THE DIGESTION OF RICE GIVEN AS A SUPPLEMENT[1] IN A MOLASSES BASED RATION

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Three bulls with permanent cannulae in the rumen and "T" cannuLae in the duodenum were fed in successive 7 d periods 0, 0.5 or 1.0 kg/d of rice grains as a supplement to a basal diet of molasses/urea and cassava forage. Dry matter and starch flows were estimated using Cr2O3 as marker, given in three infusions daily into the rumen. Rate of degradation of rice in the rumen was measured using dacron bags.

DM digestibility in the forestomachs varied from 31 to 57% and was not related to rice intake. Rice digestibility in the forestomachs varied from 8 to 44% and appeared to decrease as rice intake increased. The amount of starch in faeces was between 2 and 5 g/d. Degradation rate of rice grains in dacron bags in the rumen was fairly rapid (T1/2 - 17 hr). Flow of starch to the duodenum on the control treatment (zero rice) was 58 g/d and was assumed to represent microbial polysaccharide. Applying this correction to the results from the rice fed animals indicated that approximately 32% of starch fed as rice grains was digested in the rumen.

It is concluded that on molasses based diets, there is substantial rumen bypass of rice grains, which are subsequently almost completely digested in the intestine.

Key words: Duodenal "T" cannulae, cattle, molasses, starch bypass

It has been suggested that the major limiting nutrients in tropical feeding systems may be precursors for gluconeogenesis (Leng and Preston 1976), since in these systems the major energy sources are molasses and sugar cane and these have very low levels of starch and protein. The importance of protein in a ration based on molasses has been well demonstrated in feeding trials (Preston 1972). There have also been good responses in liveweight gain to cottonseed meal (47% protein) when used to supplement sugar cane (Meyreles et al 1979).

In this experiment, intestinally fistulated animals have been used to investigate the extent of fermentation of rice grains in the rumen, the flow of starch to the duodenum and its absorption from the intestine.

Materials and Methods

Animals, Dietary Treatments and Design: Three crossbred (Holstein x Zebu) bulls of about 180 kg and two years of age were used. These were fitted with permanent rumen cannulae and single "T"-shaped duodenal cannulae (Rowe 1979) positioned about 5 cm from the pyloric sphincter. Animals were housed inside on a concrete floor in single stalls, and were given the basic diet of molasses (2.55 urea) ad libitum, and 5 kg (fresh weight) of chopped cassava tops for four weeks prior to the commencement

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of the experiment. The basic diet was supplemented with rice grains at levels of C, 0.5 and 1.0 kg/d given with the cassava forage in the morning. Each animal received each level of supplementation for a period of 7 d.

Measurements: The intake and DM content of each component of the ration were measured. Before feeding the rice and cassava each day, the feed refusals from the previous day were collected and weighed. When the rice constituted a significant proportion of the refusals, it was separated from the cassava forage by washing and was then dried and weighed separately to measure the actual intake of rice grains. Molasses was fed in a small concrete trough with a capacity of 10 kg. The total intake of molasses during the three week period of the experiment was used to calculate the mean daily consumption of molasses for each animal. The starch contents of the cassava forage and rice were estimated.

The intestinal and faecal flow of DM was determined using chromic oxide (Cr_2O_3) as a marker. Due to fairly frequent and unpredictable interruptions in the supply of electricity, the continuous infusion of marker into the rumen was not possible. To approximate conditions of continuous infusion, the marker was injected into the rumen at 8 hr intervals for a period of 7 d. It was assumed that the concentration of marker in the DM fraction of the intestinal digesta and faecal material would approach a situation of cyclical non-steady state, and that by sampling over a 24 hr period (3 'cycles') a bulked sample could be obtained, in which the concentration of marker would provide an unbiased estimate of the daily mean concentration. During the last 24 hr of each 7 d period, samples of duodenal digesta (approximately 50 g) were taken each hour and bulked, and all faeces were collected. These samples were mixed thoroughly before taking subsamples which were dried to constant weight at 65° and analysed for Cr_2O_3 and starch.

