THE ABOMASAL FLOW OF STARCH IN ANIMALS FED SUGAR CANE SUPPLEMENTED WITH WHEAT BRAN OR DRIED CASSAVA ROOT

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Two cross bred bulls of about 200 kg and about two years old which had been fitted with permanent rumen cannulae were given chopped whole sugar cane ad libitum supplemented with 1.0 or 2.0 kg/d wheat bran, or 0.75 or 1.5 kg/d dried cassava root meal. Abomasal samples were taken at hourly intervals for twenty four hours, and bulked on a 3 hourly basis for analysis. On the day of sampling the bulls were dosed with chromic oxide and polyethylene glycol (PEG) via a rumen cannula as markers.

It was found that the chromic oxide left the rumen more slowly than had been anticipated, and that recovery of the PEG (for subsequent determination) was initially low. Therefore starch digestion was calculated with the assumption that 50% of dietary dry matter was digested in the rumen. With this assumption, the average rumen degradation of starch was 99.3 and 98.6% respectively.

Key Words: Cattle, sugar cane, starch, supplementation, rumen degradation

Although there is a wealth of data on the ruminal and post-ruminal digestion of starch by ruminants given diets common in temperate countries, there is little information on the use of diets used in tropical countries. The objective of the experiment reported here was to look at the ruminal digestion of two starch rich concentrates when supplemented to a basal diet of sugar cane. A provisional account of this experiment has been given before (Ravelo et al 1978).

Materials and Methods

Animals, Treatments and Design: Three cross-bred bulls of about 200 kg liveweight and two years old, fitted with permanent rumen cannulae, were used. Two of the bulls also had permanent abomasal cannulae, and the third a cannula located in the ileum. Four dietary treatments were imposed onto a common basal diet of chopped whole sugar cane ad libitum with 9 g urea and 2.5 g ammonium sulphate per kg fresh cane (given as a solution in water mixed into the cane), plus 80 g/d of a 1:1 mixture of dicalcium phosphate and salt, as:

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Table 1:
Composition of whole sugar cane and supplements

	% DM	°Brix	Sugar (% DM)[1]	Starch (% DM)
Whole sugar cane				
Period 1	23.1	10.3	38.2	-
Period 2	25.9	10.4	33.2	-
Period 3	26.7	14.7	47.3	-
Period 4	27.7	16.0	49.7	-
Wheat bran	91.4	-	-	21.9
Cassava root meal	89.5	-	-	82.0

[1] Calculated according to Ferreiro et al (1977)

A. Basal plus 1.0 kg/d wheat bran
B. Basal plus 2.0 kg/d wheat bran
C. Basal plus 0.75 kg/d ground sun dried cassava root meal
D. Basal plus 1.5 kg/d ground sun dried cassava root meal

The average composition of the cane and its supplements is given by Table 1. Due to the limited number of animals, no formal design was possible. Therefore the treatments were imposed in the order:

Abomasal cannulated animal	#7 C, D, A, B
Abomasal cannulated animal	#40 - B, D, C
Illeal cannulate animal	#34 D, C, B, A

