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Lipid Derivatives in the Tissues of the Freshwater Teleost, *Saurotherodon mossambicus* (alias *Tilapia mossambica*) (Peters)—Effect of Methyl Parathion

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Total lipids and phospholipids decreased while free fatty acids and total cholesterol showed elevation in the red muscle, gill, liver and brain tissues of methyl parathion exposed fishes. These changes are discussed in relation to β-oxidation to meet the energy demands caused by methyl parathion impact.

Key Words: **Methyl parathion, Total cholesterol,** *Saurotherodon mossambicus*

Introduction

The pesticides are known to spread through all segments of the environment (Jensen et al. 1969, Legator et al. 1969, Mrak 1969) due to indiscriminate usage as these compounds form a group of economically useful poisons (Datta & Dikshith 1973), causing untold hazards to non target species like fishes (Matsumara et al. 1972, Holden 1972). Many workers attempted to evaluate these hazards on biota (Lutz-Ostertag et al. 1969, Rand 1977). However the work concerning pesticide impact on lipids is lacking. Since most of the pesticides are lipophilic in nature (Holden & Marsden 1967), the present study is attempted by taking methyl parathion, (an organophosphate pesticide) to study its toxic impact on some aspects of lipid metabolism in the freshwater teleost, *Saurotherodon mossambicus*, an edible fish of wide availability in this region and which acclimatises to the laboratory conditions very quickly.

Materials and Methods

The details of collection, maintenance and acclimatisation of *S. mossambicus* has been already described (Siva Prasada Rao & Ramana Rao 1979a). Technical grade methyl parathion of 80% purity was used for the study.

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The preparation of standard stock solution and the determination of LC_{50} values have been described earlier (Siva Prasada Rao & Ramana Rao 1979b) LC_{50} was found to be 0.26 ppm for 48 hr of exposure. Hence 0.09 ppm concentration of methyl parathion was chosen to represent sublethal concentration which is about one third the LC_{50} value (Konar 1969). Fishes weighing about 10.0± 2.0g were exposed to 0.09 ppm of methyl parathion for 48 hr. During experimentation, the water in the aquaria containing the normal and methyl parathion exposed (MPE) fishes were aerated periodically to prevent anoxia or hypoxia (Khorram & Knight 1977).

After the exposure, four metabolically and functionally active tissues like red muscle, gill, liver and brain were isolated and kept in cold. The lipids were extracted from the above tissues repeatedly by a mixture of chloroform: methanol (2:1 v/v) according to the procedure of Folch et al. (1957). The total lipids were determined gravimetrically (Folch et al. 1957). The phospholipids were determined as phospholipid phosphorus by the method of Zilversmith and Davis (1950). The values of inorganic phosphorus were multiplied by a factor 25 to get the phospholipid values (Bieri & Prival 1965). The free fatty acids and total cholesterol were estimated by the method of Natelson (1971). The statistical correlations were conducted using student's 't' test as described by Bailey (1965).

Results and Discussion

Data presented in table 1 show that the total lipids and phospholipids attenuated, while the free fatty acids and total cholesterol increased in all the four tissues of MPE fishes. Within the tissues, the percent decrease in total lipids was: red muscle>liver> gill>brain, while attenuation of phospholipids showed: red muscle>gill>liver> brain. The increase in free fatty acids was: liver>red muscle>brain>gill, while the total cholesterol increase showed: gill>brain >liver>red muscle.

Since more energy is needed to mitigate any stress condition, the observed decrease in total lipids and phospholipids might be due to the utilisation, of these compounds. The phospholipids showed a rapid decrease since they are actively degraded (Harper et al. 1977), suggestive of their immediate utilisation to meet the energy demands. The total lipids and phospholipids of brain were less affected than the other tissues so as to permit this organ to function properly and maintain metabolic harmony during this stress condition. The considerable decrease of total lipids and phospholipids in the red muscle might be due to the drastic decrease in glycogen (—78%) content in the same tissue (Siva Prasada Rao & Ramana Rao 1979a) which is an immediate source of energy during toxic stress condition, indicative of induced glyconeogenesis in the red muscle.

The free fatty acids showed an increase in all the four tissues suggestive of increased lipolysis during methyl parathion exposure and this agrees with the decreased total lipid and phospholipid contents. Since liver is the centre of lipid metabolism (Lehninger 1978), the higher level of free fatty acids can be expected in liver than the other tissues as evidenced in the present study.

The increase in the total cholesterol content in the tissues suggests an increased diversion of acetyl CoA to acetoacetate for the synthesis of cholesterol. This diversion may be expected as there is a possibility of accumulation of acetyl CoA, since Kreb's cycle enzymes are inhibited during stress condition (Kabeer et al. 1978). Besides, as organophosphate pesticides inhibit the metabolism of steroids (Kupfer 1969), the cholesterol increase might also be due to the non-utilisation of cholesterol for the synthesis of steroidal hormones causing accumulation in the tissues.

