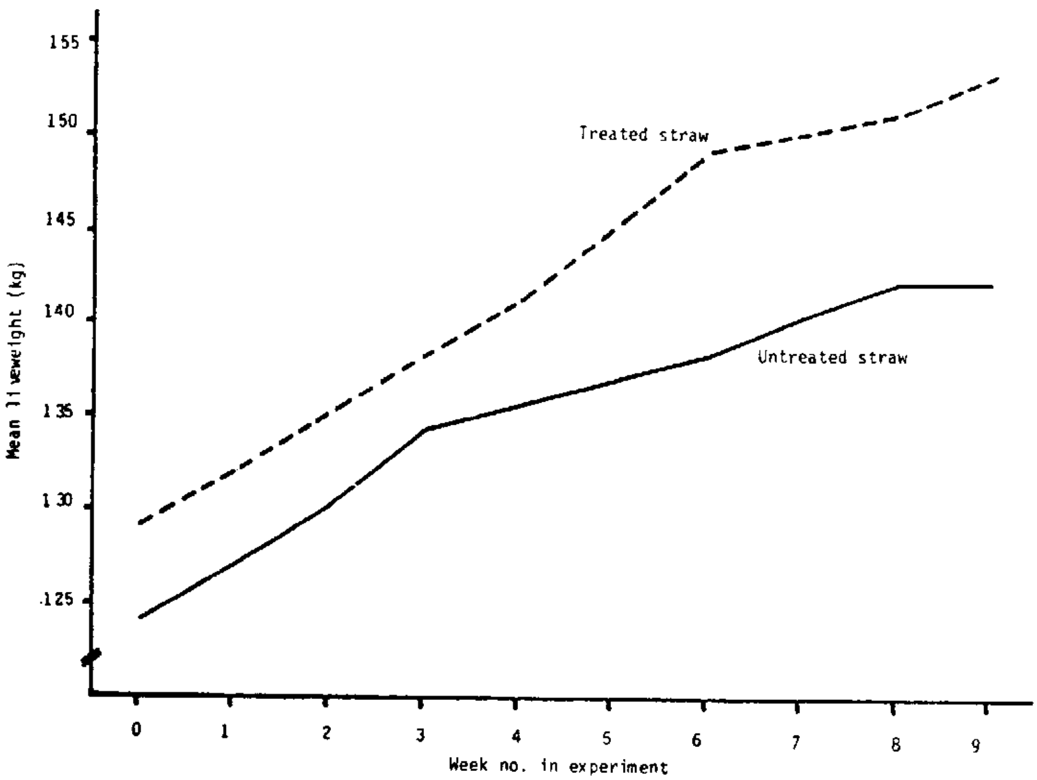


Behavioural pattern: No difference was observed in the behavioural pattern of the two groups (Table 2), with the cattle spending slightly less than half the recorded period eating, 22% ruminating and the remainder at rest. Although the number of chews/bolus and chews/minute varied greatly within groups, there was no difference between the mean values of each group, the cattle having a mean chewing rate of 49.4 jaw movements/minute , and chewing each bolus an average 39.5 times.

Table 2:
The proportion of time spent eating, ruminating or at rest and the number of chews/bolus and chews/minute as influenced by the diet offered

	Untreated straw	Treated straw	Mean	SE Means
Proportion of time spent (%)				
Eating	48.3	47.6	47.9	0.68
Ruminating	23.4	22.1	22.8	1.14
Rest	28.3	30.3	29.3	0.91
Chews/Bolus	39.8	39.2	39.5	2.08
Chews/minute	49.3	49.5	49.4	1.86

Figure 2:
Mean liveweight against time in experiment 2



Liveweight: The group receiving TS had an average initial liveweight of 129 kg, 5 kg more than the US group at the start (Figure 2) and gained weight at a greater rate than the US group throughout the experiment (0.38 and 0.29 kg/head/day respectively) reaching a final mean liveweight of 153 kg, 11 kg more than the US group when the experiment was terminated (63 days). However, these differences were not significant.

Slaughter trials: From Table 3 it may be seen that the group receiving TS had heavier gastrointestinal tracts, but significantly less gut fill than those cattle offered US ($P < 0.05$). The difference in gut fill was due almost entirely to the weight of the reticulorumen contents, the ᵓan weight of 35.1 kg for the US group being 7.7 kg heavier than the TS ᵕup ($P < 0.01$). The weights of material in the remainder of the gut similar: 11.3 and 11.2 kg for the US and TS groups respectively. greater deposition of fat was found within the abdominal cavity of le which received TS: 2.2 kg, 0.9 kg more than the US group, and yielded a larger quantity of saleable carcass than the cattle ᵓen given US; 61.1 as against 50.8 kg respectively. These diff- not significant.

Discussion

ᶦntake of the TS group, 4.54 kg/head/day (0.25 kg more v be a result of an increase in the rate of passage

Table 3:

Details of gastrointestinal tract measurements obtained at slaughter, as influenced by the diet offered. (US - untreated straw, TS - treated straw, RR - reticulo-rumen, OA - omasum-abomasum, SI - small intestine and LI - large intestine).

