THE INFLUENCE OF STARVATION ON THE CARBOHYDRATE TRANSPORT IN CARP GUT

Golovanova IL
I.D.Papanin Institute for Biology of Inland Waters
Russian Academy of Sciences, 152742, Borok, Yaroslavl
Phone:(085)2253845 Fax:(085)2253845
e-mail:golovanova@ibiw.yaroslavl.su

Functional topograpy of carbohydrate absorption in carp gut

In the present time the regularities of carbohydrate membrane hydrolysis and transport in vertebrate have been studied sufficiently (Ugolev,Kuz' mina,1993). At the same time, the data on distribution of transport activities in the fish intestine are discrepant. The maximal level of the glucose transport was found in the proximal part of the several marine and freshwater fish (Ferraris,Ahearn,1984). In the works of the other authors the glucose transport rate was shown as maximal in the middle or distal parts of fish intestine. In the most cases the maximum of the transport activities in the distal part of intestine was found in the omnivorous and the carnivorous fish species with comparatively short gut. Such discrepant data may be due to transport peculiarities in different fish species or dissimilar research methods. So far as the mucosa mass and diameter of gut vary along the intestinal length, the way of transport activity expression (mmol/l, mmol/sm,mmol /g wet mass) can influence the results of investigations.

As the functional topography of the carbohydrate absorption in the carp intestine is not clearly understood and in the most works the authors deal with the transport of free monomers, mainly glucose, the absorption of free monomers as well as hydrolises-released monomers along the intestine of carp ***Cyprinus carpio L.*** is investigated in the present work. The accumulation of hexose in the mucosa of intestinal strips in vitro under incubation in equivalent 10mmol solutions of glucose, galactose, fructose, maltose, saccharose, and solution of starch (1.8g/l) at 20 ^{0}C during 60 min was studied. Proximo-distal gradient of the free and hydrolysis-released monomers accumulation was found in carp intestine (Figure 1). The maximal level of glucose, galactose, maltose and saccharose accumulation was shown in the 7th-8th segments (fructose in 12th) of the gut. The maximal accumulation of starch was found in the 7th and 12th segments of the intestine (mmol/l).

As the diameter and the mucosa mass in the carp intestine decreased in the distal direction, the hexose accumulation in mmol per the mass of an intestinal portion was estimated. In this case the proximo-distal gradient of the carbohydrate accumulation differed from the above. The maximal level of the free monomers accumulation was in the first intestinal segment. The maxima of the disaccharides accumulations were in the 1th and 8th segments. The accumulation of glucose as a product of starch hydrolysis was the highest in the 10th gut segment.

The foregoing demonstrates that the estimation of the carbohydrate accumulation per unit of mucosa mass discovers the significant role of the distal intestinal part in the

transport process, that may be considered as adaptation to the reduction of the gut relative length in fish as compared with the higher vertebrate animals. The estimation of the accumulation per gut segment mass reveals the important role of the proximal intestinal part due to the maximal mucosal mass of this intestinal part in benthophage carp.

