REVISTA ESPAÑOLA DE FISIOLOGIA, 35, 111-114. 1979

Studies on the Competitive Intestinal Absorption of Amino Acids, and Sugars in Two Teleost Fishes

V. K. Garg

Department of Zoology, D.A.V. (P. G.) College
Muzaffarnagar (India)

(Received on September 6, 1978)

V. K. GARG. *Studies on the Competitive Intestinal Absorption of Amino Acids, and Sugars in Two Teleost Fishes*. Rev. esp. Fisiol., 35, 111-114. 1979.

In both fishes *Ophiocephalus punctatus* and *Heteropneustes fossilis*, the compound of the same group inhibited the transport rate of another compound such as, both glucose and fructose inhibited the uptake of xylose. Glucose was comparatively more inhibitory in nature than fructose. Transport of one amino acid was also inhibited in the presence of another amino acid. In glycine transport, leucine was stronger inhibitor than tyrosine. Almost similar results have been observed in both fishes irrespective of different feeding habits.

Non-electrolyte transport in the intestine, is believed to be mediated by at least three separate and parallel sodium-dependent absorption mechanisms, responsible respectively for the absorption of monosaccharides, neutral amino acids and dibasic amino acids (14). Studies on the action of sugars on neutral amino acid transport have been more widespread (1) and have to lead to discussion on the mechanism of interaction. WISEMAN (17) first suggested that the monoamino-monocarboxylic amino acids shared a common transport mechanism in the intestine. The effect of neutral amino acids on the transport of dibasic amino acids and vice versa, originally was believed to be negligible (5). Earlier reports revealed that some neutral amino acids inhibit the intestinal absorption of arginine and lysine *in vitro*, whereas others stimulate it (13). However, the studies on the effect of neutral amino acids on neutral amino acids and the interaction between monosaccharides for their transport are much fewer. Therefore, the present study is designed in two teleost fishes *Ophiocephalus punctatus* and *Heteropneustes fossiles* of different feeding habits.

Materials and Methods

The fishes of almost equal in size (20 cm in length end 75 g in weight in case of *Ophiocephalus punctatus* and 40 g in weight and 20 cm in lenght in *Heteropneustes fossiis*) were starved for 48 hrs to clear off the alimentary canal from any food material. After anesthetizing with solvent ether, fishes were dissected and the intestine and pyloric caeca both were washed thoroughly with Kreb's Ringer bicarbonate (KRB) solution and then the sacs were prepared *in vivo* according to MUSACCHIA and BRAMANATE (9). To observe the effect of glucose or fructose (1.25 mM) on transport of xylose (1.25 mM), and of leucine or tyrosine (1.25 mM) on transport of glycine (2.5 mM), two batches of control and experimental fishes were run side by side. In case of control fishes, the transported amount of xylose and glycine was separately determined at intervals of 10, 20, 30, 35, 40, 50 and 60 min according to SASTRY and GARG (15). In experimental fishes, after the time interval of 30 min, 1.25 mM concentration of desired sugar or amino acid was made in the filling solution in addition to the presence of xylose or glycine and then transported amount was determined and compared with control ones at different time intervals of 35, 40, 50 and 60 min. All experiments were repeated thrice in each case at 28 ± 2.5° C.

Results

The experiments showed that the addition of glucose or fructose inhibits the transport of xylose in both fishes. At 35 minutes stage, the transport of xylose does not show any effect in case of

