GLUCOSE METABOLISM IN CATTLE ON SUGAR CANE BASED DIETS: THE PATTERN OF AVAILABILITY OF GLUCOSE IN CALVES SUCKLED ONCE A DAY[1]

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In order to determine the pattern of glucose availability to calves Buckled once tally, glucose entry rates were measured using isotope dilution procedures. Eight calves were given between 0 and 2.5 litres of milk tally from a bottle and (2- 3H) glucose was injected 15 min after consumption of the milk or 6.5 hr later. The major findings were that glucose entry rates and glucose concentrations increased significantly with level of milk consumption, immediately after feeding milk. Calves not given milk were hypoglycaemic in the early morning before they were given their ration of auger cane but there were no significant differences among the groups 6 hr later. Apparently there were no residual effects of supplying bypass nutrients in milk on glucose entry rates some 6.5 hr after the animals had hat their milk feet. m e results suggest that the supply of bypass nutrients in the diet should be timed to complement the supply of bypass nutrients in milk.

Key words: Sugar cane, suckled calves, oesophageal groove reflex, glucose metabolism, isotope dilution, bypass nutrients

Restricted suckling has been suggested (see Leng & Preston 1976; Preston 1977) as a means of supplying growing calves with bypass nutrients which are so critical for promoting appetite and therefore growth. Two systems of restricted suckling have evolved; one system depends on once a day milking followed by suckling, whereas the other one allows the animal to suckle twice a day following each milking (Gaya et al 1977). The calves in these systems normally have free access to sugar cane and, or molasses/urea. The supply of bypass nutrients, particularly the supply of essential amino acids and glucose or glucose precursors appears to be critical on this diet. In particular, glucose provided as a single meal may be less efficiently used than when supplied on a continuous basis since glucose is not readily stored in quantity in the body. Calves given more glucose (from the milk) than required over any time period may therefore necessarily oxidise the glucose. Glucose supplied in this way is used for oxidative purposes instead of being available for tissue synthesis.

In order to examine the pattern of availability of glucose in calves allowed to suckle once daily, glucose entry rates have been examined immediately following a milk feed and then 6 hr later when all nutrients from that feed should have been completely absorbed.

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[1] This work was supported in part with funds provided by the Organization of American States through the project Fondo Mar del Plato

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Materials and Methods

Calves: Friesian males about 3 mth of age and weighing between 70 and 90 kg were used. They were maintained on a basal diet of chopped sugar cane supplemented with urea, minerals and vitamins in the same proportion as used previously (see Preston et al 1976). The animals had been suckled on their dams, and for the experimental period were converted to bottle feeding and given between 0 and 3 litres of milk daily at 9 a.m. The calves had free access to the sugar cane mixture.

Experimental procedure: The day before an isotope experiment a cannula was placed in one jugular vein; on the day of the experiment the animals were given their milk ration at 10 a.m. and this was drunk almost immediately. (2-3H) glucose was injected at 10:15 a.m. and 4:30 p.m. Following injection 8 blood samples were taken at half hour intervals for up to 4 hr. The blood was immediately chilled and centrifuged, the plasma removed and stored at -15° until analysed.

Chemical methods: Glucose was estimated by the glucose oxidase method of Hugget and Nixon (1957) and the glucose was isolated as a pentsacetate derivative and its radioactivity determined by scintillation counting as previously described (Ferreiro et al 1978; Ravelo et al 1978).

Calculations: Calculations of the parameters of the dynamics of glucose metabolism were as described previously (Ravelo et al 1978).

