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LIVER AND KIDNEY DAMAGE IN GREY MULLET *LIZA PARSIA* (HAMILTON AND BUCHANAN) ON EXPOSURE TO AN ORGANOPHOSPHATE 'NUVAN'

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ABSTRACT

In bioassay experiments with *Liza parsia* to 'Nuvan' for acute exposure, the 48 and 96 hr LC50 were found to be 0.750 and 0.482 ppm respectively in a brackishwater medium of salinity 10 ± 1.0‰, temperature 27.5 ± 1.5°C and pH 6.0 ± 0.5. For sub-lethal effects the fishes were exposed to 1/5th and 1/15th concentrations of this 96 hr LC50 value for 45 days. In histological investigations of liver and kidney of the fishes from both these acute and sub-lethal exposures, disorders such as vacuolation, extensive coagulative necrosis with pyknosis, karyorrhexis and karyolysis in liver tissue and enlargement of renal tubules, necrosis of epithelial tubular cells in kidney were observed. Safe levels for long-term use are yet to be found out.

INTRODUCTION

PESTICIDES are synthetic chemicals widely used for protecting crops from pests. Though their short-term benefits are undeniable, they are considered hazardous because of interference with the environment. Pesticides wherever applied, ultimately find their way into water bodies affecting aquatic fauna.

The backwaters and estuaries in general serve as nurseries for many organisms including several commercially important fishes and prawns. *Liza parsia*, a brackishwater fish of economic importance inhabiting both the coasts of India, spends most of its lifetime in estuarine condition where it is subjected to toxicity by several pollutants discharged into the environment.

As organochlorine persists in the environment and accumulates in different tissues, its use as pesticide in agriculture, has given rise to criticism in recent years prompting to prefer organophosphates by most of the agriculturists. The water soluble organophosphate insecticide 'Nuvan' is widely used in the Kolleru region of Andhra Pradesh for control of ectoparasites such as *Lernea*, *Argulus*, etc. (Muthu *et al.*, 1988). But the long-range effects of this practice are not known.

Several studies have identified histological disorders in liver and kidney of fishes exposed to pollutants (Mukherjee and Bhattacharya, 1975 ; Bass *et al.*, 1977 ; Konar, 1977; Sastry and Malik, 1979 ; Goel and Garg, 1980 ; Dubale and Shah, 1981 ; Kumar and Pant, 1981 ; Ramalingam and Reddy, 1981 ; Akulendra Naidu *et al.*, 1983 ; Bakthavathsalam *et al.*, 1984 ; Desai *et al.*, 1984 ; Rashatwar and Ilyas, 1984 ; Radhaih *et al.*, 1986 ; Razani *et al.*, 1986 ; Gupta and Dalela, 1987 ; Mukhopadhyay *et al.*, 1987 ; Ram and Satyanesan, 1987 ; Bhatnagar *et al.*, 1987).

The degree of damage to the organs help in determining the level of toxicity. The liver