Table I. *Effect of sugars on transport of xylose (1.25 mM).*

Sacs	Sugars added	Transport (μmoles/g/min)						
		10	20	30	35	40	50	60
				Ophiocephalus punctatus				
	None	3.1±0.6	4.2±0.6	5.6±0.6	5.9±0.7	6.8±0.9	8.1±0.8	9.0±1.1
PC	Glucose				5.8±0.3	5.0±0.6	3.8±0.3	3.2±0.2
	Fructose				5.8±0.3	5.3±0.3	4.4±0.3	3.9±0.2
	None	7.1±0.3	8.7±0.6	10.1±1.2	10.7±0.9	11.3±1.3	11.8±1.2	12.4±1.3
AI	Glucose				10.3±0.8	8.2±0.8	6.4±0.8	5.7±0.5
	Fructose				10.6±0.8	10.4±0.9	9.3±0.7	8.6±0.8
	None	4.5±0.4	6.3±0.8	7.4±0.9	7.9±0.8	8.3±0.6	9.7±1.2	10.2±1.4
PI	Glucose				7.9±0.7	6.4±0.9	5.4±0.5	4.7±0.3
	Fructose				7.4±0.6	7.7±0.9	6.2±0.7	5.8±0.7
				Heteropneustes fossilis				
	None	8.8±0.9	9.4±1.1	10.6±1.2	11.3±0.8	13.1±1.3	14.8±1.3	15.7±1.2
AI	Glucose				11.9±0.9	9.4±1.7	7.3±0.9	7.0±0.9
	Fructose				11.7±1.2	10.3±1.0	9.6±0.7	8.4±0.8
	None	8.1±0.8	8.8±0.8	10.2±0.9	11.8±0.9	12.8±1.1	13.3±1.2	14.3±0.9
MI	Glucose				11.9±0.9	10.2±0.8	8.4±0.4	6.6±0.9
	Fructose				12.1±0.8	11.9±1.1	10.0±0.8	8.8±0.7
	None	12.1±1.1	14.8±1.2	15.4±1.6	15.9±1.1	16.3±1.2	16.9±1.1	17.3±1.6
PI	Glucose				16.4±1.2	14.4±1.1	12.5±1.3	10.4±1.2
	Fructose				16.6±1.2	15.8±1.2	14.8±1.3	11.3±1.1

PC: Pyloric caeca; AI: Anterior intestine; MI: Middle intestine; PI: Posterior intestine.

Table II. *Effect of amino acids on transport of glycine (2.5 mM).*

Sacs	Amino acids added	Transport (μmoles/g/min)						
		10	20	30	35	40	50	60
				Ophiocephalus punctatus				
PC	None	5.4±0.6	7.3±1.3	10.8±0.8	12.2±1.3	14.6±1.5	17.5±1.7	20.7±2.1
	Leucine				11.4±0.8	10.5±0.9	8.7±0.6	5.5±0.6
	Tyrosine				11.8±1.1	11.4±0.9	10.7±0.8	9.0±0.8
AI	None	9.3±1.2	14.4±1.7	18.7±1.1	21.2±2.4	23.4±2.4	27.6±2.1	29.3±2.1
	Leucine				19.2±1.4	18.3±1.7	15.4±1.1	11.2±1.1
	Tyrosine				20.6±1.7	19.7±1.9	18.2±1.3	16.7±1.7
PI	None	9.6±0.9	12.8±1.7	16.2±1.3	17.8±1.7	18.3±1.9	21.5±2.3	24.6±2.3
	Leucine				16.0±1.3	16.8±1.5	13.3±1.3	11.4±1.3
	Tyrosine				17.2±1.8	16.8±1.7	15.4±1.7	13.5±1.2
				Heteropneustes fossilis				
AI	None	10.5±0.8	15.6±1.3	18.2±1.2	20.6±1.8	23.3±2.6	28.2±2.3	33.3±3.2
	Leucine				19.8±1.6	18.9±2.1	15.7±1.6	13.4±1.7
	Tyrosine				20.4±1.3	19.8±1.7	17.8±1.6	15.8±1.5
MI	None	10.2±0.7	14.3±1.1	17.6±1.7	18.9±1.7	21.6±2.1	28.3±2.3	31.7±2.8
	Leucine				18.0±1.9	17.6±1.3	15.3±1.8	12.8±1.4
	Tyrosine				18.5±2.1	18.0±2.1	17.1±1.2	15.8±1.7
PI	None	7.8±1.1	11.0±0.9	14.3±0.9	16.2±1.3	18.1±1.8	22.8±1.9	28.6±2.3
	Leucine				15.7±1.6	15.2±1.4	13.3±1.4	11.5±1.5
	Tyrosine				16.0±1.6	15.4±1.7	14.4±1.7	12.9±0.9

PC: Pyloric caeca; AI: Anterior intestine; MI: Middle intestine; PI: Posterior intestine.

Ophiocephalus while in case of *Heteropneustes* there was a slight increase in xylose transport at this stage but with further increase in incubation time there was corresponding decrease in xylose uptake in both fishes. The decrease in xylose uptake was quite significant at 60 minutes interval. Glucose was found to be more effective than fructose.

The uptake of glycine was inhibited in both fishes due to the addition of leucine or tyrosine in the filling solution of glycine. The effect was less in the beginning but increased with lapse of time. In contrast to tyrosine, leucine was strong inhibitor in transport of glycine. Overall, inhibition in xylose and glycine transport was greater in *Ophiocephalus* than that in *Heteropneustes*. Among all the sacs the pyloric caeca was affected most and in no case the regional variation was disturbed.

