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Effect of Fructose, Leucine and Prefeeding of Sucrose on Transport of Nutrients

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Effect of fructose and leucine (5 and 20 mM) has been observed separately on transport of glucose, xylose, glycine, leucine and tyrosine (2.5 mM) in two teleost fishes of different feeding habits, carnivorous *Ophiocephalus punctatus* and omnivorous *Heteropneustes fossilis.* Addition of the nutrient was made at 30 min stage and its effect was observed at 35, 40, 50 and 60 min intervals. Fructose stimulated amino acid transport while in all other cases the uptake decreased being greater in more rapidly absorbable substances. Sucrose prefeeding also inhibited the transport rate of glucose and leucine in both fishes.

The characteristics of absorption of amino acids or sugars or mixture of the two often show different trends. Methods for distinguishing amino acid or sugar transport systems in a given cell or tissue have come to rely almost exclusively on mutual inhibition studies. Interactions for intestinal absorption between the dibasic amino acid group and monosaccharides have been reported (17); studies on the action of sugars on neutral amino acid transport have been more widespread (1); whereas the effect of neutral amino acid on neutral amino acid transport and that of monosaccharide on the transport of other monosaccharide are much less known. Very little consideration has been given to intestinal preconditioning. KERSHAM *et al.* (9) found that if rats are fed a restricted diet there is a striking increase in the rates of absorption of L-histidine and glucose. REISER *et al.* (15) studied the effect of fed sucrose to the rats on transport of monosaccharides. In the present investigation all of these factors have been tested in two teleost fishes of different feeding habits.

Materials and Methods

The fishes of almost equal size (20 cm in length and 75 g in weight in case of *Ophiocephalus punctatus* and 20 cm in length and 40 g in weight in *Heteropneustes fossilis*) were starved for 48 h to clear off the alimentary canal from any food material. After anesthetizing the fishes with solvent ether, they were

Table I. *Effect of fructose on intestinal transport of sugars and amino acids (2.5 mM).* ($P < 0.05$).

Fructose (mM)	Transport (μ moles/g/h)							
	«Ophiocephalus punctatus»				«Heteropneustes fossilis»			
	a. Glucose	b. Xylose	c. Glycine	d. Leucine	e. Glucose	f. Xylose	g. Glycine	h. Leucine
Nil	48.7±3.2	27.5±3.1	24.3±2.4	18.8±1.8	93.2±7.2	40.7±3.3	28.6±2.8	27.5±2.6
5.0	42.4±3.4	22.2±2.6	27.4±2.3	20.6±1.7	85.5±6.4	32.3±3.8	31.4±2.6	30.7±2.6
20.0	28.6±3.1	11.7±1.1	31.3±2.5	25.8±1.9	63.4±5.1	25.7±2.7	38.8±2.8	39.0±3.1

t (Sig. diff.)
2a, 3a*
2b, 3b*
2c, 3c
2d, 3d
2e, 3e*
2f, 3f
2g, 3g
2h, 3h

* Significant; other insignificant.
«a» to «h» words indicates the different nutrients in the column «t sig. diff.» which are mentioned adjacent to these words respectively.

Table II. *Effect of leucine on intestinal transport of sugars and amino acids (2.5 mM).*

Leucine (mM)	Transport (μ moles/g/h)							
	«Ophiocephalus punctatus»				«Heteropneustes fossilis»			
	a. Glucose	b. Xylose	c. Glycine	d. Tyrosine	e. Glucose	f. Xylose	g. Glycine	h.Tyrosine
Nil	48.7±3.2	27.5±3.1	24.3±2.4	13.7±1.5	93.2±7.2	40.7±3.3	28.6±2.8	18.0±1.7
5.0	41.5±3.8	23.3±2.4	20.4±1.7	11.5±1.2	86.6±6.4	34.8±2.8	25.1±2.1	16.2±1.8
20.0	26.1±2.3	15.6±1.7	14.3±1.4	7.4±0.6	62.5±5.7	23.4±2.2	18.2±1.8	12.3±0.9

t (Sig. diff.)
2a, 3a*
2b, 3b*
2c, 3c
2d, 3d*
2e, 3e*
2f, 3f*
2g, 3g*
2h, 3h

* Significant; other insignificant ($P < 0.05$).
«a» to «h» words indicates the different nutrients in the column «t sig. diff.» which are mentioned adjacent to these words respectively.