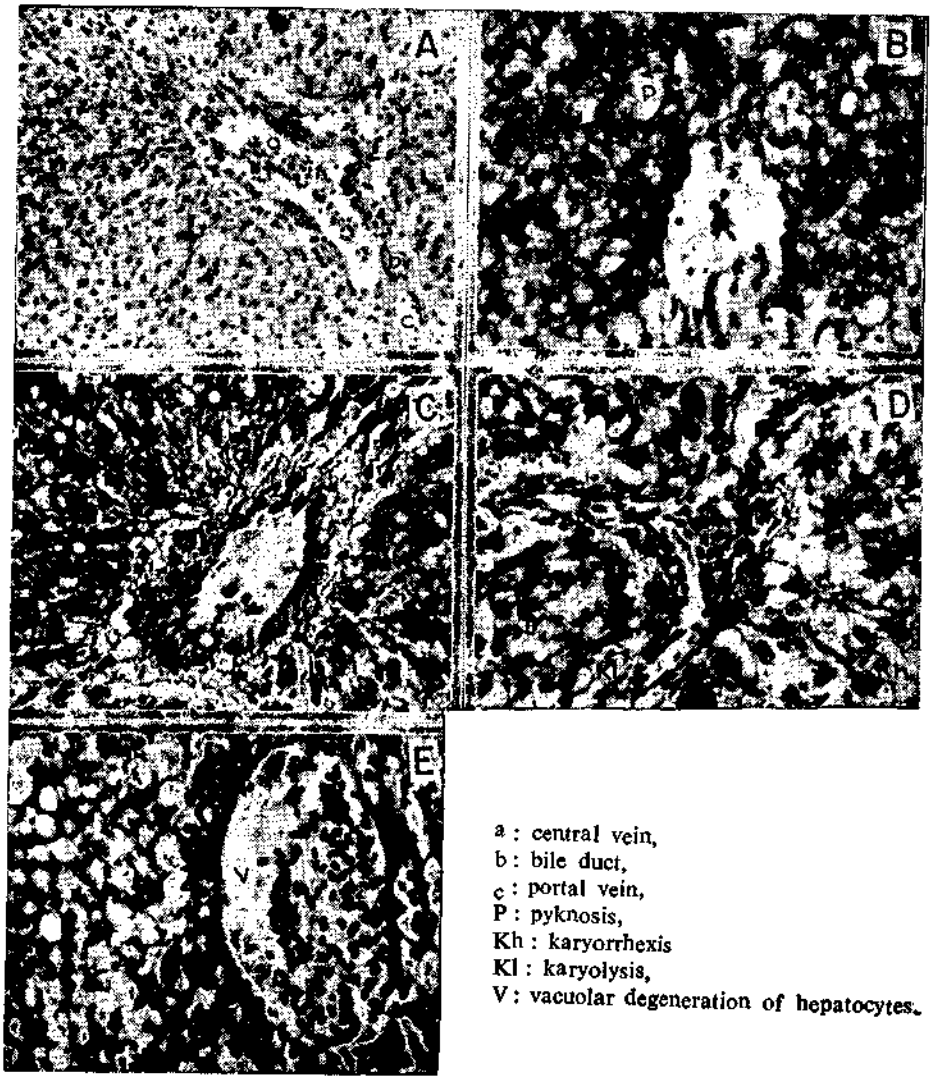

PLATE I. Cross-section of liver (H & E) — A : normal (X 100), B : exposed to 48 hr LC50 for 48 hrs (X 400), C : exposed to 96 hr LC 50 for 96 hrs (X 400), D : exposed to 1/15th 96 hr LC 50 for 45 days (X 400), E : exposed to 1/5th 96 hr LC50 for 45 days (X 400).