The rate of degradation of rice grains in the rumen was estimated by suspending dacron bags containing rice in the rumen for periods of between 2 and 50 hr. During each period, separate bags were removed after 6, 10, 14, 18 and 22 hr in the rumen; others were removed either before 6 hr or after 22 hr to obtain information on the effect of long or short retention time in the rumen.

Analyses: Chromic oxide concentration in DM was estimated by the method of Bolin et al (1952). The method of analysis for starch was based on that of MacRae and Armstrong (1968), modified as described by Ravelo et al (1978).

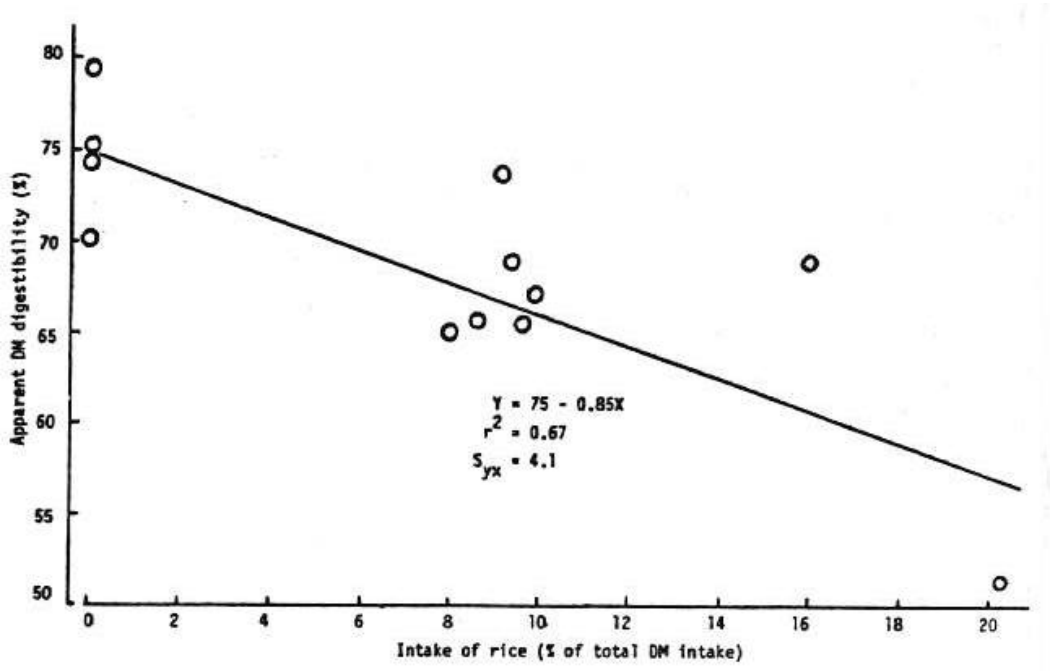
Results

Feed intake and the flows of DM in the duodenal and faecal material are given in Table 1. The DM content of cassava forage was 19.9%; rice 95.1%; and molasses 70.1%. The apparent digestibility of DM in the forestomachs and in the gastrointestinal tract are also given in Table 1 The apparent digestibility of DM in the forestomachs varied between 31 and 57% and did not seem to be related to the amount of rice given in the ration. However, the apparent digestibility of DM2 in the gastrointestinal tract was found to be negatively correlated ($r^2 = .67$) with the intake of rice, expressed as a percentage of total DM intake (Figure 1).

Table 1:
Intake of the different components of the ration and the flow of DM through the duodenum, and in faecal material. The apparent digestibility of DM in the different parts of the gastrointestinal tract are given as percentages.

Animal	One			Two			Three		
Period	1	2	3	1	2	3	1	2	3
Intake of fresh material, kg/d									
Molasses (2.5% urea)	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2
Cassava forage	4.1	4.5	5.0	3.5	4.3	4.1	3.8	4.7	4.0
Rice grains	0.4	0.4	0.0	0.0	0.4	1.0	0.7	0.0	0.4
Flow of DM, kg/d									
Total intake	4.1	4.1	3.9	3.6	4.1	4.6	4.4	3.9	4.2
Duodenal flow	2.3	2.3	1.9	2.5	1.9	2.5	2.3	2.4	1.8
Faeces	1.4	1.1	1.0	0.9	1.3	2.2	1.4	0.8	1.4
Apparent digestibility, %									
Forestomachs	44	44	51	31	54	46	48	38	57
Gastrointestinal tract	66	73	74	75	68	52	68	79	67

Figure 1:
The relationship between the intake of rice (% of totat DM intake) and apparent digestibility of DM in the gastrointestinal tract.