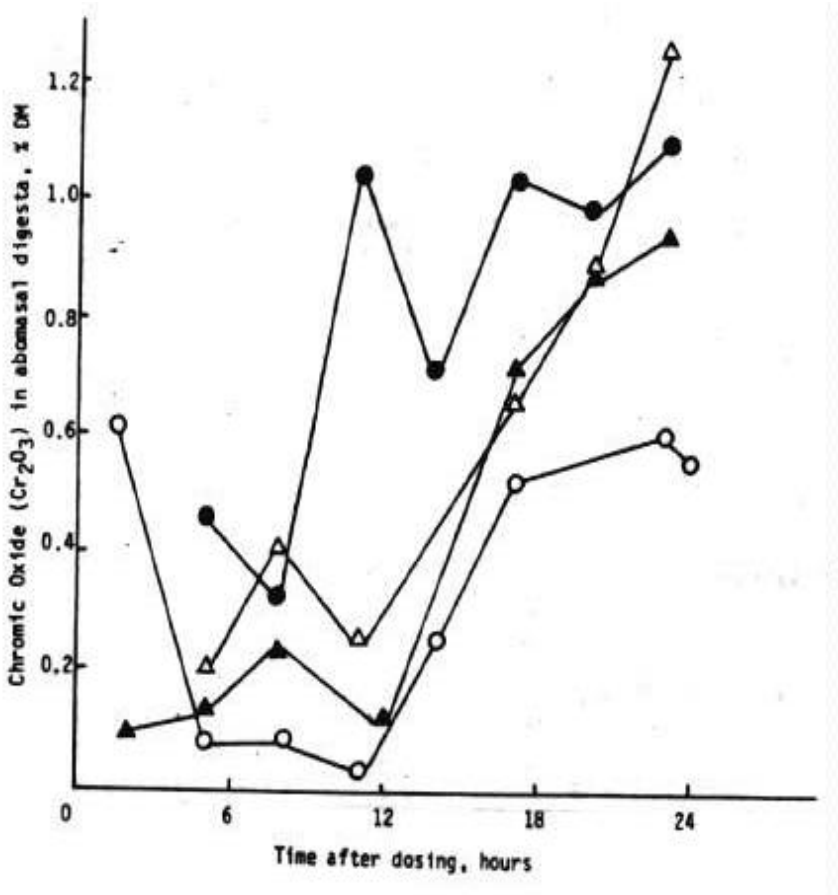
The adaptation period for each supplement was three weeks, but for the change of level of each supplement, one week.

Management and Sampling: The bulls were kept in individual stalls and were individually fed once daily in the morning. The supplement was sprinkled onto the top of the cane, and assumed to be completely consumed (as far as could be seen, this was the case). The animals were sampled for abomasal and ileal digesta in the penultimate 24 h of each period at hourly intervals starting one hour after feeding. Rum en samples were taken at three hourly intervals, starting 2 h after feeding. They were strained and stored in a refrigerator. The abomasal and ileal samples (100 g fresh material) were bulked by three hour periods (300 g fresh material) and were dried at 65°C for preservation.

Markers and Measurements: Two markers were used. 40 g Chromic Oxide (Cr_2O_3) and 100 g Polyethylene Glycol (PEG). These were mixed with about 100 ml water, the dense solution of PEG suspended the Chromic Oxide. The solution/suspension was then introduced into the rumen at three or four different sites using a syringe and long tube. The markers were given immediately after the animal had been given its cane,

and immediately before receiving its supplement. Daily cane intake was recorded as well as cane dry matter and Brix° (by refractometer). PEG was determined by the method of Malawar and Powell (1967), the absorption of the final solution being read on a Bausch and Lomb 88 Spectrophotometer at 650 mu. Chromic Oxide was determined (as dichromate) on the acid digest of the dried material, using a sulphuric acid/perchloric acid mixture with molybdenum sulphate as catalyst as described by Bolin et al (1952). The dichromate solution was then read at 450 mu. Standards were prepared by digesting known amounts of Chromic Oxide in dried digesta. Starch was determined by a method essentially that of MacRae and Armstrong (1968) with the difference that samples were boiled for 3-4 h before digestion with X-amylase (Agidex, BDH, Poole, England), and that the resulting glucose solution was measured using the Boehringer Manheim Glucose Oxidase Peroxidase kit. The developed colour was measured at 436 mu on the spectrophotometer. Recoveries of test samples were found to be 90-98%.