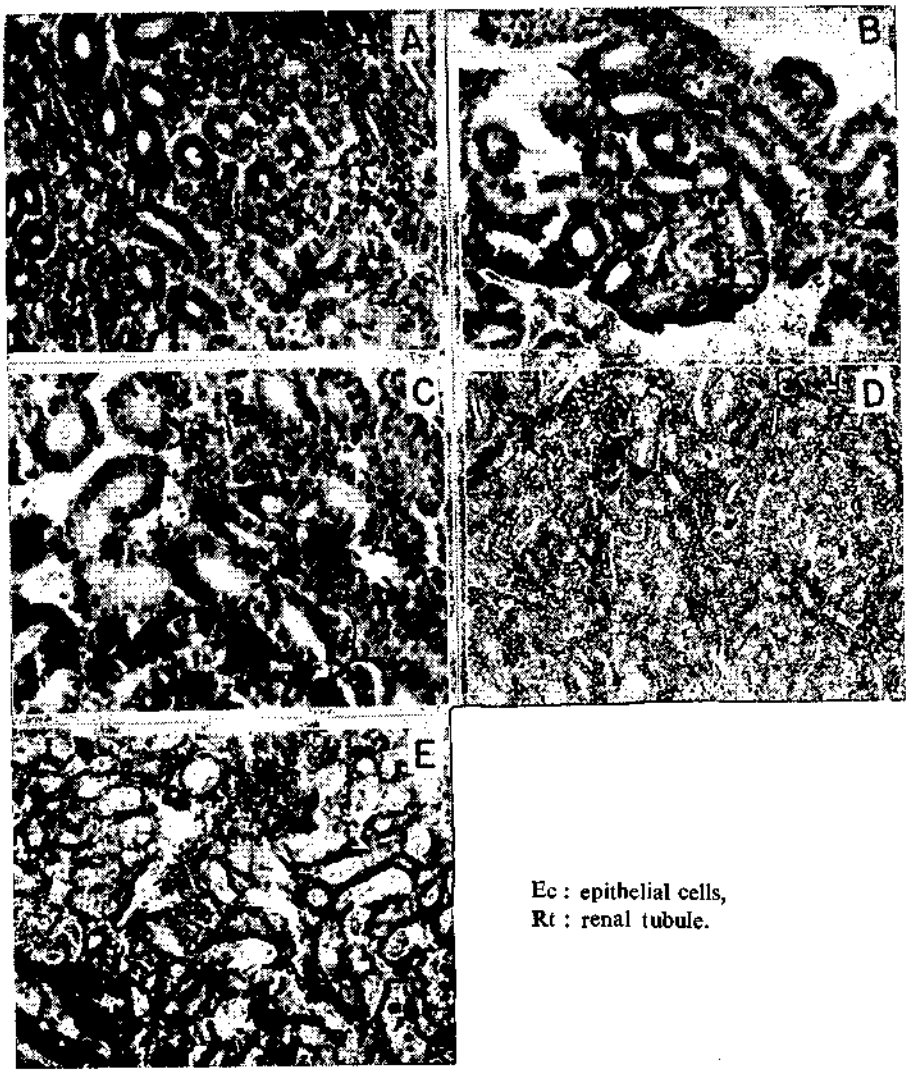

PLATE II. Cross-section of kidney (H & E) — A : normal (X 200), B : exposed to 48 hr LC50 for 48 hrs (X 200), C : exposed to 96 hr LC50 for 96 hrs (X 200), D : exposed to 1/15th 96 hr LC 50 for 45 days (X 40), E : exposed to 1/5th 96 hr LC50 for 45 days (X 200).

and kidney of teleosts are 2 vital organs which get affected by pollutants. The present investigation was undertaken to study the histological changes caused by 'Nuvan' on the liver and kidney of grey mullet *L. parsia*.

Material and Methods

L. parsia of 85-120 mm sizes and 6.50-13.25 g weight were collected live from brackish-water canals of Puduvypeen area, near Cochin and acclimatized to laboratory condition for about 2 weeks by maintaining them in plastic pools of 2 tonne capacity containing water of salinity 10.0 ± 1‰, pH 6.0 ± 0.5 and temperature 27.5 ± 1.5°C. To avoid fungal attack of test animals the medium was treated with 11 mg of malachite green per 100 litres of water. The fish were fed once a day.

The commercial grade 'Nuvan' of Ciba-Geigy composed of 'Dichlorvos 76% m/m Emulsifier 10.6% m/m and Solvent 13.4% m/m' was used for the preparation of stock solution.

A static bioassay was conducted after APHA-AWWA-WPCF (1975) and Reish and Oshida (1987). The 48 hr and 96 hr LC50 values were found by 'Probit analysis' on computer. For sub-lethal effects the fishes were exposed to 1/5th and 1/15th concentration of the 96 hr LC50 for 45 days.

The liver and kidney of test animals exposed to lethal and sub-lethal concentrations were used for histological studies. The tissues were fixed in Bouin's fluid for about 24 hrs and then processed by routine histological techniques. Sections of 4-5 μ were stained with haematoxylene and eosin and mounted in DPX. Photomicrographs were taken using and Olympus Universal Research Microscope.

Results

The LC50 values for 48 and 96 hr were respectively 0.750 and 0.482 ppm.

In normal liver the hepatocytes are polygonal and have distinctive central nuclei with densely stained chromatin margins and prominent nucleoli. The portal triad and hepatocytes in transverse section of normal liver are shown in (Pl. I A). Palate I A : a, b and c show the central veins, bile duct and portal vein respectively of the portal triad. Fishes sacrificed after acute exposure to 'Nuvan' (*e.g.* 48 hr LC50 and 96 hr LC50 for 48 and 96 hr respectively) showed extensive coagulative necrosis with pyknosis, karyorrhexis, karyolysis and vacuolar degeneration of cytoplasm of hepatocytes (Pl. I B, C). In sublethal concentration (*e.g.* 45th day in 1/15th 96 hr LC50) vocuolar degeneration, pusning of nuclei to one side, karyolysis and pyknosis were observed (Pl. I D), but in sections of fishes exposed to 1/5th 96 hr LC50 for 45 days showed the similar observations, but of greater magnitude (Pl. 1 E).

Sections of kidney of an unexposed fish showed normal size and structure of renal tubules and epithelial cells (Pl. II A). Fishes sacrificed after acute exposures to 48 hr LC50 and 96 hr LC50 showed enlargement of renal tubules (Pl.II B, C). After sub-acute exposure to 1/15th 96 hr LC50 for 45 days vacuolation of epithelial cells of renal tubules were observed (Pl. II D). On exposure to 1/5th concentration of 96 hr LC50 for 45 days, marked necrosis and extensive desquamation, and flattening were observed in the tubular epithelial cells (Pl. II E).

