

THE EFFECTS OF FORAGE ON RUMEN FLUID VOLUME AND OUTFLOW IN CATTLE GIVEN MOLASSES BASED DIETS

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Cattle appear to require a proportion of their feed intake on a molasses based diet to be in the form of roughage. It has been suggested that a major reason for this is that rumen fluid outflow rate decreases rapidly if the forage is not given when the molasses is the main energy source in the diet. A comparison of rumen fluid volume and intake of cattle given a molasses based diet with 1 kg lucerne hay or oaten straw chaff or cotton lint were not markedly different but lucerne hay apparently promoted the fastest turnover with the smallest rumen fluid volume. Removal of the forage from the diet decreased rumen turnover rate only slightly.

Key words: Cattle, molasses diet, roughage quality, rumen volume rumen fluid, outflow rate.

The establishment of an efficient rumen function in cattle on sugar based diets is of major importance for efficient animal production. Where molasses is the basal diet, this means feeding a roughage with 'characteristics' which maintain rumen fluid outflow high (Peron and Preston, 1971; Rowe et al, 1979). In studies with cattle fed a basal diet of molasses it has been found that roughages vary in their ability to promote intake and utilisation of molasses. For instance, sugar cane tops added to a molasses based diet appear to be less able to increase productivity than wheat straw or sweet potato forage indicating that there are unknown qualities associated with the roughages which are related to the maintenance of efficient rumen function (see Preston and Willis 1970). Rowe et al (1979) showed that with cattle given molasses/urea diets supplemented with 11 kg wet weight sweet potato forage, rumen fluid outflow rates were of the order of two volumes per day. When the forage was removed from the diet, the animals maintained their molasses/urea intakes, but rumen volume increased and rumen fluid outflow rate decreased from approximately two volumes per day to less than 0.1 volumes per day after seven days.

Re-addition of forage back to the diet increased flow rates. This observation suggested the possibility of examining the ability of a forage to maintain rumen function on a molasses based diet and the change in fluid flow from the rumen on cessation of the feeding of the forage. Initially we wished to study the effects of roughages in molasses based diets in maintaining a high outflow and to examine the effects of removing that forage in the same way as carried out in Rowe's work (Rowe et al, 1979). In the studies presented here three roughages were examined.

Materials and Methods

Animals and treatment. Four Hereford steers weighing between 200-240 kg liveweight were fitted with permanent rumen cannulae at least six months prior to the experiment. The animals were housed singly in pens and were given a ration consisting of molasses containing 3% urea (w/w) ad libitum and 1 kg of the forage under examination, which were lucerne hay, oaten straw chaff and cotton lint. Following measurements of rumen fluid volume and turnover on the basal diet the roughage was removed and the rumen volume and flow rate of fluid from the rumen was measured at intervals over a 24 day period. Feed intake was recorded daily.

Procedures and measurements: The period without forage lasted for up to 24 days and during this period estimations were made of the concentration and molar proportions of rumen volatile fatty acids (VFA) and of rumen fluid volume and turnover rate. The days at which these estimates were made are indicated in the figures.

Rumen fluid volume and outflow: This was measured using chromium EDTA as a marker (Downes and MacDonald 1965). 150 ml of solution of chromium EDTA containing approximately 400 parts per million chromium was injected into the rumen of these animals. Samples were taken after 3 hours and a number of samples were taken over the next 8 hours, then there was a period overnight when the animals were undisturbed and 2 samples were taken about 2 hours apart on the day following injection of chromium EDTA.

Chemical methods: The concentration of chromium EDTA was measured in rumen fluid using an atomic absorption spectrophotometer (Perkin Elmer Model 640). Total VFA were determined by steam distillation and titration; concentrations and proportions of VFA in rumen fluid were estimated by gas liquid chromatography (see Rowe et al 1979).

Calculations: the estimation of rumen pool size and fluid flow rates were done according to well established methods assuming first order processes applied (see Rowe et al 1979).

Results

The feed intake: The patterns of consumption of molasses and of the forage are shown in Figure 1

There was no apparent decrease in molasses intake by the cattle for up to 20 days following removal of any of the forages from the diet, A typical result for the dilution of the chromium EDTA with time in the rumen is shown in Figure 2.

Rumen fluid volume: The results for the change in rumen fluid volume with time after removal of forage from the diet is shown in Figure 3.

The pattern of change of rumen fluid turnover in these animals after removal of forage from the molasses based diets is shown in Figure 4.

The pattern of VFA production in the rumen: the proportions and concentrations of VFA appeared not to change irrespective of the forage or the removal of that forage, and were 60, 25, 15 for acetic, propionic and butyric acids respectively.