Results

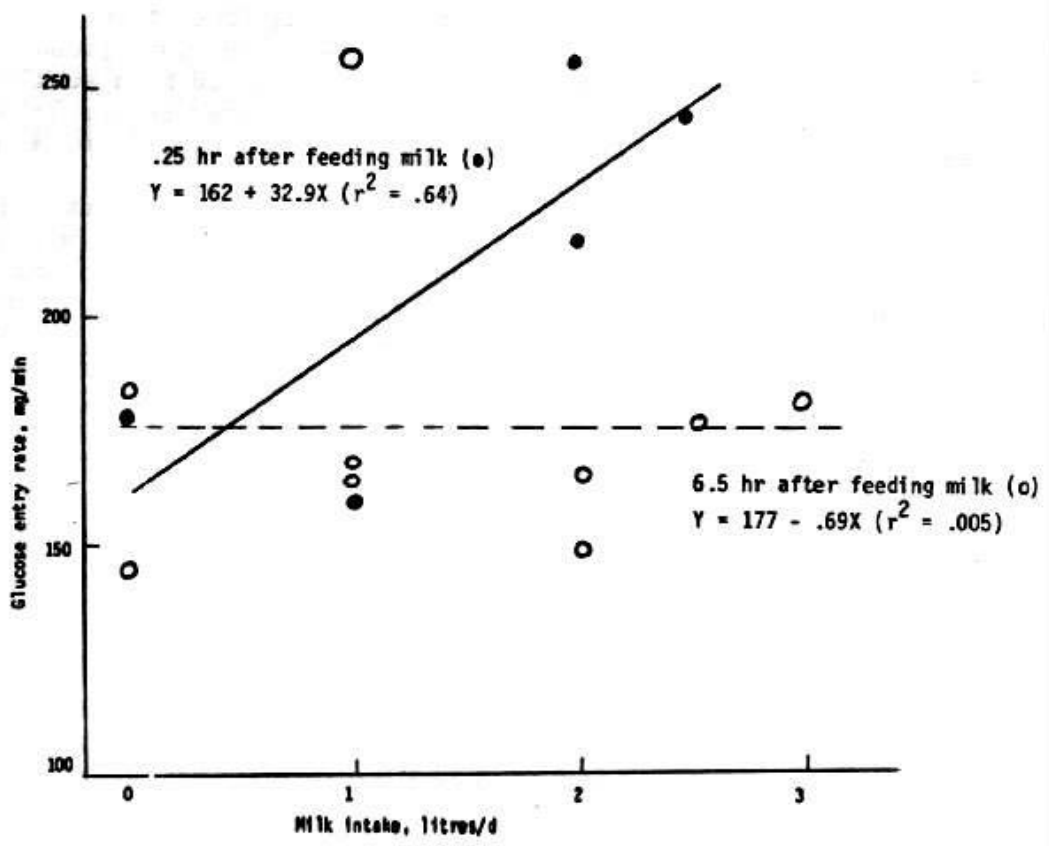
Mean values (2 animals/group) for parameters of glucose metabolism are given in table 1. There were obvious differences in glucose metabolism in the period 15 min to 4 hr after feeding as compared with 6.5 to 10.5 hr. In the period immediately after feeding there was a tendency for glucose entry rates to increase according to the level

Table 1:
Mean values (2 animals/treatment) for parameters of glucose metabolism in calves given sugar cane supplemented with milk. The calves were given access to sugar cane and given milk at about 10.30 a.m. and injected with (2-^{3}H) glucose at 10 15 am and 5.00 pm Average intake of sugar cane was 4kg/d.

Milk intake (litres/d)	Live weight (kg)	Injection time	Plasma glucose (mg/100 ml)	t1/2 (min)	Pool size		Space		Glucose entry rate	
					(g)	(mg/kg)	(litre)	(%LW)	(mg/min)	(mg/kg 0.75/min)
0	91	.25	54	91	24	237	40	40	179	5.7
		6.5	68	83	19	214	28	32	165	6.6
1	92.	.25	67	67	19	211	29	32	208	7.0
		6.5	72	86	21	225	29	32	166	5.7
2	87	.25	84	65	23	256	27	38	236	8.4
		6.5	74	97	22	252	30	28	157	5.5
2.5	92	.25	84	72	25	276	30	33	244	8. 2
		6.5	65	59	15	163	22	25	176	5.9

**We are grateful to the Instituto de Energia Nuclear, Mexico for the determination of radioactivity the penta-acetate derivatives*

Figure 1:
Relation between glucose entry rate and level of milk intake in calves fed sugar cane/urea (Probability of significance of difference between slopes of lines is P<.12)



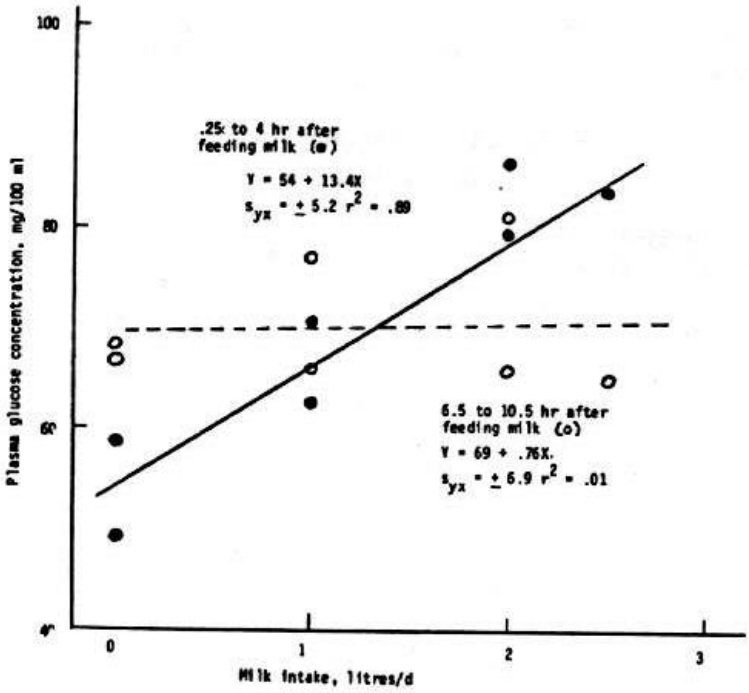
of milk given (figure 1) and this was reflected in a significant linear relationship between plasma glucose concentration and milk intake (figure 2). The calves not given milk (controls) were hypoglycaemic in the morning immediately prior to receiving their morning feed of fresh sugar cane. Between 6 and 10.5 hr after feeding, the level of milk intake of the calves had no effect on plasma glucose concentration or glucose entry rate.

