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Sucrose and Glucose Tolerance in Depancreatized Dogs.

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It is ordinarily assumed that sucrose in the diet of the diabetic produces exactly, gram for gram, the same effects as glucose. Thus in figuring the CHO content of a diet one makes no distinction between these two sugars. The work to be reported in this paper was instituted to determine whether this assumption is valid or not. The method used was essentially that of determining the comparative amounts of the two sugars that have to be administered to maintain a constant normal blood sugar in a depancreatized dog after the same amounts of insulin.[1]

On the morning of the experiment 2 or so units of insulin* were given intravenously; the purpose of this was to bring the blood sugar level to normal. Five or 6 hours after this first injection, by which time its activity had largely worn off but when the blood sugar was within normal limits, the determination proper was started.

Insulin for the determination proper was either given in one large dose (10 units), or by constant intravenous injection at a rate of about one unit per hour. Glucose and sucrose were given in amounts just sufficient to balance the activity of the insulin; in other words, to keep the blood sugar at a constant normal level. Blood sugar determinations were run every half hour in order to guide the adjustments in the amounts of sugar administered. Glucose was given either intravenously or by mouth, sucrose always by mouth.

Table I gives the results of the experiment. These figures show clearly that considerably greater amounts of sucrose than glucose can be taken with the same amounts of insulin. A possible cause of the difference between the two sugars might lie in the difference of absorption rates of them by the intestine. Since sucrose must first be inverted by digestive ferments, it might be claimed that its absorption is delayed; that it does not get into the circulation soon after feeding by mouth. A large portion of what is eaten might remain for some hours in the intestine, really piling up there and not acting to balance the insulin in the body. We have

[1] Greeley, P. O., Bergman, H. C., Tyler, D. B., and Drury, D. R., PROC. SOC. EXP. BIOL. AND MED., 1936, **34**, 121.

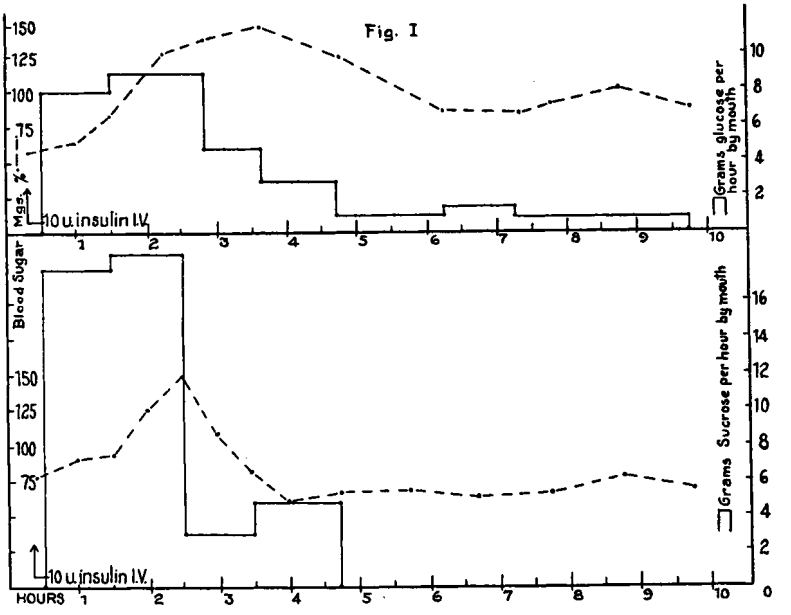
* The insulin used in this work was contributed by the Eli Lilly Company.

TABLE I.

Dog and date	Insulin per hr	Duration of run, hr	Type of sugar	Route	Total amt sugar given, g
	Results with Continuous Injection of Insulin.				
P 3-25-36	1.03	8	glucose	I.V.	30.5
P 4-20-36	1.03	8	sucrose	*Per os*	75
B 2-14-36	1.12	6.5	glucose	I.V.	31
B 3-14-36	1.12	6.5	sucrose	*Per os*	80
B 1-31-36	1.12	6.5	"	"	134
T 4-4-36	1.09	9	glucose	"	48
T 3-18-36	1.09	9	sucrose	"	96
T 3-21-36	1.09	9	"	"	94
	Results with One Large Dose (10 units) I.V.				
T 5-16-36		9	glucose	*Per os*	32
T 5-4-36		9	sucrose	"	53
R 3-14-39		7	glucose	"	10
R 3-31-39		7	sucrose	"	22

much evidence to present against this view. In the experiments in which insulin was given by constant injection, if the sucrose fed during the first hours were not rapidly absorbed it would pile up in the intestine and less and less would have to be given to balance the insulin as the experiment progressed. This was not the case, however. It was found that either a constant amount had to be given, or that this had to be increased somewhat as the experiment progressed, and behaved just like glucose in this respect. In one sucrose experiment, the feeding was stopped after 9 hours in order to see if there was enough sugar in the intestine to keep the blood sugar up. At the time of the last feeding the blood sugar was 115, after half an hour it was 100, and after one hour it was 71. This indicates that a half hour after the last feeding very little sucrose remained in the intestine.