Figure 1:
The concentration of Chromic Oxide (% DM) in the abomasal digesta of animal #7 (◦,•) and #40 (△,▲) in different periods during the first 24 hours after dosing



Results and Discussion

Measurement of Digesta Flow: When the experiment was planned we did not have sufficient PEG or Chromic Oxide to maintain a constant level in the digesta (by dosing or several days). Therefore it was decided to give a single dose, and determine flow from the semi-log plot of concentration with time. In the event it was found that the Chromic Oxide concentration had not peaked by 24 h post dosing as is demonstrated in Figure 1. There is the suggestion in some cases, of a slight surge of Chromic Oxide soon after dosing, but thereafter the concentration remained low until about 10-12 h after feeding and dosing, after which concentration rose rapidly. The implication is that rumen turnover rates were very slow.

Rumen fluid turnover rates were measured, using the disappearance of PEG from the rumen (Hyden 1961), and as can be seen in Table 2, fluid flow rates were low (average ± SD for all treatments was 0.92 ± 0.71 volumes/day).

We also intended measuring abomasal digesta flow using PEG as a marker in the same way. Initial recoveries of PEG from dried abomasal digesta were very low (50-70%). We resolved this by bringing the sample and water to boil, boiling for a few minutes, and centrifuging. Recoveries from samples prepared in this way were nearly complete. However we did not measure PEG in the samples for reasons which will be explained.

Table 2:
Rumen fluid volume and flow in Zebu bulls given chopped sugar cane supplemented with wheat bran oh sun-dried cassava root meat

Supplement	Animal %	Rumen volume (1)	Fluid flow (1/d)	Turnover (vols/d)
0.75 kg/d cassava root	7	41	45	1.1
	40	36	21	0.6
	34	-	-	-
1.5 kg/d cassava root	7	28	10	0.4
	40	31	14	0.4
	34	23	65	2.8
1.0 kg/d wheat bran	7	28	24	0.8
	40	-	-	-
	34	32	28	0.9
2.0 kg/d wheat bran	7	39	34	0.9
	40	29	11	0.4
	34	22	9	0.9

Figure 2:
Concentration of starch in abomasal digesta of animals 7•)(and 40 (△) when supplemented with 0.15 kg/d cassava root meat

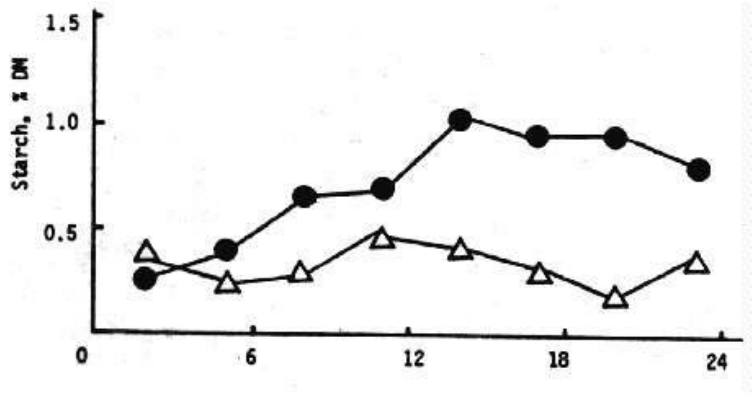


Figure 3:
Concentration of starch in abomasal digesta of animal 7•)(and 40 (△) when supplemented with 1.5 kg/d cassava root meat

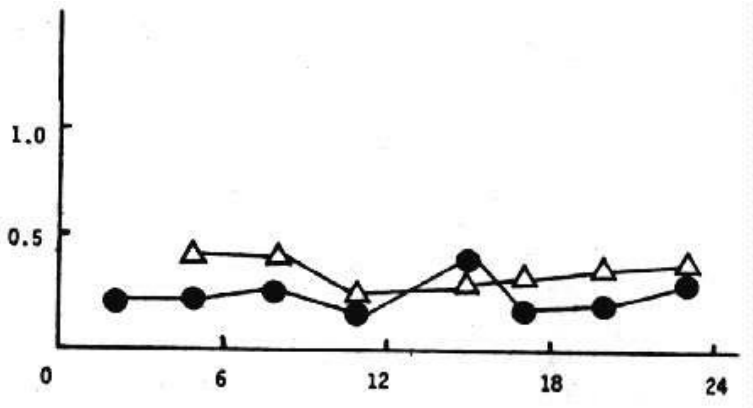


Figure 4 :
Concentration of starch in abomasal digesta of animal 7•)(when supplemented with 1.0 kg/d wheat bran