Discussion

Casillas *et al.* (1983) reported disturbance in orientation of hepatic ducts in *Parophrys vetulus* exposed to lethal concentration of carbon tetrachloride and op ned destruction of connective tissue as its possible reason. Vacuolation is reported by Razani *et al.* (1986) in *Brachydanio rerio* chronically exposed to phenol and by Sastry and Malik (1979) in *Channa ptaunctus* after sublethal exposure to

dimecron. But enlargement of nuclei was also seen by the latter authors. Along with vacuolation and degeneration of cytoplasm, Konar (1977) observed in *Heteropneustes fossilis* and *Labeo rohita* exposed to acute concentration of phosphamidon and heptachlor, also swelling of hepatocytes. Going a step further Slooff *et al.* (1983) observed enlargement of the whole liver of fish collected from polluted surface waters in the Netherlands caused mainly due to hypertrophy of hepatocytes. Vacuolation, disorientation, enlargement of nuclei and hypertrophy of cells were clearly seen along with condensation or even disappearance of nuclei in the present study. The stress on exposure to 'Nuvan' might have drawn all reserve food in liver and caused the above changes.

Gupta and Dalela (1987) reported degeneration and disolution of epithelial cells of renal tubules and hypertrophy and necrosis of renal cells in histological sections of the kidney of *Notopterus notopterus* on sublethal exposure to phenolic compounds. Similar observations were made by Csepai (1978) in *Cyprinus carpio* exposed to Anthio 40 EC, Satox 20 WSC and Basudin 10 G and Konar (1977) in *Heteropneustes fossilis* and *Labeo rohita* chronically exposed to DDVP, phosphamidon and heptachlor. The deformation of renal tubules was observed by Bakthavathsalam *et el.* (1984) on *Anabas testudineus* chronically exposed to Furadon. According to Dubale and Shah (1981) the process of destruction is a function of dosages and period of exposure and they opined that the renal tubules of kidney are the first to be affected by pesticidal stress. Rashtwar and Ilyas (1984) reported the histopathological changes in kidney to lead to cloudy swelling of renal tubules in *Nemacheilus denisonii* acutely exposed to phosphamidon. In the present study also the swelling of renal tubules in acute exposure was evident. Changes like vacuolation of epithelial cells of renal tubules and pronounced enlargement of the tubules were observed in the histological sections at higher sublethal concentration and prolonged exposure only and it draws support from the observations of Dubale and Shah (1981).

'Nuvan' in higher concentration is very toxic. Casual exposure to it as a lotion for treating ectoparasites may not be harmful. However, detailed long-term study is needed.

References

Akhilendra Naidu, K., K. Abhinender Naidu and R. Ramamurthi 1983. Histological alteration in liver and intestine of teleost *Sarotherodon mossambicus* in response to mercury toxicity. *Ecotoxicol. Environ. SAF.*, 7 (6) : 566-575.

APHA-AWWA-WPCF 1975. *Standard methods for the examination of water and wastewater. American Public Health Association—American Water Works Association—Water Pollution Control Board*, Washington. 14th edn. pp. 800-869.

Bakthavathsalam, R., R. Ramalingam and A. Ramaswamy 1984. Histopathology of liver, kidney and intestine of the fish *Anabas testudineus* exposed to Furadon. *Environ. Ecol.*, 2 (4) : 243-247.

Bass, M. L., C. R. Berry Jr. and A. G. Health 1977. Histopathological effects of intermittent chlorine exposure on blue gill (*Lepomis macrochirus*) and rainbow trout (*Salmo gairdneri*). *Wat. Res.*, 11 (8) : 731-735.

Bhatnagar, M. C., A. K. Bana and R. C. Dalela 1987. Histopathological alterations in liver of *Channa gachua* (Ham.) exposed to endosulfan. *In :* R. C. Dalela, Shashi Kant and Shma Vohra (Ed.) *Proceedings of the 8th annual session of AEB and National Symposium on 'Environmental pollution and pesticide toxicology'*. The Academy of Environmental Biology, India : pp 205-209.

Casillas, E., M. Myeris and W. E. Ames 1983. Relationship of serum chemistry values to liver and kidney histopathology in English sole (*Parophrys vetulus*) after acute exposure to carbonte trachloride. *Aquatic Toxicology*, 3 : 61-78.

