

# Level of Plasma Amino Acids in Eviscerate Rats Given Glucose and Fructose with and without Insulin

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This is one of a series of studies on the effect of hormones upon protein metabolism in the eviscerate rat. Insulin causes a temporary decrease in the level of plasma amino acids (PAA) in the eviscerate rat and suppresses the rate of increase in PAA.<sup>1</sup> How do this and other effects of insulin upon protein metabolism relate to the action of insulin upon carbohydrate utilization? If the changes in protein metabolism are secondary to a primary action of insulin upon the utilization of carbohydrate it should be possible to suppress the rise in PAA in the eviscerate rat by enhancing the utilization of carbohydrate by other means. There is some evidence that fructose is well utilized in the absence of insulin, and it is commonly believed that insulin does not affect the utilization of fructose. In the present experiments we have tested the hypothesis that fructose might suppress the rise in PAA following evisceration. The results are negative.

## METHODS

Male rats of the Sprague-Dawley strain weighing  $250 \pm 5$  gm. were fed Rockland rat diet. Nonfasted rats were anesthetized (intraperitoneal injection of 18 mg. of cyclopentenyl<sup>1</sup>-allylbarbituric acid sodium) and functionally eviscerated by the technic of Russell,<sup>2</sup> the gut being removed, but the liver remaining *in situ* after its arterial and portal vessels were ligated. The kidneys and adrenal glands remained intact. Continuous intravenous infusions of solutions of glucose or fructose with or without regular insulin (Lilly) were made by the method of Ingle, Prestrud and Nezamis.<sup>3</sup> The fluid was delivered into the saphenous vein of the right hind leg at the rate of 20 ml. per 24 hours per rat. Six rats were infused at a time so that rats receiving glucose and rats receiving fructose were compared simultaneously. All infusions were for a period of three hours beginning immediately following evisceration.

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At the end of the infusion period the blood was drained from the abdominal aorta by cannula. Heparin was used as an anticoagulant. The level of plasma amino acids (PAA) was determined by the method of Hamilton and Van Slyke<sup>4</sup> and the level of reducing substances in whole blood by the blood glucose method of Miller and Van Slyke.<sup>5</sup>

## RESULTS

The conditions of the experiments and data are summarized in table 1. The level of PAA was affected by insulin and was not significantly changed when fructose was substituted for glucose. Insulin suppressed the level of reducing substances in blood under all of the conditions studied here.

## DISCUSSION

In the absence of insulin the values for reducing substances in blood were lower when fructose was administered than when an equal load of glucose was given. In the presence of insulin the level of reducing substances in blood was depressed to a lower level when glucose was given than when an equal load of fructose was given. Since a method specific for fructose was not used, it is not possible to know the extent to which the changes in levels of reducing substances represent exogenous fructose or endogenous glucose. It seems probable that fructose is better tolerated by the eviscerate rat without insulin than is glucose, and that insulin has a smaller effect upon fructose tolerance than upon glucose tolerance.

The effect of insulin upon the level of the reducing sugars of blood was striking in eviscerate rats given either glucose or fructose, but this does not prove that insulin affected the metabolism of fructose. The apparent effect in the rats given fructose may have been due solely to accelerated disappearance of the endogenous glucose present in the extracellular fluids at the time of evisceration.

It is clear that the administration of fructose without insulin to the eviscerate rat does not suppress the rise in PAA, although greater amounts of reducing sugars

TABLE 1

Level of Plasma Amino Acids (PAA) and Reducing Substances (RS) of Whole Blood Three Hours Following Evisceration Averages and Standard Errors

Carbohydrate* load mg./100/h	units insulin 24 hrs.	glucose			fructose		
		N rats	RS	PAA	N rats	RS	PAA
16	0	16	190± 6.58	8.56±0.27	16	137± 9.45	8.45±0.14
25	0	9	209± 16.02	7.72±0.26	9	187± 13.1	8.17±0.26
25	16	9	40± 4.41	2.93±0.86	9	65± 4.83	3.01±0.19
40	0	9	306± 13.8	7.16±0.44	9	220± 3.28	7.54±0.32
40	16	9	55± 4.21	3.12±0.11	9	87± 3.13	2.95±0.07
60	0	9	416± 8.12	8.51±0.27	9	268± 4.20	8.00±0.29
60	16	9	85± 9.52	3.39±0.12	9	146± 6.60	3.09±0.15

\*The carbohydrate load is expressed as milligrams per 100 gm. of rat per hour.

disappear from the blood than when glucose without insulin is given. In other experiments<sup>6, 8</sup> we have shown that acceleration of glucose utilization by muscle work does not simulate the action of insulin upon PAA, nor is the rise in PAA affected by glucose load even in the absence of insulin.<sup>7</sup>

## SUMMARY

Insulin suppresses the rise of plasma amino acids in the eviscerate rat. One hypothesis as to how the effects of insulin upon the metabolism of carbohydrate and protein are related holds that insulin stimulates the utilization of carbohydrate to meet energy requirements, thereby averting the need to catabolize protein, and also supplies the energy needed for protein synthesis.

It has been claimed that fructose is better utilized than glucose in the absence of insulin. The possibility that fructose would substitute for insulin in suppressing the rise in plasma amino acids was tested in the present experiments. Functionally eviscerated rats were given continuous intravenous infusions of either glucose or fructose with and without insulin for a period of three hours. The level of plasma amino acids was suppressed by insulin, but was not significantly changed when fructose was substituted for glucose.

## SUMMARIO IN INTERLINGUA

*Le Nivello del Amino-Acidos Plasmatic in Rattos Eviscerate, Recipiente Glucosa e Fructosa con e sin Insulina*

Insulina supprime le augmento de amino-acidos plasmatic in rattos eviscerate. Un del hypotheses in re le interrelation del effectos de insulina super le metabolismo de hydratos de carbon e super le metabolismo de proteina stipula que insulina stimula le utilisation de hydrato de

carbon in responsa al requirimentos de energia e assi evita le necessitate de catabolisar proteina e in plus provide le energia requirite pro le synthese de proteina.

Il ha essite asserite que fructosa es melio utilisate que glucosa in le absentia de insulina. Le possibilitate que fructosa pote ager como substituto de insulina in supprimer le elevation del amino-acidos plasmatic esseva investigate per le experimentos hic reportate. Functionalmente eviscerate rattos recipeva continue infusiones intravenose de glucosa o de fructosa con e sin insulina pro un periodo de tres horas. Le nivello del amino-acidos plasmatic esseva supprimate per insulina sed non esseva significativamente alterate quando fructosa esseva substituite pro glucosa.

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