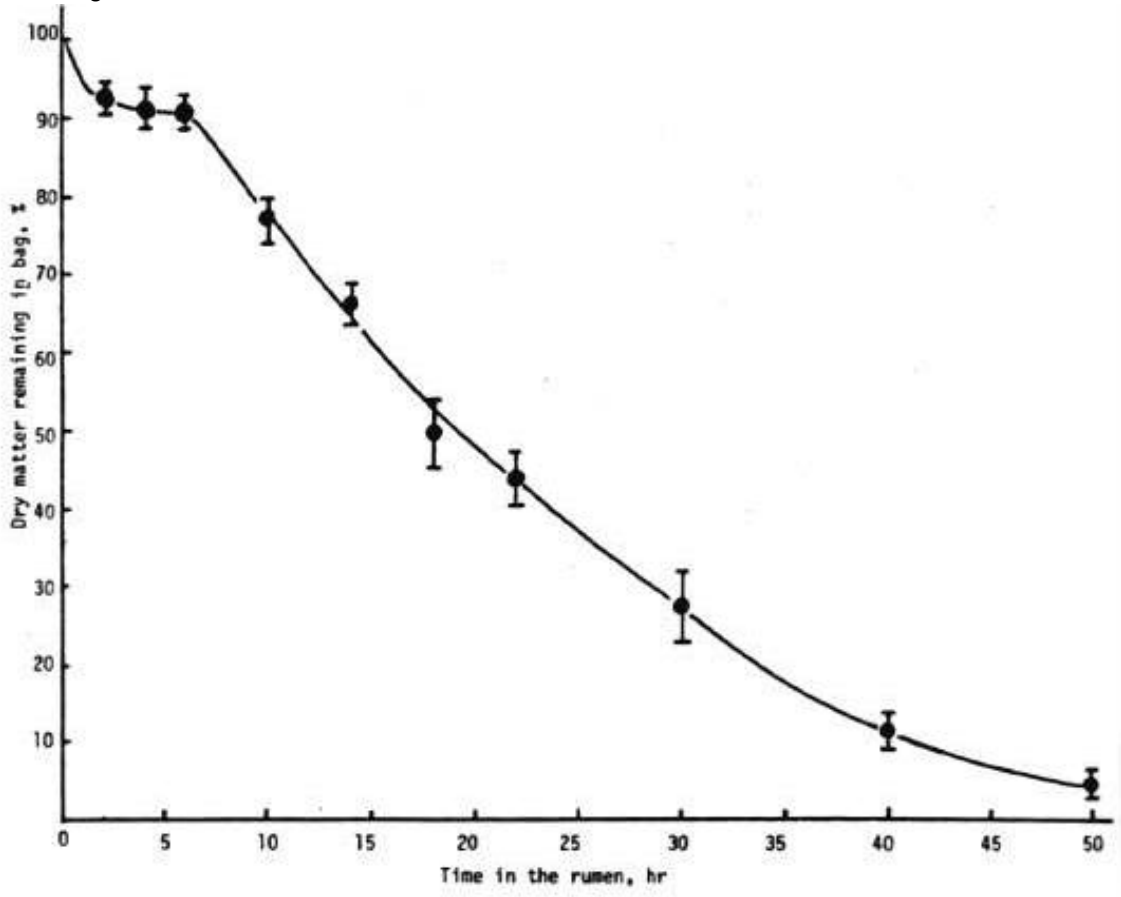
The intake of starch and its flow in the intestine and in faecal material is shown in Table 2. There was a wide variation in the apparent digestibility of starch in the forestomachs (8 to 44%). The apparent digestibility of starch was not related to the estimated digestibility of DM in the forestomachs in this experiment but there was a tendency towards a lower digestibility of starch at higher intakes of rice. When no rice was given in the ration, the mean flow of starch to the duodenum was 58 g/d, presumably reflecting the carbohydrate associated with microbial synthesis. The flow of starch estimated in the faeces was very low (between 2 and 5 g/d) except in Animal 3 (38 and 33 g/d), where the digestibility of starch in both the forestomachs and in the whole digestive tract was lower than in the other animals.