Diet	Liveweight (kg)	Gut section	Tissue weight (kg)	S.E.*	Tissue weight % liveweight	Contents weight (kg)	S.E.†	Contents weight % liveweight
US	142	RR	3.9	0.67	2.7	35.1	0.98	24.5
		OA	1.8	0.10	1.3	4.9	0.24	3.4
		SI	2.1	0.11	1.5	3.1	0.29	2.2
		LI	1.2	0.12	0.8	3.3	0.12	2.3
		Total	9.0	0.69	6.3	46.4	0.74	32.4
TS	153	RR	4.6	0.77	3.0	27.4	1.81	17.9
		OA	2.2	0.23	1.4	3.5	0.37	2.3
		SI	2.5	0.16	1.7	4.0	0.32	2.6
		LI	1.7	0.13	1.1	3.7	0.41	2.4
		Total	11.0	0.62	7.2	38.6	2.30	25.2

* Standard error tissue mean weight

† Standard error contents mean weight

(Campling et al 1961)due to the urea treatment. When compared on a liveweight basis both groups had similar DM intakes (3.1 and 3.0% for the TS and US respectively). These levels far exceed that which European cattle appear to be capable of ingesting when offered a similar diet. Andrews et al (1972) reported that cattle receiving barley straw ad libitum could ingest only 1.5% of their liveweight as DM and Lyons et al (1970) recorded similar results with cattle, also offered barley straw, consuming 1.7% of their body weight as DM/day.

Due to the slightly higher DDM intakes, the TS group gained weight at a faster rate; 0.38 kg/head/day, 0.09 kg more than the US group, to reach liveweights of 153 and 142 kg respectively. In comparison the cattle used by Andrews et al (1972) gained at only 0.07 kg/day, while those of Lyons et al(1970) and Ørskov et al (1980) lost liveweight at the rates of 0.22 and 0.45 kg/day respectively.

The difference between the two treatments with regard to liveweight can only be fully appreciated if the empty bodyweights (the liveweight minus the gut contents) are compared; the mean empty weight of the TS group is 114.4 kg while that of the cattle receiving US is markedly lower at 96.6 kg.

Observation of the feeding-ruminating pattern of the two groups of cattle over the 24 hour period was not possible as there was no lighting in the building used to house the cattle; if lights had been installed this would have imposed a new factor on the behavioural pattern. Although the period over which the cattle were observed does not give their com -

plete diurnal behaviour, it is argued that if their behaviour pattern had been influenced to any extent by the urea treatment, then this would have been observed. The proportion of time spent eating, ruminating or at rest, as well as the number of chews/bolus and chews/minute were not, however, altered as a result of the urea treatment, during the observed period.

The slaughter trial presented the most informative results as regards possible factors which could affect voluntary intake. The cattle offered US had smaller mean gastrointestinal weights than the TS group although they had a significantly greater ($P < 0.05$) gut fill. The difference in the weight of gut contents between the two groups was almost entirely due to the rumen fill; the US group having a significantly greater ($P < 0.01$) mean reticulo-rumen fill of 35.1 kg which accounted for 25 .5% of the liveweight, than the TS group with reticulo-rumen weighing only 27.4 kg, 17.9% of the liveweight. The cattle which had been given the TS diet had greater fatty deposits in the abdominal cavity, especially the mesenteric tissue, and this may in part account for the heavier gut tissue weight of these animals.

As it was not possible to conduct an experimental comparison with European purebred or crossbred cattle, the present results (Table 3) were compared with data from the literature (Makela 1956) based on the slaughter of 24 cows given timothy and clover hays.

This revealed that the weight of the gastrointestinal tract on a % of liveweight basis of the Bangali cattle was proportionately heavier than that of the European cattle, mainly due to the Bangali cattle having a relatively heavier reticulo-rumen and small intestine. The weight of gut contents of the cattle which received US when expressed on a liveweight basis was twice that found in the European cattle, accounting for a total of 32.4 and 16.9% of the liveweight respectively. Although the proportion of liveweight accounted for by the gut contents of the animals which were given TS (25.2%) was less than that of the US group it still greatly exceeds that of the European cattle.

Gut contents equivalent to those of the Bangali cattle have only been observed in young calves offered good quality roughages. Stobo et al (1966) reported that at 17 weeks of age, the gut contents of hay fed Ayrshire bull calves accounted for 26.9% of their liveweight, while Hodgson (1973) found that the gut contents of Friesian calves offered dried grass ad libitum and slaughtered at about 15 weeks of age, represented 32.4% of their liveweight. These high gut fill values do not, however, continue as the fill per unit body weight declines as cattle increase in weight (ARC 1980).

The results from this slaughter trial tend to indicate that Bangali cattle have adapted their digestive system to ingest and process large amounts of bulky, low energy density feeds, a process at which they appear to be superior to European cattle. The results strongly suggest that cross-breeding with exotic breeds may adversely affect the ability of the indigenous cattle to consume the resources available and should be examined in detail before a large scale cross-breeding programme is undertaken. More work is required to fully explore the possibility of whether cross-bred animals given the same environmental conditions from birth could adapt to consume and survive on diets consisting mainly of straw.

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