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Effects of sublethal levels of DDT, malathion and mercury on tissue proteins of *Sarotherodon mossambicus* (Peters)

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Abstract. Liver and muscle total proteins declined in *Sarotherodon mossambicus* subjected to sublethal concentrations of DDT, malathion and mercury. The results indicate their role in maintenance of energy supply irrespective of the nature of the toxicant. The qualitative variations in serum protein pattern also support the quantitative changes in tissues.

Keywords. Toxic stress ; proteolysis ; iso-osmotic ; milieu interior.

1. Introduction

Tissue total proteins as energy sources for fishes during thermal stress, spawning and muscular exercise have been demonstrated by several investigators (Fontaine and Hatley 1953 ; Idler and Clemens 1959). However, studies on the impact of toxicants on tissue energy sources are relatively few, though considerable information is available dealing with the determination of acute toxic levels of several pollutants and their influence on oxidative metabolism. In this paper, an attempt has been made to determine the extent of changes in the level of proteins in two principal tissues, liver and muscle and also the electrophoretic pattern of serum proteins in the fish *Sarotherodon mossambicus* exposed to sublethal concentrations of DDT, malathion and mercury.

2. Materials and methods

Sarotherodon mossambicus (Peters) (15–20 g) were obtained from local ponds maintained by Tamil Nadu state fisheries research station, and acclimated in the laboratory for 15 days. They were fed with cooked rice mixed with dried prawn powder. DDT (III-Trichloro 2–2–Bis (P-Chlorophenyl ethane) as 10% wettable powder and malathion (S–1,2 Bis (ethoxy-carbonyl) ethyl *o*, *o*-dimethyl phosphorodithiate) as 5% wettable powder, supplied by M/s Parry and Company Limited,

Madras, were employed for the sublethal tests. The chloride form of mercury ($HgCl_2$) was used as the heavy metallic compound. Acetone was used as the solvent for DDT and water for both malathion and mercury. Two sets of fishes each consisting of five were exposed to 0·01 ppm of DDT, 0·95 ppm of malathion and 0·09 ppm of mercury, the respective sublethal levels representing the active ingredients of the toxicants. The sublethal concentrations of them were calculated by multiplying an application factor of 0·25 × with the respective LC 50 values determined from the acute toxicity tests, as recommended by the Ontario Ministry of Environment (1974). The fishes were exposed for the 24 hr, 7 days and 15 days simultaneously along with controls for each. At the end of respective intervals, fishes were sacrificed and tissues were taken for total protein analysis. The protein was estimated following the procedure of Lowry *et al* (1951). For the qualitative study of serum proteins, disc electrophoresis using polyacrylamide gel was carried out. The pattern of fractions obtained after 15 days exposure is indicated in figure 3.

3. Results

The levels of total protein in the liver and muscle of control and toxicant exposed groups are shown in figures 1 and 2. There appears to be no significant difference either in the liver or muscle of the control and the three toxicant exposed groups at 24 hr interval. However, a significant decrease was noticed after 7 and 15 days in both tissues ($P = 0·05$). Electrophoretic studies revealed that serum proteins in fishes kept under control showed eleven fractions. On the contrary, in fishes exposed to DDT—a total of fourteen fractions, and in those exposed to malathion and mercury, ten and nine fractions were discernible respectively.

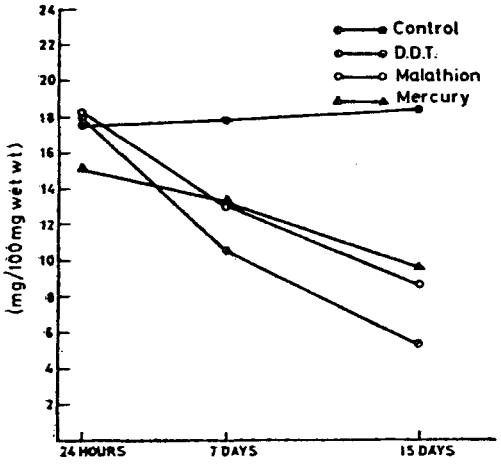

Figure 1. Total protein (liver) (mg/100 mg wet wt.).

