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Fish physiology

**EFFECT OF WATER pH DIFFERENT VALUES ON ACTIVITY
OF SOME DIGESTIVE ENZYMES IN CARP (*CYPRINUS CARPIO* L.)**

**W P Ł Y W W O D Y O R Ó Ż N Y C H W A R T O Ś C I A C H p H
N A A K T Y W N O Ś Ć E N Z Y M Ó W T R A W I E N N Y C H U K A R P I A (*CYPRINUS CARPIO* L.)**

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Data concerning the effect of environmental pH low values on the activity of intestine carbohydrases of carp (*Cyprinus carpio* L.) fingerlings are given in the research.

It is shown that the character of activity changes because of the hydrogen ions concentrations is analogous for all the studied enzymes. As for the physiological range of environmental pH values the activity level of the enzymes doesn't differ or somewhat lower than that of the control group of fish (pH = 7.0), by the significant increase of hydrogen ions concentration the level of carbohydrases activity grows. By pathological values (pH 3) of the α -amylase and maltase activity do not change while the saccharase and total carbohydrase activities decrease.

INTRODUCTION

Significant influence of anthropogenic factors upon water ecosystems is known to take place during the last decades. An ingredient of the complex is the acidic pollution resulting in uneven changes of environmental response that significantly effect both the numerical dynamics and exterior characters of fish populations and also the physiological processes taking place in the organism of water animals (Review: Wendelaar, Dederen, 1986). In this connection data concerning the effects of hydrogen ions concentrations on the digestion in fish intestines are of certain interest. Much literature exists on the effects of the environmental pH factor upon the activity of digestive enzymes (Vonk, 1927; Ananichev, 1959; Kuzmina and

Nevalyonny, 1983 et. al.). However, these studies were being carried out in vitro, as a rule, and there are no data concerning the influence of low values of the environmental pH on the digestive function of the whole organism.

The aim of the studies is the research into the effect of low values of the environmental pH (in vivo) on the activity of some enzymes responsible for the membranous hydrogen hydrolysis in the carp intestine.

MATERIAL AND METHODS

The studies were being carried out in aquaria; 71 fingerlings of carp were involved. Fish were maintained in waters where pH concentrations equaled 4, 5, 6, 7 for 5 hrs. and for an hour (up to death) in water pH of which equaled 3. The needed values of hydrogen ions concentrations were obtained by adding concentrated H_2SO_4 . The homogenates of the carp intestine mucous membrane served as enzymic active substances. The solutions of saccharose (2%), maltose (2%) and soluble starch (2% and 0.01 g/l) prepared in Ringer solution for cold-blooded animals were used as substrates. The α -amylase activity was determined by the starch decrease using Smith's and Roy's method modified by A.M. Ugolev (1969). The total carbohydrase and saccharase activities were detected using Nelson's method modified by A.M. Ugolev and N.N. Iezuitova (1969). The maltase activity was determined using V.K. Gorodetsky's method (1958). The enzymic activity was expressed per 1 g of wet weight ($mg \times g^{-1} \times min^{-1}$ or $mM \times g^{-1} \times min^{-1}$). The results were statistically treated using the conventional method.

RESULTS AND DISCUSSION

The studies of the effect of the low values of the environmental pH on the total carbohydrase activity levels (fig. 1A) showed that the activity of the enzyme is twice as low in the fish kept by pH 6 as in the fish kept by the neutral environmental reaction. Meanwhile there are no significant statistical differences between the fish kept by pH 6 and pH 7 values. The minimum level of the total carbohydrase activity was observed while keeping carp in water where the hydrogen ions concentration equaled 4. In fishes kept by pH 3 the enzymic activity was 2.5 times as low as the maximum value observed by pH 4 and it was close to the values noticed by pH 6.

Due to the fact that the total level of the carbohydrase activity was the result of the functioning of some enzymic systems we initiated the differential research of both the adsorbic pancreatic α -amylase (fig. 1B) involved into the initial stages of the carbohydrates and of that of saccharase (fig. 1C) and maltase (fig. 1D) concluding the process of hydrolysis.