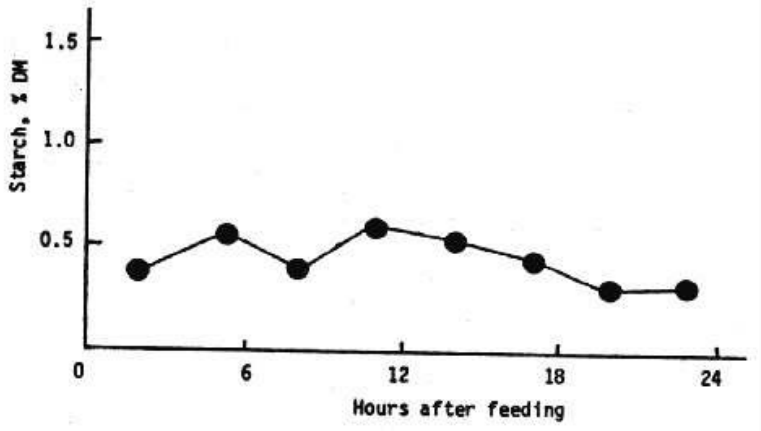


Figure 5:
Concentration of starch in abomasal digesta of animals 7•)(and 40 (△) when supplemented with 2.0 kg/d wheat bran

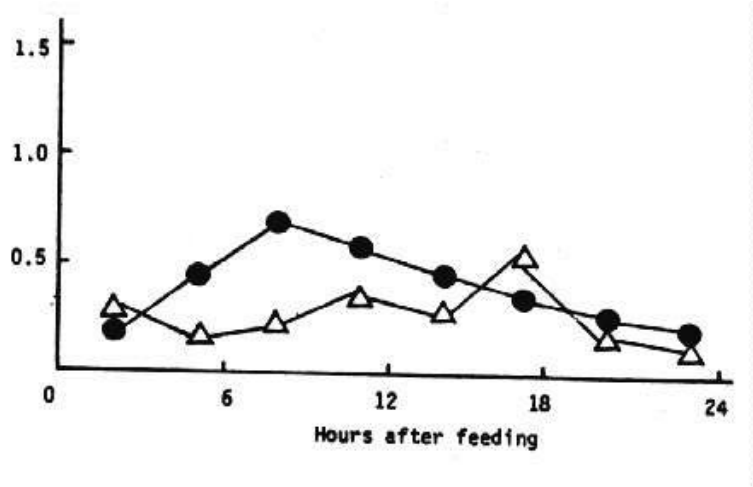


Table 3 :
Food intake and rumen digestion of starch by Zebu bulls given chopped whose sugar cane supplemented with wheat bran or cassava root meat

Supplement	Animal #	Food consumption k=(kg/d)[4]				Starch			
		Fresh cane [1]	Dry matter basis			Intake (g/d)	Abomasum		
			Cane	Supplement	Total		(%DM)	(g/d)	
Cassava root meal (0.75 kg/d)	7	6.7	1.64	0.67	2.31	550	0.20	8	98.8
	40	11.7	3.24	0.67	3.91	550	.0.28	5	99.3
	34[3]	11.1	2.56	0.67	3.23	550	-	-	-
Cassava root meal (1.5 kg/d)	7	8.9	2.21	1.34	4.55	1100	0.23	4	99.6
	40	11.5	3.06	1.34	4.40	1100	0.33	7	99.4
	34 [3]	-	-	1.34	-	1100	-	-	-
Wheat bran (1.0 kg/d)	7	10.7	2.96	0.91	3.87	202	0.42	8	99.1
	40	-	-	-	-	-	-	-	-
	34 [3]	10.2	2.72	0.91	3.63	202	-	-	-
Wheat bran (2.0 kg/d)	7	10.3	2.85	1.82	4.67	404	0.39	9	97.8
	40	10.3	2.54	1.82	4.36	404	0.26	6	93.0
	34 [3]	13.0	3.60	1.82	5.42	404	-	-	-