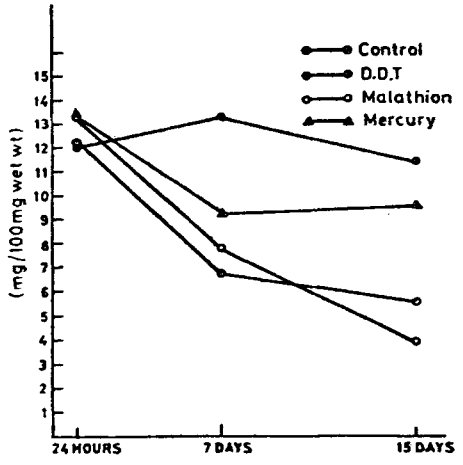

Figure 2. Total protein (muscle) (mg/10 mg wet wt.).

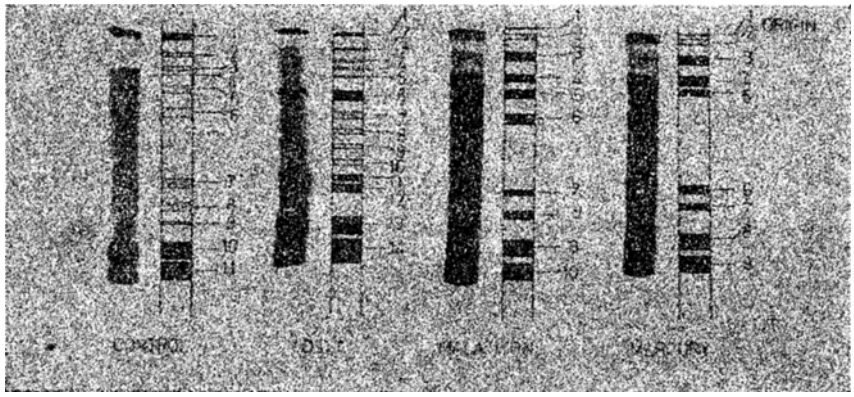

Figure 3. Polyacrylamide-gel-electrophoretic patterns of serum proteins of control group *vs.* toxicant-exposed groups.

4. Discussion

The total proteins in the liver and muscle showed a steady decline after 7 and 15 days, in contrast to 24 hrs interval. The absence of considerable alterations in the total protein content during the initial period of exposure (24 hrs) supports the concept of Fry (1971) that fishes tend to resist a changed situation for a specific period, but will eventually succumb as a result of their inability to continuously adapt. The pattern of changes in the total carbohydrates in blood, the free sugars in liver and muscle and the consequent depletion of glycogen in these tissues at the initial period of exposure (24 hr) in this animal (Ramalingam 1980) also lends support to the view extended by Umminger (1970) that carbohydrates represent the principal and immediate energy precursors for fishes exposed to stress conditions while proteins being the energy source to spare during chronic periods of stress.

Depletion of tissue proteins in fishes exposed to various toxicants has been reported by several investigators (McLeay and Brown 1974 ; Sakaguchi and Hamaguchi 1975 ; Shakoori *et al* 1976). Besides the above changes, the protein fractions in the serum of fishes exposed to toxicants, revealing an increase in the case of DDT while a decrease in malathion and mercury-exposed ones also indicate the conversion of tissue proteins into soluble fractions reaching the blood for utilisation. Similar qualitative changes have been reported by Anees (1974) in *Channa punctatus* exposed to diazinon, dimethoate and methyl parathion for 14 days.

The decline in the liver and muscle protein would suggest an intensive proteolysis which in turn could contribute to the increase of free aminoacids to be fed into the tricarboxylic acid cycle (TCA) as keto acids, thus supporting the hypothesis of Kabeer Ahamad *et al* (1978). Such a possibility is further strengthened by the investigations of Shaffer (1967)—Mehrle *et al* (1971), Shakoori *et al* (1976) which revealed both qualitative and quantitative variations in the tissue aminoacids of fishes exposed to toxicants. In addition, studies of Bell (1968), McKim *et al* (1970), Lane and Scura (1970), Sakaguchi

and Hamaguchi (1975) have also revealed marked variations in the activity of enzymes involved in transaminations in fishes at similar situations. However, an understanding of the levels of aminoacids at different intervals during stress imposed by toxicants, would be of interest in explaining the role of tissue proteins either to meet the energy demand completely or to maintain an iso-osmotic condition of the milieu interior also by increasing the aminoacids pool as suggested by Kabeer (1979).