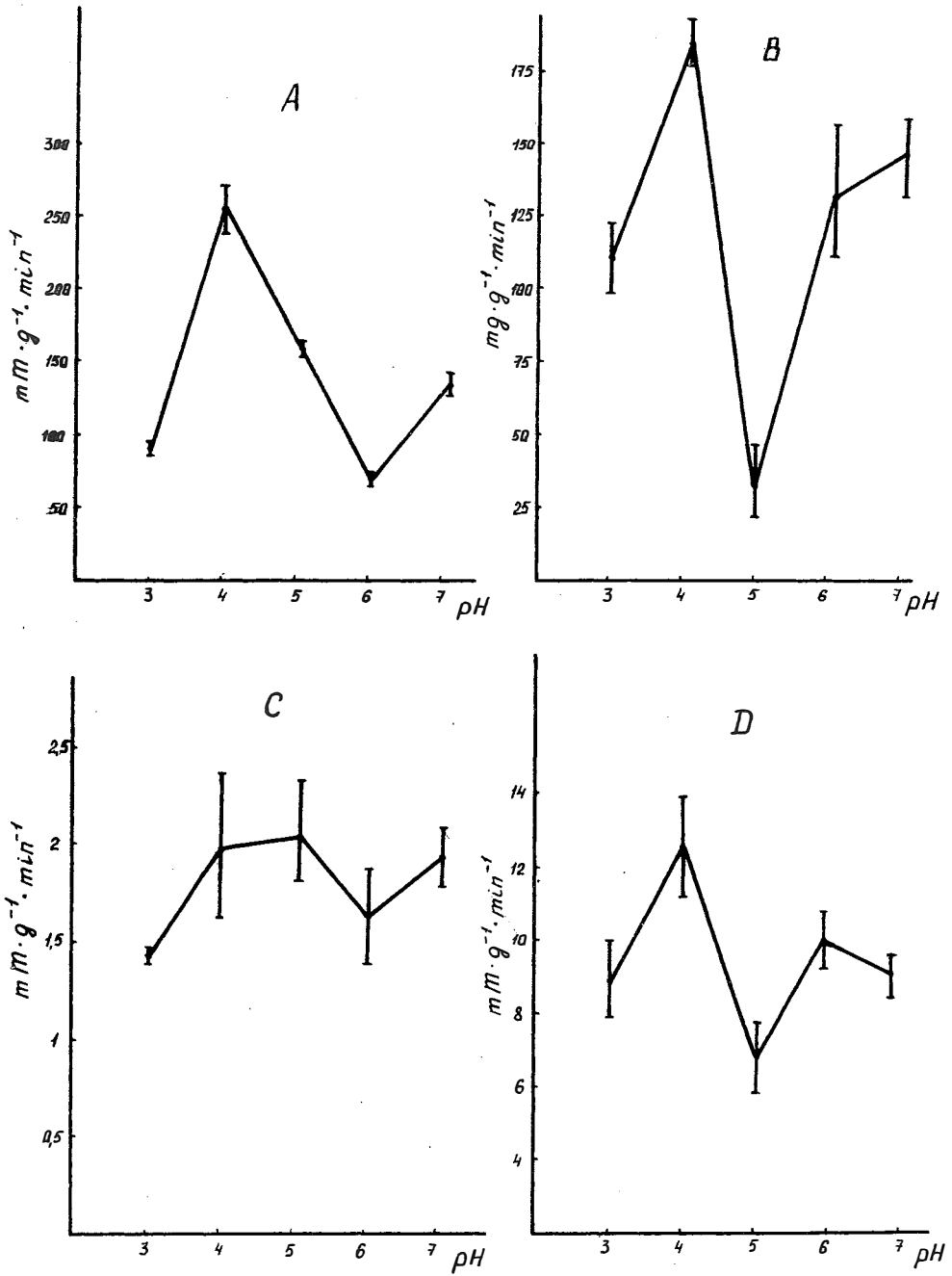


Fig. 1. Effect of hydrogen ions concentration in water on activity level of total carbohydrases (A), α -amylase (B), saccharase (C) and maltase (D) of carp intestine

It can be seen that the results obtained for α -amylase, maltase, and saccharase are similar to those for the above mentioned total carbohydrase activity with some deviations in minimum and maximum values.