Fig. 1 illustrates another type of experiment which indicates the same thing. This shows the results on the same dog on 2 different days after the injection of 10 units of insulin. In the upper chart, the insulin was balanced with glucose by mouth. In the sucrose experiment (lower figure), a large amount was fed the first 2 hours so that the blood sugar rose somewhat. The amount was then greatly diminished, the blood sugar promptly fell and remained at hypoglycemic levels for the rest of the run. If any appreciable amount of sucrose had remained in the intestine after the second hour it would have been absorbed in corresponding amounts at this time, and the blood sugar level would have continued to rise as it did during this period in the upper chart. Likewise, if any large amount had remained in the intestine after the fifth hour, it would have



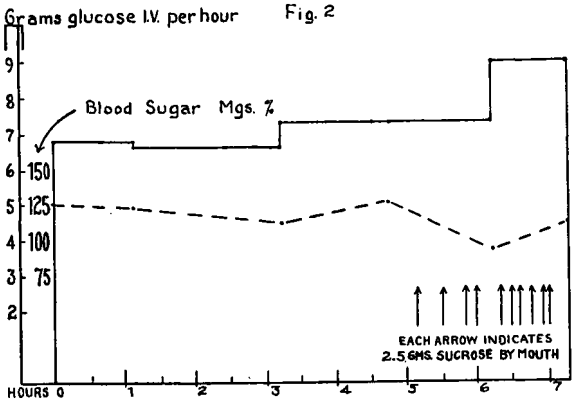
Blood sugar curves after administration of 10 units insulin. The blood sugar had been brought down by a small I.V. dose of insulin given 4 hours previously. In the upper chart the insulin activity is balanced by glucose, in the lower by sucrose. Comparison of the 2 charts shows that the large amount of sucrose given in the first 2 hours must have been absorbed very rapidly and did not leave a residue in the intestine to be absorbed in the later hours.

been absorbed in amounts sufficient to raise the blood sugar from hypoglycemic levels since, as may be seen from the upper chart, the blood sugar was kept at a normal constant level by giving such a small amount as one gram per hour.

In the case of B 3-14-36, the animal was put in a metabolism cage at the end of the experiment. Although it had taken 80 g of sucrose during the day (compared with 40 for glucose) the urine passed during the next 12 hours contained only 1.9 g glucose, an amount readily attributable to the fact that the animal had not received the fasting basal insulin during this time.[2] If the difference between glucose and sucrose were to be explained by the slow absorption of the latter and if in this experiment the 40 g extra sucrose were still in the intestine at the end of the run, it would have been absorbed during the next 12 hours and since the animal received no insulin during this time it would have been flooded with sugar.

Fig. 2 shows the effect of sucrose feeding superimposed upon an

[2] Greeley, P. O., *Am. J. Physiol.*, 1937, **120**, 345.



Shows effect of feeding sucrose to a depancreatized dog in which constant intravenous insulin is balanced by constant intravenous glucose. The animal received 1.12 units insulin per hour throughout. The injection of insulin at this rate and of the balancing glucose was started 5 hours before the 0 hour of the chart.

animal in which insulin activity is balanced with intravenous glucose. This animal received 1.12 units insulin per hour throughout the experiment. During the first 5 hours the insulin activity is balanced by intravenous injection of 7 g glucose per hour. Then during a period of an hour and a half this rate is maintained, but in addition 10 g of sucrose is given by mouth. The blood sugar showed a sharp drop. Even with an increase in the rate of intravenous injection to 9 g of glucose per hour with 15 g sucrose by mouth the blood sugar does not rise to the level it was when the sucrose feeding was started. The urine passed during the next 9 hours contained only 0.7 g of glucose, an amount again attributable to the fact that the dog did not receive its fasting basal insulin during this time.

Conclusion. Definitely more sucrose than glucose can be tolerated in depancreatized dogs with the same dose of insulin.