Discussion

The absorption characteristics of sugar, administered separately and as a mixture, often differ; the same is also true for amino acids. It was found that slow absorbable nutrients have less effect on the transport rate of other nutrient than the more absorbable ones. 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. WISEMAN (17) was first to use competition studies to explore the possibility that there might be more than one transport system for L-amino acids. He found evidence of competition between various monoaminomonocarboxylic acids, but not between these and the diamino or dicarboxylic acids. The results of the present investigation on neutral amino acid transport agree with the published data of FEARON and BIRD (4). HERZBERG *et al.* (6) 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 (8). Mutual inhibition in intestinal transport of aromatic amino acids *in vitro* systems occurs when there is relatively, a large ratio of the inhibitor to the inhibited amino acid (2). WAPNIR and LIFSHITZ (16) noted inhibition of intestinal absorption of L-phenylalanine *in vivo* by L-alanine. *In vitro* studies have shown that glycine absorption was reduced by methionine (10, 11), alanine (7) and histidine (5) and that histidine absorption was inhibited by glycine, alanine and methionine (5). Methionine also reduced both glycine and histidine absorption *in vivo* in rat and chick, whereas glutamic acid did not effect histidine absorption (10, 12). On the other side, ROBINSON and FELBER (13) found that L-arginine uptake could be stimulated by the presence of a variety of neutral amino acids. Recently, DEBNAVE and LEVIN (3) 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 were effected more.

Resumen

En ambos peces, *Ophiocephalus punctatus* y *Heteropneustes fossilis*, el compuesto del mismo grupo inhibía la velocidad del transporte de otra combinación, v.g., la glucosa y la fructosa inhibían respectivamente el consumo de xilosa. La glucosa inhibía más comparativamente que la fructosa. La presencia de un aminoácido también inhibía el transporte de otro aminoácido. En el transporte de glicina, la leucina se mostraba más inhibidora que la tirosina. Se han observado casi idénticos resultados en ambos peces, independientemente de los diferentes tipos de dieta.

Acknowledgement

The author is grateful to Dr. V. P. AGRAWAL and Dr. K. V. SASTRY for the valuable suggestions. Finantial assistance from U.G.C. is also acknowledged.

References

1. ALVARADO, F.: *Science*, **151**, 1010-1012, 1966.
2. COHEN, L. I. and HUANG, K. C.: *Amer. J. Physiol.*, **206**, 647-652, 1964.
3. DEBNAVE, G. S. and LEVIN, R. J.: *Gut.*, **17**, 92-93, 1976.
4. FEARON, J. R. and BIRD, F. H.: *J. Nutr.*, **93**, 198-202, 1967.
5. FINCH, L. R. and HIRD, F. J. R.: *Biochim. Biophys. Acta*, **43**, 268-277, 1960.
6. HERZBERG, G. R., SHEERIN, H. E. and LERNER, J.: *Comp. Biochem. Physiol.*, **40**, 229-235, 1971.
7. MATTHEWS, D. M. and LASTER, L.: *Amer. J. Physiol.*, **208**, 593-600, 1965.
8. MUNCK, B. G. and SCHULTZ, S. G.: *Biochim. Biophys. Acta*, **183**, 182-193, 1969.
9. MUSACCHIA, X. J. and BRAMANATE, A. Y.: Proc. 3rd Internat. Symp. mammalian Hibernation. 1967, 15-19.
10. NEWEY, H. and SMYTH, D. H.: *J. Physiol.*, **164**, 527-551, 1962.
11. NEWEY, H. and SMYTH, D. H.: *J. Physiol.*, **170**, 328-343, 1964.
12. PAINE, C. M., NEWMAN, H. J. and TAYLOR, M. W.: *Amer. J. Physiol.*, **97**, 9-12, 1959.
13. ROBINSON, J. W. L. and FELBER, J. P.: *Biochem. Z.*, **343**, 1-8, 1965.
14. ROBINSON, J. W. L. and VANNOTTI, A.: *Schweiz. Med. Wochenschr.*, **96**, 1002, 1966.
15. SASTRY, K. V. and GARG, V. K.: *Acta Physiol. Hung.*, **50**, 313-318, 1977.
16. WAPNIR, R. A. and LIFSHITZ, F.: *Proc. Soc. Exp. Biol. Med.*, **152**, 307-311, 1976.
17. WISEMAN, G.: *J. Physiol.*, **127**, 414-422, 1955.