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References

Anees M A 1974 Changes in starch gel electrophoretic pattern of serum proteins of a freshwater teleost *Channa punctatus* (Bloch) exposed to sublethal and chronic levels of three organophosphorous insecticides ; *Ceylon J. Sci.* **11** 53

Bell G R 1968 Distribution of transaminases (aminotransferases) in the tissues of Pacific salmon (*Oncorhynchus*) with emphasis on the properties and diagnostic use of glutamic-oxaloacetic transaminase ; *J. Fish. Res. Bd. Can.* **25** 1247–1268

Fontaine M and Hatley J 1953 Contribution al etude du metabolisme glucidique du salmon *Salmo salar* L. a liver ses etapes de son development et de ses migrations ; *Physiol. Comp. Et Oecologia* **3** 37–52

Fry F E J 1971 In Fish Physiology (eds.) W S Hoar and D J Randall (New York : Academic Press) Vol. **6** p. 1.

Idler D R and Clemens W A 1959 The energy expenditures of Frasher river sockeye salmon during spawning migration to Chilke and Stuart lakes ; *Int. Pacific. Salmon Fish. Comm. Prog. Rep.* Jackson Printing New Westminster B C 80 pp

Kabeer Ahamad I, Begum Md, Sivaiah S and Ramana Rao K V 1978 Effect of malathion on free aminoacids, total proteins, glycogen and some enzymes of pelecypod *Lamellidens marginalis* (Lamarck) ; *Proc. Indian Acad. Sci.* **87** 377–381

Kabeer Ahamad Sahib I 1979 Studies on some aspects of protein metabolism and associated enzyme systems in the freshwater teleost *Tilapia mossambica* to malathion exposure. Ph.D. Thesis, Sri Venkateswara University, Tirupati

Lane G E and Scura E D 1970 Effects of dieldrin on glutamic oxaloacetic transaminase in *Poecilia latipinna* ; *J. Fish. Res. Bd. Can.* **27** 1869–1871

Lowry D H, Rosebrough N J, Farr A L and Randall R J 1951 Protein measurement with the Folin phenol reagent ; *J. Biol. Chem.* **193** 265–275

McLeay D J and Brown D A 1974 Growth stimulation and biochemical changes in juvenile coho salmon (*Oncorhynchus kisutch*) exposed to bleached kraft pulpmill effluent to 200 days ; *J. Fish. Res. Bd. Can.* **31** 1043–1049

McKim J M, Christensen G H and Hunt E P 1970 Changes in the blood of brook trout (*Salvelinus fontinalis*) after short term and long term exposure to copper ; *J. Fish. Res. Bd. Can.* **27** 1883–1889

Mehrle P M, Stalling D L and Bloomfield R A 1971 Serum aminoacids in rainbow trout (*Salmo gairdneri*) as affected by DDT and dieldrin ; *Comp. Biochem. Physiol.* **38** 373–377

Ontario Ministry of the Environment 1974 *Guidelines and criteria for water quality management in Ontario.* Supervised for publication by the Hon William G Newsman, Minister and Everst Biggs, Deputy Minister, 135 St. Clair Avenue, West Toronto

Ramalingam K 1980 Studies on the effects of sublethal concentrations of a few toxicants on Biochemistry, Physiology and Histology of *Tilapia mossambica* (Peters). Ph.D. Thesis, University of Madras, Madras

Sakaguchi H and Hamaguchi A 1975 Physiological changes in the serum and hepatopancreas of yellow tail injected with carbon tetrachloride ; *Bull. Jpn. Soc. Scient. Fish.* **41** 283–290

Schafer R 1967 The effects of pollutants on the free aminoacid content of the fish *Leuciscus cephalus* (L.) albus ; *Rev. Biol.* **59** 385–407

Shakoori A R, Saleem A Z and Muhammed S A 1976 Effect of malathion, dieldrin and endrin on blood serum proteins and free aminoacids pool of *Channa punctatus* (Block) : *Pak. J. Zool.* **8** 124–134

Umminger B L 1970 Physiological studies on supercooled killifish fundulus heteroclitus. III. Carbohydrate metabolism and survival at subzero temperature, *J. Exp. Zool.* **173** 159-174