Figure 1:
 Mean daily intake of molasses by two cattle on a molasses based diet with 1 kg/day of lucerne hay (G),
 oaten straw chaff (#) or cotton lint (# before and after removal of forage from the diet.

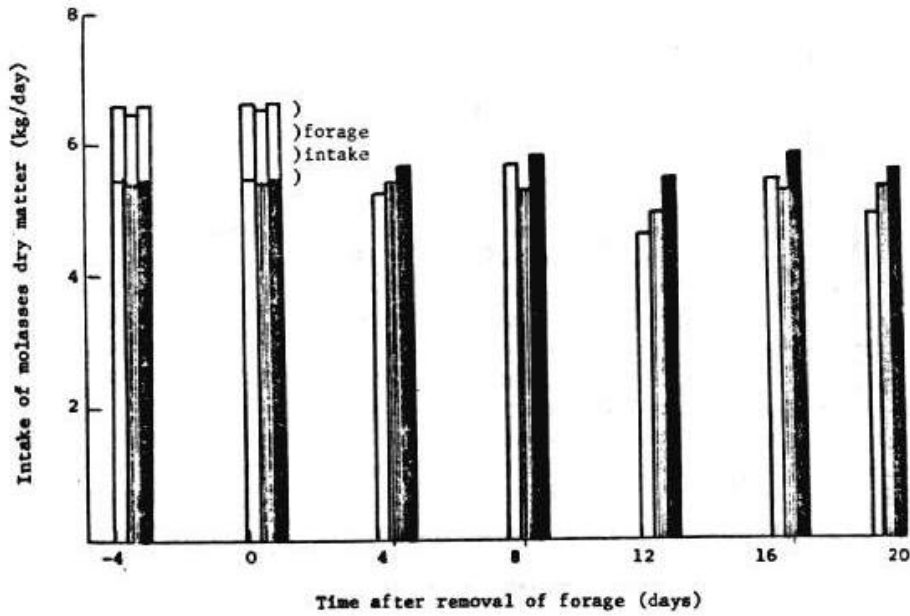


Figure 2:
 The concentration of CrEDTA¹ in rumen fluid of of steer given molasses/lucerne diet, following injection of
 300 mg CrEDTA.

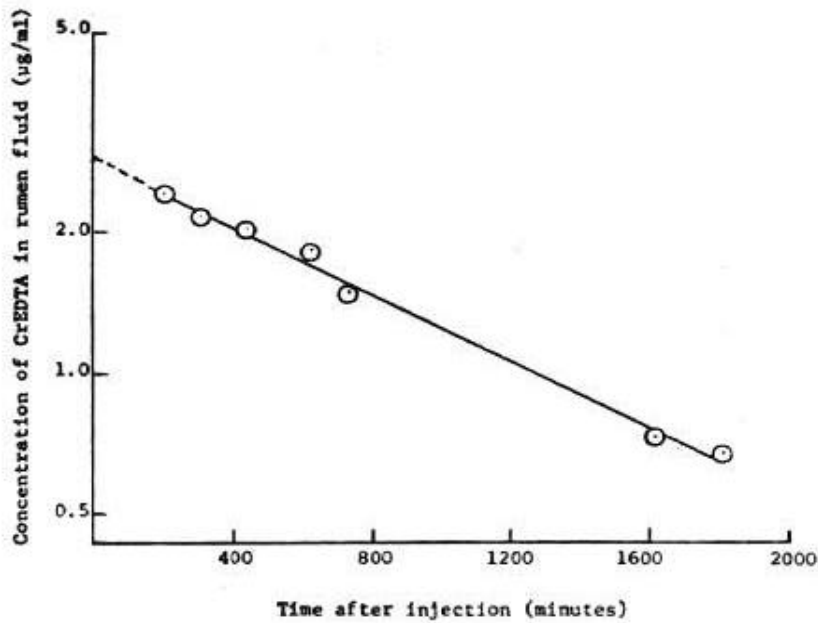


Figure 3:
 Mean rumen fluid volume in two steers given molasses based diets with 1 kg/day of lucerne hay (!),
 oaten straw chaff (") or cotton lint (X) and following removal of the forage from the diet.