*Csepai, E. 1978. Histological detectable dystrophies in the carps' kidneys exposed to chronic effect of some pesticides. *Magy. Allatorv. Lapja.*, 33 (1) : 55:58.

* Not referred to in Original.

DESAI, A. K., U. M. JOSHI AND P. M. AMBADKAR 1984. Histological observations on the liver of *Tilapia mossambica* after exposure to monocrotophos, an organophosphorus insecticide. *Toxicol. Lett.*, **21** (3): 325-331.

DUBALE, M. S. AND P. SHAH 1981. Histopathology of the kidney of the fish *Channa punctatus* exposed to cadmium. *J. Anim. Morphol. Physiol.*, **28** (1-2) : 166-171.

GOEL, K. A. AND V. GARG 1980. Histopathological changes produced in the liver and kidney of *Channa punctatus* after chronic exposure to 2, 3, 4- triamino azobenzene. *Bull. Environ. Contam. Toxicol.*, **25** (2) : 330-334.

GUPTA, S. AND R. C. DALELA 1987. Kidney damage in *Notopterus notopterus* (Pallas) following exposure to phenolic compounds. *J. Environ. Biol.*, **8** (2) : 167-172.

KONAR, S. K. 1977. Hazards of water pollution by pesticides. Symposium on Environmental Pollution and Toxicology. *Haryana Agricultural University and Indian National Science Academy*, pp. 83-93.

KUMAR, S. AND S. C. PANT 1981. Histopathological effects of acutely toxic levels of copper and zinc on gill, liver and kidney of *Puntius conchonius* (Ham.). *J. Exp. Biol.*, **19** (2) : 191-194.

MUKHARJEE, S. AND S. BHATTACHARYA 1975. Histopathological lesions in the hepatopancreas of fishes exposed to industrial pollutants. *Indian J. Exp. Biol.*, **13** (6) : 571-573.

MUKHOPADHYAY, M. K., B. B. GHOSH AND H. C. JOSHI 1987. Biomonitoring of pollution in the Hoogly Estuary by using *Rita rita* as test fish. *J. Environ. Biol.*, **8** (4) : 297-306.

MUTHU, M. S., K. A. NARASIMHAM, K. GOPALAKRISHNAN AND A. K. SHARMA 1988. Recent developments in prawn and fish culture in Andhra Pradesh. *Mar. Fish. Inform. Serv., T & E. Ser.*, **90** : 16-21.

RADHAIAH, V., M. GIRIJA, P. PRASAD RAO AND K. JAYANTHA RAO 1986. Histopathology of kidney of the freshwater fish *Tilapia mossambica* exposed to heptachlor. *Environ. Ecol.*, **4** (4) : 600-601.

RAM, R. N. AND A. G. SATYANESAN 1987. Histopathological changes in liver and thyroid of the teleost fish *Channa punctatus* (Bloch) in response to ammonium sulfate fertilizer treatment. *Ecotoxicol. Environ. SAF.*, **13** (2) : 185-190.

RAMALINGAM, R. AND Y. S. REDDY 1981. Acute histopathological effects of lindane (Y—benzene hexachloride) on the liver of *Colisa lalia*. *Curr. Sci.*, **50** (13) : 578-580.

RASHATWAR, S. S. AND R. ILYAS 1984. Effect of phosphamidon in a freshwater teleost fish *Nemacheilus denisonii* (Day)—histopathological and biochemical studies. *J. Environ. Biol.*, **5** (1) : 1-18.

RAZANI, H., K. NANBA AND S. MURACHI 1986. Acute toxicity effect of phenol on Zebrafish *Brachydanio rerio*. *Bull. Jap. Soc. Sci. Fish.*, **52** (9) : 1547-1557.

REISH, D. L. AND P. S. OSHIDA 1987. Manual of methods in aquatic environment research, Part 10—Short-term static bioassay. *FAO Fisheries Technical paper* 247. FAO, Rome, pp. 1-62.

SASTRY, K. V. AND P. V. MALIK 1979. Studies on the effect of Dimecron on the digestive system of a freshwater fish *Channa punctatus*. *Arch. Environ, Contam. Toxicol.*, **8** (4) : 397-407.

SLOOFF, W., C. F. V. KREIJL AND A. J. BAARS 1983. Relative liver weights and xenobiotic-metabolizing enzymes of fish from polluted surface waters in the Netherlands. *Aquatic Toxicology*, **4** : 1-14.