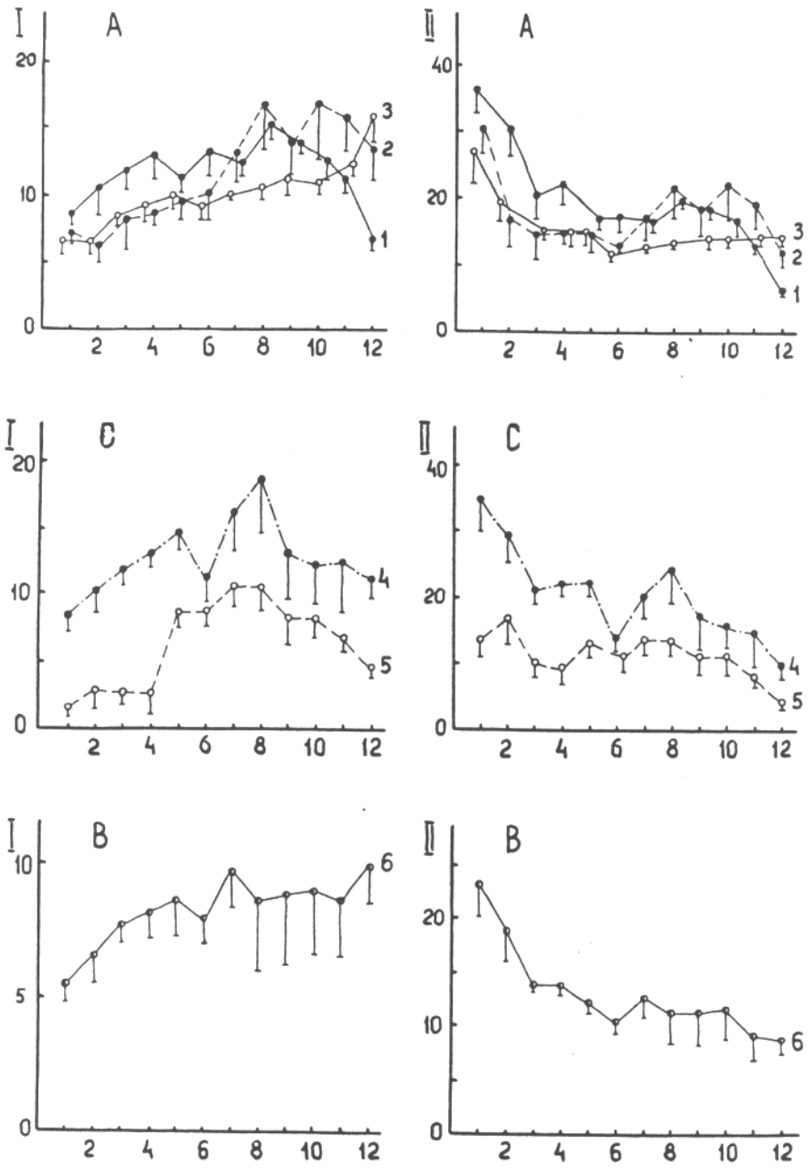

Figure 1. Accumulation of glucose(1), galactose(2), fructose(3), maltose(4), saccharose(5) and starch(6) by various segments of carp intestine at 20 ^{0}C during 60 min. Abscissa, segments of the carp intestine; ordinate, I - hexose concentration in the intestinal mucosa (mmol/l), II - hexose quantity (mmol/mucosa mass of intestinal segment). N = 6-12.

The effect of starvation on carbohydrate transport in carp.

The significant individual variability of the functional topography depends on an animal age, its functional condition, food composition and another factors in the

higher vertebrate animals has been shown (Kushak,1983). One of the main important factors, influencing the efficiency of the hydrolytic and transport system function is a degree of fish feeding. The model "satiety-starvation" is more frequently used. At present it is known that the starvation is accompanied by a series of functional and structural reorganizations. However the data of these experiments are contradictory. In some works the starvation increases the nutrition hydrolysis , but the other authors show the decrease of intensity of the process. Such descrepancy in the data to a larger extent depends on methods of enzyme and transport activity determination and the duration of starvation. For example, the mass and thickness of fish intestine decreases significantly during the period of winter starvation (McLeese,Moon,1989). It may be one of the reason for an increase of glucose transport expressed in mmol/g mass of an intestine in starving fish. However, the main effect of starvation on glucose transport is assosiated with the lack of luminal nutrients (Karasov,Diamond,1983). The investigation of the carbohydrates accumulation in carp intestine exposed to 48 hour starvation has shown the level of glucose and galactose as well as of monomers of maltose and saccharose hydrolysis to be lower along the intestine length in starving than in feeding fish (Figure 2). At this the most significant changes occured in the proximal segments of intestine. The maximal level of the above carbohydrates was 1.5-2 times as low in starving than in feeding fish. Early the similar changes in glucose and galactose transport under starvation were observed in rats, hamsters, mice and turtles (Ugolev,1972).