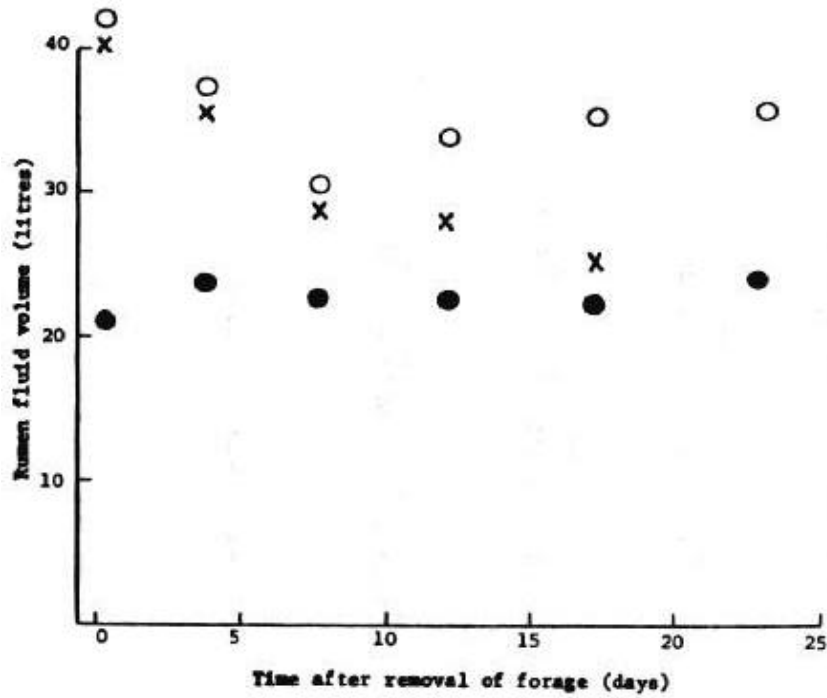
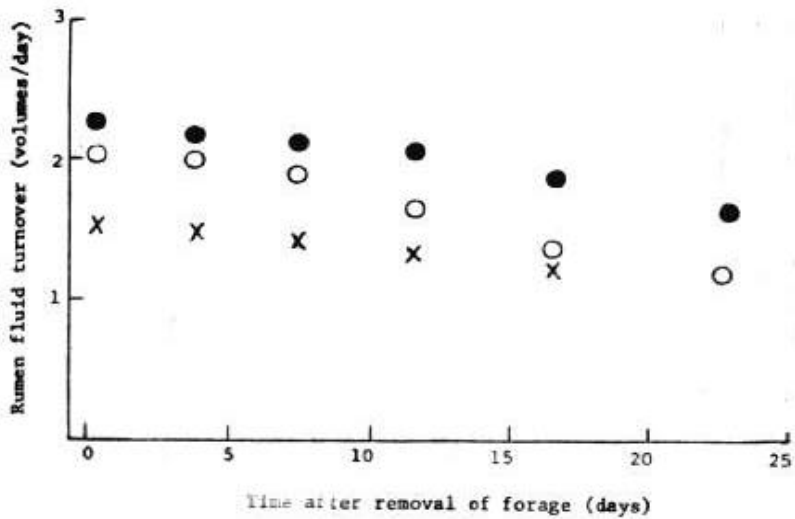


Figure 4:
 Mean turnover of rumen fluid in two steers given molasses based diets with 1 kg/day of lucerne hay (!),
 oaten straw chaff (") or cotton lint (X) and following removal of the forage from the diet.



Discussion

The main reason for investigating the effects of forages on flow rate from the rumen in the studies of Rowe et al (1979) was the observation that the removal of forage from the diet resulted in some cases in molasses toxicity or cerebral necrosis which occurs in these animals at about the time (7 days) that minimum flow rates from the rumen apparently occurred. In the studies now presented, there was no apparent molasses toxicity in the cattle throughout a 21 day period without forages in the diet. Unfortunately no estimates were made of the amount of forages retained in the rumen but the digestibility of the forages used was in excess of 50%, although this was not as high as digestibility of the sweet potato forage used by Rowe and his colleagues (1979).

The fact that no molasses toxicity was observed and that rumen fluid flow rate decreased to only a relatively small extent may be circumstantial evidence for an association of the low rumen flow rates with the molasses toxicity that was observed by Rowe et al (1979).

The other characteristic of all the forages used in these studies was that they were dried and preserved materials whereas the forage that Rowe used was freshly harvested green material fed at an appreciable higher level. Of major interest is that when lucerne was given as hay and therefore having long fibres, rumen volume was the least and outflow the highest, however the lucerne contained appreciable bypass protein which may also have had effects on the rumen function. A possibility is that the forages used here, which are of temperate country origin have different roughage characteristics to tropical plants.

Conclusions

The main conclusion that arises from this study is that the characteristics of a forage to be used in a molasses based diet for cattle in order to support efficient utilisation of feed are not known. More studies are required to compare the effects of a wider variety of forages on rumen fluid turnover rates in cattle on molasses based diets.

References

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