Table III. *Effect of sucrose prefeeding on transport of glucose and leucine (2.5 mM).* ($P < 0.05$).

Fed with	Transport (μ moles/g/h)				t (sig. diff.)
	«Ophiocephalus punctatus»		«Heteropneustes fossilis»		
	a. Glucose	b. Leucine	c. Glucose	d. Leucine	
1. Nil	48.7±3.2	18.8±1.8	93.2±7.2	25.7±2.6	1a, 2a* 1b, 2b*
2. Sucrose	29.5±2.3	11.4±0.9	65.7±4.8	18.8±1.8	1c, 2c* 1d, 2d*

* Significant.
«a» to «d» words indicates the different nutrients in the column «t sig. diff.» which are mentioned adjacent to these words respectively.

dissected and the intestine was washed thoroughly with Kreb's Ringer bicarbonate (KRB) solution and only one sac was prepared from it *in vivo* according to MUSACCHIA and BRAMANATE (11). In order to observe the effect of two different concentrations (5 and 20 mM) of fructose or leucine on transport of glucose, xylose, glycine and leucine (2.5 mM), and glucose, xylose, glycine and tyrosine (2.5 mM) respectively, two batches of control and experimental fishes were run side by side. In case of control fishes, the transport rate was determined separately for each nutrient according to SASTRY and GARG (18). But in experimental fishes, 5 or 20 mM concentration of fructose or leucine was made in KRB solution in addition to the concentration of the previous nutrient. Then transport rate was determined and compared with control ones. To observe the effect of prefeeding of sucrose on transport of glucose and leucine, another two batches of control and experimental fishes were run. The experimental fishes were orally fed with 50 mg sucrose tablet daily for five days. Then the transport rate of glucose and leucine was determined after two h of feeding on last day, as mentioned above. All the experiments were repeated thrice in each case at 28 ± 2.5° C.

Results

When fructose of 5 mM concentration was added in the solution of glucose or xylose, it inhibited their uptake while the transport rate of glycine and leucine was increased by its addition in both fishes. On raising fructose concentration up to 20 mM, there was comparatively more inhibition in sugar transport while a corresponding increase was noted in the transport of amino acids. Overall, higher concentration of fructose was more effective than the lower concentration.

At both the concentrations of leucine, inhibition in transport of glucose, xylose, glycine and tyrosine have been noted in both the fishes. However, the effect was more marked at 20 mM concentration. The inhibition was more in glucose uptake than that of xylose. In case of amino acids, the uptake of glycine was appreciably inhibited.

Sucrose prefeeding brought a significant decrease in the transport of glucose and leucine. However, the effect was more marked in the case of glucose.

Discussion

REISER and CHRISTIANSEN (13) claim that glucose actually stimulates amino acid transport. The present investigation also shows the stimulation in amino acid transport in the presence of fructose. REISER and CHRISTIANSEN (14) also observed that fructose activated leucine uptake. The mechanism by which fructose activates glycine uptake has not been elucidated. ALVARADO (2) has shown that hamster intestine preincubated with fructose, will stimulate cycloleucine transport from a fructose free medium. REISER *et al.* (15) observed that intracellular as well as extracellular fructose stimulates leucine transport. Inhibition of sugar transport by amino acids has been noted here in both the fishes. Similar results have been demonstrated *in vivo* by BOLUFER *et al.* (4) and *in vitro*, by ALVARADO (3).

The absorption characteristics of sugar, administered separately and as a mixture, often differ; the same is true for amino acids also. The inhibition of the absorption of one sugar by the presence of another sugar or of one amino acid by another amino acid, suggests that the two sugars or two amino acids share a common transport system. The results of the present investigation on neutral amino acid transport agree with published data of FEARON and BIRD (6). HERZBERG *et al.* (8) investigated competition among cationic amino acids. The active transport of L-amino acids by the mammalian intestine and the interactions between individual compounds have been studied by MUNCK and SCHULTZ (10). On the other side, ROBINSON and FELBER (16) found that L-arginine uptake could be stimulated by the presence of a variety of neutral amino acids. Recently, DEBNAVE and LEVIN (5) reported the effect of specific dietary sugars on the transport of other sugar and gave their view in support of multiple sugar carriers. However, in contrast to slowly absorbable substances, more rapidly absorbable substances are effected more.