Thus the analyses of the results allowed to bring to light the same S-shaped dependence for all the studied enzymes, i.e. both the lowering of the activity by the slight changing of the environmental pH (pH 6) and the maximum of the activity by higher hydrogen ions concentration. It was earlier noticed by N.S. Stroganov (1962) that the significant acidifying of environment led to the daily diet increase of sturgeon and stellate sturgeon and at the same time to the fish weight reduction. This fact as the author means is connected with organism's spending the digested food on adaptation to unfavourable environmental factors. Hence it may be supposed that our experimental increasing the enzymic activity by pH 4 is a peculiar compensatory response of an organism to the sharp environmental pH reduction. It also should be noted that the sharp change of the environmental pH value is a stress-factor the intensity of which produces a definite influence upon the rate of organism's physiological processes and is characterized by the laws described earlier (Selye, 1960). Our results concerning the levels of the activity of various digestive enzymes are in accordance with the concept of "the general adaptation syndrome".

I.A. Arshavsky (1982) considered that it is necessary to differentiate between the physiological stress-factors which are comparatively easy convertible and pathological ones responsible for inconvertible after-effects.

True, reduced activity levels of the studied enzymes by negligible changes of the environmental pH which are not rare in natural water bodies may be considered as a transitional step to some new stage of more or less physiological character for the given fish species. Whereas more significant changes of the pH levels result in extraordinary stress of the digestive function which, after all, can lead to inconvertible consequences and, quite possible, – to death.

REFERENCES

- Ananichev A.V.**, 1959: Digestive enzymes of fish and seasonal changes of their activity. *Biochemistry*, **24**, 6: 1033–1040.
- Arshavsky I.A.**, 1982: *Fiziologicheskie mekhanizmy i zakonomernosti individualnogo razvitiya*, Moskva, Nauka.
- Gorodetsky V.K.**, 1958: Enzymatic method of quantitative blood glucose calculation with the help of a homeproduced preparation of glucoseoxydase. – In the book: *Modern methods in biochemistry*. Moscow, Meditsina: 311–316.
- Khaidarlin C.H.**, 1984: *Functional biochemistry of adaptations* (edited by F.I. Furdui), Kishinev, Shtluntsa: 272.
- Kuzmina V.V. and A.N. Nevalyonny**, 1983: Influence of hydrogen ions concentrations on fish activity of some fish intestine carbohydrase activity. *Voprosy ikhtiologii*, **23**, 3: 481–490.
- Selye N.**, 1960: *Essays on adaptation syndrome*. Moscow, Meditsina: 254.
- Stroganov N.S.**, 1962: *Ecological physiology of fish*. Moscow, MGU: 444.

- Ugolev A.M.**, 1969: Definition of amylotic activity. In book: Research of digestive organs of man. Review of modern methods. Leningrad, Nauka: 187–192.
- Ugolev A.M.** and **N.N. Iezuitova**, 1969: Definition of activity of invertase and other disaccharidases. In book: Research of digestive organs of man. Review of modern methods. Leningrad, Nauka: 192–196.
- Vonk N.**, 1927: Die Verdaunung bei den Fischen. Z. Vergl. Physiol., Bd. 5, 3: 445–546.
- Wendelaar B.S.E.** and **L.H.T. Dederen**, 1986: Effects of acidified water on fish. Endeavour, 10, 4: 198–202.

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WPLYW WODY O RÓŻNYCH WARTOŚCIACH pH NA AKTYWNOŚĆ ENZYMÓW TRAWIENNYCH
U KARPIA (*CYPRINUS CARPIO* L.)

STRESZCZENIE

W badaniach wykazano wpływ niskich wartości pH wody na aktywność carbohydrazy jelitowej u narybku karpia.

Wykazano, że charakter aktywności zmienia się w zależności od stężenia jonów wodorowych i jest analogiczny dla wszystkich badanych enzymów. Przy pH 3 aktywność alfa-amylazy i maltazy nie zmienia się, podczas gdy aktywność sacharazy i ogólnej carbanhydrazy zmienia się.

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