COMPARATIVE EVALUATION OF GLUCOSE AND ARABINOSE ABSORPTION IN THE DIGESTIVE TRACT OF HEALTHY ANIMALS AND IN EXPERIMENTAL DIABETES

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It has been known since the studies of Cori [4] that in the digestive tract the hexoses, galactose and glucose, are most intensively, and the pentoses least of all, absorbed. Cori's explanation of this was that galactose and glucose are subjected in the intestinal mucous membrane to phosphorylation, whereas the pentoses are assimilated mainly as a result of simple diffusion. This point of view is in accordance with the findings of many research workers on the acceleration of glucose absorption in the intestine under the influence of injections of insulin, a hormone activating the phosphorylation of sugars in the organism [2-4]. On this basis, retarded hexose absorption might be expected in diabetes mellitus. However, literature data on this are scarce and contradictory. Published observations indicate both inhibition [6] and acceleration [1] of glucose absorption in that disorder, and also the absence of disturbance in this process, at least as regards galactose [7].

The scant attention given to the study of this problem prompted us to make studies; the aims of which were to compare monose absorption in healthy animals and in animals with diabetes. For this purpose were chosen glucose, which is subjected in the intestine to active absorption as a result of phosphorylation, and arabinose, a pentose the absorption of which is determined mainly by its concentration in the digestive tract.

EXPERIMENTAL METHODS

There were 2 series of experiments. In the first series there were 38 trials on 10 dogs (an angiostomy cannula was applied to the portal vein); 7 dogs were healthy and 3 were depancreatized at the time the angiostomy cannula was applied. The trials began 6-7 days after the operation with complete healing of the operation wound. During the investigations the blood sugar in the depancreatized dogs was from 131 to 304 mg %. The portal vein was punctured and blood was taken for analysis before and 30, 60, and 75 min after administration of the sugars with the food. The nutritive loads were 30% solutions of glucose and arabinose at the rate of 3 g per kg liveweight.

The second series of trials was on 30 rats; 15 animals were healthy and in 15 diabetes had been produced by subcutaneous injection of alloxan (blood sugar during the investigations was from 177 to 354 mg %). The experiments were conducted according to the method of Verzar [8]. In conditions of thiopental narcosis laparotomies were performed on the rats. The intestine was tied with a ligature in the first part of the duodenum and washed with a few milliliters of physiological solution. The residues of the physiological solution was removed by air into the large intestine after which a second ligature was applied on the boundary between the small and large intestines. A 5% solution of glucose or arabinose at the rate of 200 mg sugar per 100 g liveweight was injected into the intestine.. The exact sugar content of the injected solution was measured. After 30 min the intestine was cut open, its contents were collected in graduated test tubes and the amount of fluid drawn off and the monosaccharide concentration were estimated. The difference in the amounts of sugar injected and extracted was calculated. The absorption value was expressed in mg absorbed sugar per 100 g liveweight of the rat. The concentration of the test sugars was estimated in all cases by the method of Frank and Kirberger [5].

TABLE 1. Glucose and Arabinose Contents of Portal Vein Blood of Healthy and Depancreatized Dogs after a Nutritive Load of Glucose and Arabinose (M ± m)

Test group	No. of trials	Substance administered	Monosaccharide content (in mg %)				Hyperglycemic coefficient
			initial	after loading			
				after 30 min	after 60 min	after 75 min	
Healthy dogs	15	Glucose	108 ±8 (100)	169 ±8 (157)	151 ±5 (140)	100 ±5 (93)	1.72 ±0.12
Depancreatized dogs	11	"	197 ±20 (100)	278 ±15 (139)	246 ±18 (120)	203 ±21 (103)	1.41 ±0.04
Healthy dogs	6	Arabinose	0	47 ±5	19 ±4	0	–
Depancreatized dogs	6	"	0	58 ±7	24 ±6	0	–

TABLE 2. Absorption of Glucose and Arabinose from the Intestine of Healthy Rats and Rats with Alloxan-Induced Diabetes (M ±m)

Test group	No. of trials	Substance administered	Absorbed in 30 min (in mg per 100 g liveweight)
Rats, healthy	10	Glucose	131 ±6
" with diabetes	10	"	69 ±8
" healthy	5	Arabinose	116 ±9
" with diabetes	5	"	105 ±10

EXPERIMENTAL RESULTS

Table 1 presents results of trials on healthy and depancreatized dogs. As follows from Table 1, 30 min after administration of glucose with the food there was a significant increase in the concentration of that monosaccharide in blood from the portal vein (on average 57%), falling to initial values by after 75 min. The extent of the increase in the glucose content of portal vein blood was also characterized by the value of the hyperglycemic coefficient, the ratio of the maximum glucose concentration during the study to its initial value, which in healthy dogs was 1.72. In the trials on depancreatized dogs the maximal increase in blood glucose concentration was on average not more than 39%. The hyperglycemic coefficient was also correspondingly lower, 1.41 ($P < 0.05$). Thus, it could be assumed that in depancreatized animals entry of glucose into the portal vein blood from the intestine is inhibited.

It should, however, be kept in mind that the angiostomy method does not permit complete quantitative evaluation of the intensity of absorption, as the volume of the blood circulating in the portal vein is not taken into account. In connection with this, the investigations were supplemented with experiments carried out according to Verzar's method (Table 2).

As is shown, these experiments gave similar results: the amount of glucose absorbed in 30 min from the intestine of rats with diabetes was significantly less than in healthy animals ($P < 0.001$).

These features were not noted with regard to arabinose absorption. In depancreatized dogs the increase in the level of arabinose in portal vein blood 30 and 60 min after nutritive loading was just as good as that in healthy animals (see Table 1).

No statistically significant difference was detected between the amount of arabinose absorbed in 30 min in rats with alloxan-induced diabetes and the corresponding amount in healthy animals (see Table 2).

The findings presented show that in insulin deficiency there are selective disturbances in the absorption of glucose from the digestive tract. This also indicates that insulin is necessary to ensure a specific degree of permeability of the intestinal epithelial membranes for glucose.

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