Prefeeding the fishes with sucrose diet, inhibited the transport of glucose and leucine. REISER *et al.* (15) have shown that after 5 min of incubation, sucrose was hydrolysed by the intestinal cells. A similar rate of sucrose hydrolysis may be present in teleost fishes which could produce, glucose and fructose. GRAY and INGELFINGER (7) also observed that sucrose digestion may produce varying local concentrations of luminal glucose and fructose. This liberated fructose was not able to stimulate the transport of leucine while glucose could inhibit transport of leucine. Similarly, due to the additional quantity of hydrolysed glucose, glucose transport process becomes less active. Inhibition by sucrose may be the result of a specific property of a disaccharide transport system (12).

Resumen

Se estudia el efecto por separado de la fructosa y la leucina (5 a 20 mM) sobre el transporte de glucosa, xilosa, glicina, leucina y tirosina (2,5 mM) en dos peces teleósteos de diferentes hábitos de alimentación, el *Ophiocephalus punctatus*, carnívoro, y el *Heteropneustes fossilis*, omnívoro. La adición del nutriente se hizo a los 30 min y se observó su efecto a intervalos de 35, 40 y 60 min. La fructosa estimuló el transporte del aminoácido, mientras que en todos los otros casos el consumo descendió, siendo éste mayor en las sustancias más rápidamente absorbibles. La prealimentación con sacarosa también inhibió el ritmo de transporte de la glucosa y de la leucina en ambos peces.

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References

1. ALVARADO, F.: *Science*, **151**, 1010-1012, 1966.
2. ALVARADO, F.: *Nature*, **219**, 276-277, 1968.
3. ALVARADO, F.: In «Intestinal transport of electrolytes, amino acids and sugars». C. C. Thomas, Springfield. III, 281-318, 1971.

4. BOLUFER, J., RARRALDE, J. and PONZ, F.: *Rev. esp. Fisiol.*, **30**, 111-118, 1974.

5. DEBNAVE, G. S. and LEVIN, R. J.: *Gut.*, **17**, 92-99, 1976.

6. FEARON, J. R. and BIRD, F. H.: *J. Nutr.*, **93**, 198-202, 1967.

7. GRAY, G. M. and INGELFINGER, F. J.: *J. Clin. Invest.*, **45**, 388-398, 1966.

8. HERZBERG, G. R., SHEERIN, H. E. and LERNER, J.: *Comp. Biochem. Physiol.*, **40**, 229-235, 1971.

9. KERSHAM, T. G., NEAME, K. D. and WISEMAN, G.: *J. Physiol.*, **152**, 182-185, 1960.

10. MUNCK, B. G. and SCHULTZ, S. G.: *Biochem. Biophys. Acta*, **183**, 182-193, 1969.

11. MUSACCHIA, X. J. and BRAMANATE, A. Y.: Proc. 3rd internat. symp. mammalian hibernation. Oliver and Boyd, Edinburgh, 15-19, 1967.

12. RAMASWAMY, K., MALATHI, P., CASPARY, W. F. and CRANE, R. K.: *Biochim. Biophys. Acta*, **345**, 39-46, 1974.

13. REISER, S. and CHRISTIANSEN, P. A.: *Biochim. Biophys. Acta*, **183**, 611-624, 1969.

14. REISER, S. and CHRISTIANSEN, P. A.: *Amer. J. Physiol.*, **216**, 914-924, 1971.

15. REISER, S., MICHAELIS, O. E. and HALLFRISCH, J.: *Proc. Soc. Exp. Biol. Med.*, **150**, 110-114, 1975.

16. ROBINSON, J. W. L. and FELBER, J. P.: *Gastroenterologia*, **101**, 330-338, 1964.

17. ROBINSON, J. W. L. and FELBER, J. P.: *Biochem. Z.*, **343**, 1-8, 1965.

18. SASTRY, K. V. and GARG, V. K.: *Acta Physiol. Hung.*, **50**, 313-318, 1977.