[1] Average intake day of, and day preceding sampling digesta
[2] Assuming 50% of degraded in rumen
[3] Cannulated in ileum
[4] For composition see Table 1

Rumen Digestion of Starch: Figures 2 to 5 show the concentration of starch in abomasal dry matter. With both cassava and wheat bran, concentrations were low. In Table 3, the rumen digestion of dietary starch has been calculated from the average abomasal concentration of starch with the assumption that 50% of the animals' dry matter intake was digested in the rumen - that is, flow post the abomasum were equal to the other 50%. Calculated in this way, the average rumen digestibilities of cassava and wheat starch were 99.3 and 98.6%. It is clear that even if the abomasal flow of dry matter was 70% of intake, the effect on the digestion value will be little changed (for example, that of animal #7 at the low level of cassava forage would change from 98.8 to 97.9%).

Thus the conclusion is that cassava and wheat bran starch are almost completely degraded in the rumen of animals receiving a sugar cane basal diet. Minor adjustments to the values obtained by using marker estimated flows will not alter this basic conclusion, and therefore we did not continue with the PEG determinations.

Figure 6:
Concentration of starch in ileal digesta of animal 34 when supplemented with 0.15 (△) or 1.5 (▲) kg/d dried cassava root

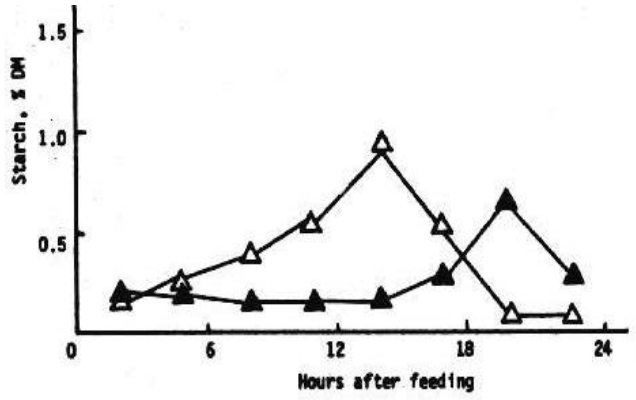
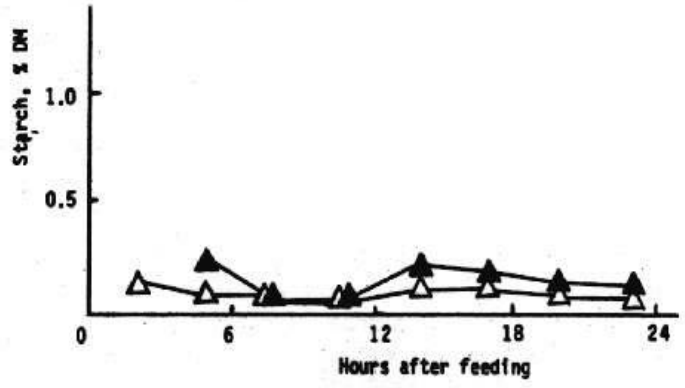


Figure 7:
Concentration of starch in ileal digesta of animal 34 when supplemented with 1.0 (△) or 2.0 (▲) kg/d wheat bran



Figures 6 and 7 show the concentration of starch in the ileal contents of animal #34. When given wheat bran this was very low, but when given cassava root meal, there was a distinct. peak at 14 and 20 h after feeding. This implies that the small proportion of cassava starch which escaped fermentation wee not very digestible in the small intestine - possibly it wee contained in small fibrous particles.

Conclusions

The rumen digestion of starch from wheat bran and cassava root is practically complete in the rumens of cattle receiving sugar cane.

References

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