When plasma glucose concentration was plotted against glucose entry rate for both periods after feeding in all animals, there were obviously two distinct groups of data which precluded the use of regression analysis. However it was fairly obvious that at high glucose entry rates, plasma glucose concentration had been increased (figure 3).

Discussion

As might be expected, glucose entry rates in the calves were increased immediately after ingestion of milk. The values tended to reflect the amounts of milk given and, therefore, at the levels of milk provided, this suggests no apparent limitation to glucose absorption.

Figure 2: Relationship between plasma glucose concentration and milk intake



Calculations indicated that over the 4 hr period fallowing milk feeding about 8 g of extra glucose was made available to the animal for each litre of milk consumed which contained about 32% of lactose. Apparently all the glucose from the milk lactose was absorbed within 6.5 hr following ingestion of milk since the glucose entry rates were similar in all animals after that time. This result probably indicates that the glucose absorbed was depressing gluconeogenesis. This has been observed where glucose has been supplied by intravenous infusions (see for review Leng 1970).

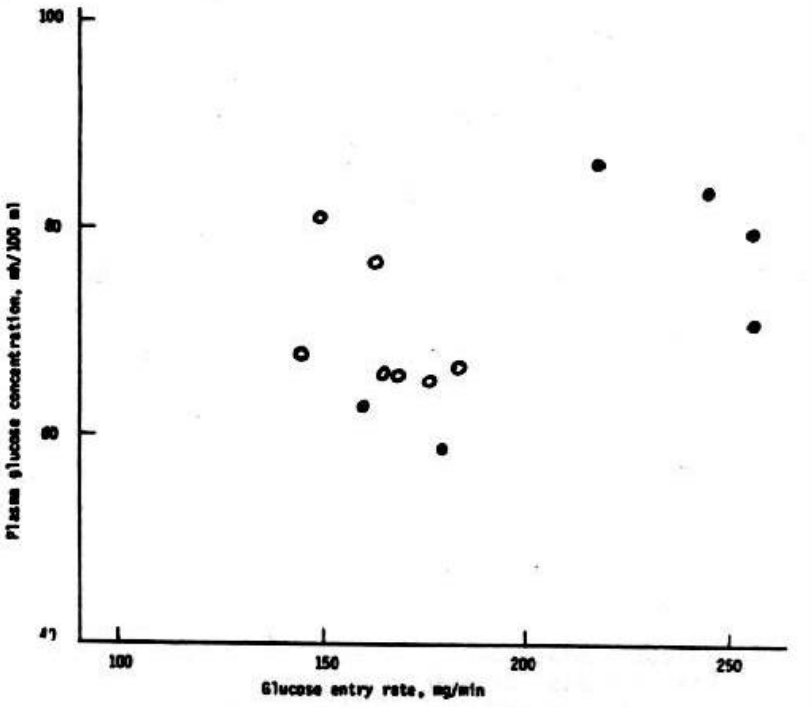
Glucose from the digestive tract might have inhibited mobilization of body reserves since the hypoglycaeria in the control calves at that time indicated difficulties in obtaining sufficient glucose precursors.

The results show that in the period 6.10 hr after milk feeding there were no carry-over effects of the milk feed on any aspect of glucose metabolism. This indicates that the effects of giving glucose precursors in this way were of a short term nature.

It appears therefore that feeding strategies should be aimed at providing more bypass nutrients (from supplements other than milk) at times which will complement the supply of bypass nutrients from milk. In other words if suckling take place in the morning then the supplement should be given in the afternoon.

In this experiment the milk feeds were given from a bottle in order to simulate as closely as possible the effect of natural suckling. It must be emphasized that giving milk by bucket feeding may not have the same effects. It is known that there can be a considerable spillage into the rumen by non activation of the oesphogeal groove reflex.

Figure 3:
Relationship between plasma glucose concentration and glucose entry rate (•) samples taken from .25 to 4hr after feeding milk (○) samples taken from 6.5 to 10 hr after feeding milk



The control animals, which did not receive milk, were not able to maintain their plasma glucose levels during the night when the only feed available was the sugar cane which had been offered some 16 to 24 hr previously. This indicates that these animals had difficulty in maintaining their plasma glucose concentration when given only sugar cane and stresses the importance of milk feeding after voluntary overnight fasting.

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Received 20 March 1978