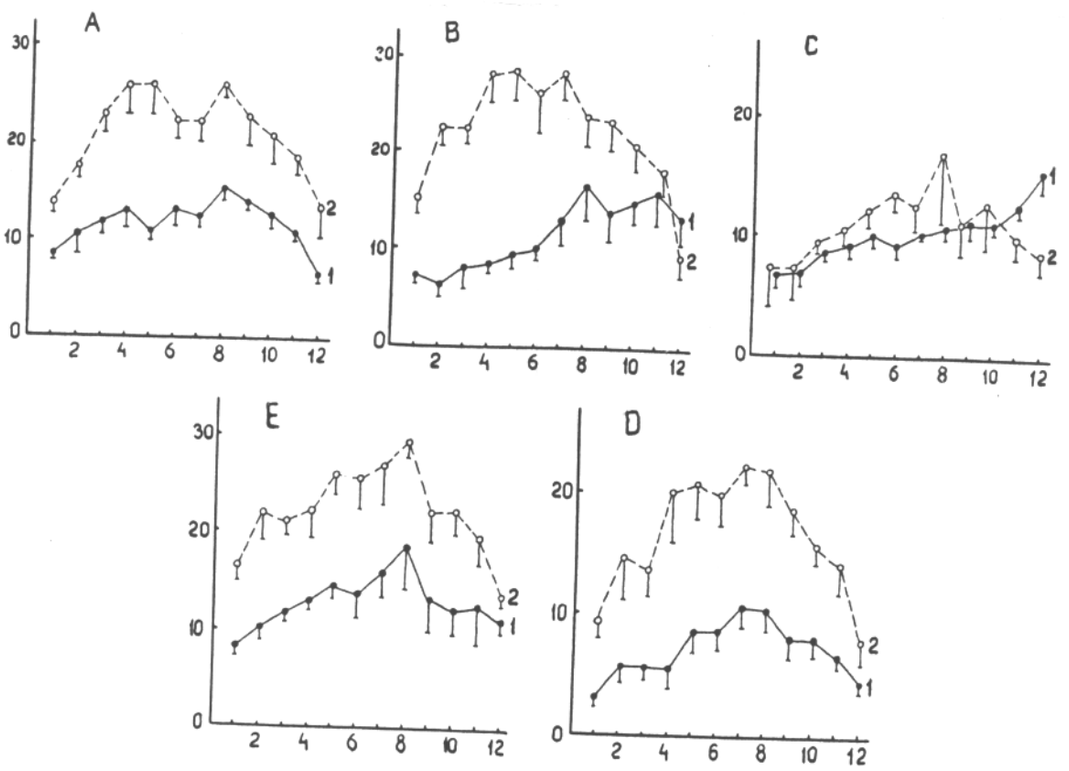

Figure 2. The influence of starvation (48 h) on the hexose accumulation in the carp intestinal strips under incubation in equivalent solutions of glucose (A), galactose (B), fructose (C), maltose (E) and saccharose (D) in feeding (1) and starving (2) fish. Abscissa, segments of the carp intestine; ordinata, hexose concentration in the intestinal mucose (mmol/l). N = 4-9.

So the starvation of fish like of many vertebrate animals not only changes the intensity of transport but proximal-distal gradient of carbohydrate accumulation along the intestinal length.

References.

Ferraris,RP & Ahearn,GA 1984 Sugar and amino acid transport in fish intestine // Comp.Biochem.Physiol. Vol.77A, N3, pp.397-413.

Karasov,W & Diamond,JM 1983 Adaptive regulation of sugar and amino acids transport by vertebrate intestine // Am.J.Physiol. Vol.245, N4, pp.443-465.

Kushak,RI 1983 Digestive-transport systeme of enterocytes. Riga, 304 p. (In Russian).

McLeese, JM & Moon, TW 1989 Seasonal changes in the intestinal mucosa of winter flounder ***Pseudopleuronectes americanus Walbaum*** // J.Fish.Biol. Vol.35, pp.381-393.

Ugolev, AM 1972 Membrane digestion: polysubstrate processes, organization and regulation, Leningrad. 358 p. (In Russian).

Ugolev, AM & Kuz'mina, VV 1993 Digestion processes and adaptations in fish. Sanct-Petersburg. Russia. 238 p. (In Russian).