Table 2:
Intake of starch, its flow inthe duodenum, and in faecal mate

Animal	One			Two			Three		
Period	1	2	3	1	2	3	1	2	3
Flow of starch, g/d									
Intake	328	320	0	0	420	800	592	0	352
Duodenal	184	227	79	56	317	687	543	38	305
Faecal	5	3	3	4	4	2	38	2	33
Apparent digestibility %									
Forestomachs	44	29	-	-	25	14	8	-	13
Gastrointestinal tract	98	99	-	-	99	100	94	-	91

There were no significant between-animal differences in the rates of degradation of rice in the rumen nor any between periods, as estimated from the disappearance of rice from. dacron bags suspended in the rumen. All of the observations on the rate of degradation of rice made during this experiment have been combined and are shown graphically in Figure 2. During the first 6 hr, the disappearance of DM was slow in comparison with the linear rate of degradation between 6 and 22 hr ($T_{1/2}$ of approximately 17 hr). A slower rate of degradation was observed beyond 22 hr.

Figure 2 :
Rate of degradation of rice grains in the rumen. Percentage dry matter remaining in bags is plotted against time in the rumen.

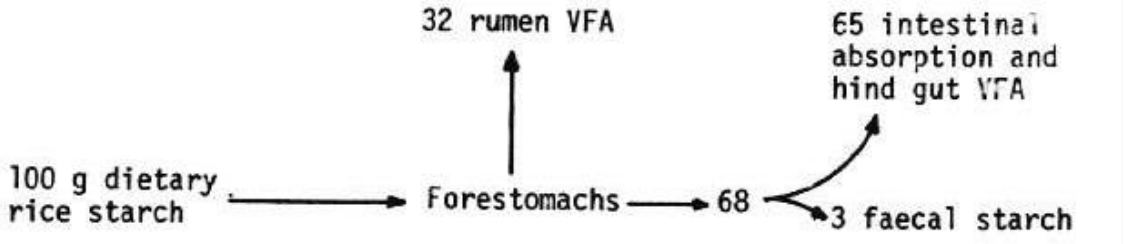


Discussion

The variability in the estimated digestibility of DM and starch in the forestomachs (Tables 2 and 3) indicates that the method used for measuring the flow of duodenal digesta in this experiment may not facilitate the same level of precision as is possible in animals with re-entrant c cannulae (MacRae 1975) or when a continuous intra-ruminal infusion of Ru-P and Cr-EDTA is used in animals fitted with single "T"-shaped cannulae (see Faichney 1975). However, these data provide sufficient information to quantify the ?pattern of digestion of rice grains in this experiment.

Assuming that the microbial carbohydrate contributed 58 g/d to the duodenal starch flow in all animals, the mean duodenal flow of starch from rice grains may be calculated as 318 g/d. The mean intake of starch was 469 g/d and the extent of fermentation of rice starch in the rumen was the,refore approximately 32% of the amount eaten.

The mean apparent digestibility of starch in the digestive tract was 97% and from this, the following schematic representation, the digestion of rice starch was derived.



The mean residence time of rice grains in the rumen required for 32% degradation of starch to occur may be estimated from Figure 2 as approximately 13 hr. Although this estimate assumes that the rate of starch degradation was the same as that of the rice DM, it does provide a relatively simple method of estimating the mean retention time of a portion of the rumen DM pool. It is possible that the rate of DM turnover in the rumen is variable between animals given the same ration and it is suggested that it is due to this variability in retention time that the variable extent of starch fermentation in the rumen may be attributed.

The results of this experiment confirm that significant amounts (68%) of rice grains escape rumen fermentation in molasses based diets given to cattle. This is in agreement with the data for sugar cane diets (Elliott et al 1978). The fact that low rumen~en degradability of starch, as reported here, was obtained using whole rice grains lends support to the observation of Elliott (personal communication) that it is the rice tips (pieces of rice grain) which contribute most to the rumen bypass of starch when rice polishings are fed with sugar cane.

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Received 25 September 1979