Table 1 *Levels of total lipids, phospholipids, cholesterol and free fatty acids (mg/g wet wt) in the selected tissues of normal and methyl parathion-exposed (MPE) fishes*

Tissue	Red muscle		Gill		Liver		Brain	
	Normal	MPE	Normal	MPE	Normal	MPE	Normal	MPE
Total lipids	66.76 ±2.88	56.73 ±2.35 −15% $P<0.001$	77.01 ±2.32	71.47 ±1.73 −7% $P<0.001$	165.14 ±3.30	146.76 ±2.32 −11% $P<0.001$	213.12 ±5.30	202.64 ±12.63 −5% NS
Phospholipids	3.323 ±0.380	1.604 ±0.131 −52% $P<0.001$	3.881 ±0.334	3.215 ±0.569 −17% $P<0.01$	32.470 ±2.662	28.620 ±2.213 −12% $P<0.01$	81.320 ±6.320	73.990 ±6.430 −9% $P<0.05$
Free fatty acids	17.76 ±1.61	20.52 ±1.74 +15% $P<0.005$	8.54 ±1.17	9.49 ±1.01 +11% NS	48.99 ±2.81	58.52 ±4.54 +19% $P<0.001$	35.12 ±3.15	39.79 ±3.11 +13% $P<0.01$
Total cholesterol	1.685 ±0.074	1.881 ±0.149 +12% $P<0.005$	3.433 ±0.596	4.623 ±0.654 +35% $P<0.005$	15.561 ±1.323	18.932 ±2.50 +22% $P<0.005$	25.426 ±1.940	32.708 ±5.030 +28% $P<0.005$

Each value is a mean of six individual observations; ±indicates SD
The signs + or − indicate percent increase or decrease over normal; P= '*t*' test (significant); NS=Not significant

Since liver is the major site for the synthesis of cholesterol, the latter might have mobilised into the blood from the liver. This agrees with the observed increase of total cholesterol in the gill, as it is more vascularised compared to other tissues. The liver thus occupies a pivotal position in the metabolism of cholesterol as it does in the case of other lipids. The increase of total cholesterol in serum and aorta was also reported in the rats treated with organophosphates (Buchet et al. 1977).

Hence it can be inferred that the free fatty acids, formed due to the breakdown of lipids might be diverted to yield energy through β-oxidation to mitigate the stress condition caused by methyl parathion impact.

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References

Bailey N T J 1965 *Statistical Methods in Biology* (Great Britain : The English Language Book Society and English University Press Ltd).

Bieri J G and Prival E L 1965 Lipid composition of testes of various species; *Comp. Biochem. Physiol.* **15** 275–279

Buchet J P, Lauwerys R and Roels H 1977 Long-term exposure to organophosphorus pesticides and lipid metabolism in the rat; *Bull. Environ. Contam. Toxicol.* **17** 175–183

Datta K K and Dikshith T S S 1973 Histopathological changes in the testes and liver of rats repeatedly exposed to pesticides; *Exp. Path.* **8** 363–370

Folch J, Lees N and Sloane Stanley G 1957 A simplified method for isolation and purification of total lipids from animal tissues; *J. Biol. chem.* **V226** 497

Harper A, Rodwell V W and Mayes A 1977 *A Review of Physiological Chemistry*, 16th ed., (California: Lange Medical Publications) p. 289

*Holden A V and Marsden K 1967 Organochlorine pesticides in seals and porpoises; *Nature* **216** 1274–1276

—— 1972 The effects of pesticides on life in fresh water; *Proc. R. Soc. Lond.* **B180** 383–394

Jensen S, Johnels A G, Olsson M and Otterlind G 1969 DDT and PCB in marine animals from Swedish waters; *Nature* **224** 247–250

Kabeer Ahamad I, Begum Md R, Sivaiah S and Ramana Rao K V 1978 Effect of malathion on free amino acids, total proteins, glycogen and some enzymes of pelecypod, *Lamellidens marginalis* (Lamark); *Proc. Indian. Acad. Sci.* **87** 377-380

Khorram S and Knight A W 1977 The toxicity of kelthane to the grass shrimp (*Crangon franciscorum*); *Bull. Environ. Contam. Toxicol.* **18** 674–682

*Konar S K 1969 in *Environmental pollution by pesticides* p. 233 (ed Edwards C A) (London and New York: Plenum Press)

*Kupfer D 1969 in : *Environmental pollution by pesticides* p. 206 ed C A Edwards (London and New York: Plenum Press)

*Legator M S, Palmer K A, Green S and Peterson K W 1969 Cytogenic studies in rats of cyclohexylamine, a metabolite of cyclamate; *Sci.* **165** 1139

Lehninger A L 1978 *Biochemistry* 2nd edn. (Ludhiana: Kalyani Publishers) 280 pp

*Lutz-Ostertag Y, Meiniel R and Lutz H 1969 Effects du parathion sur le development de l'embryon de caille et de certains de ses organes *in vivo* et *in vitro*; *Biol. Abstr.* **52** (22) 12 311

Matsumara F, Boush G M and Misato T 1972 *Environmental Toxicology of Pesticides* (New York and London: Academic Press) 30 pp.

*Mrak E M (ed) 1969 Report of the secretary's commission on pesticides and their relationship to environmental health; US Dept. Health, Education and Welfare, Washington, DC

*Originals not seen

Natelson S 1971 *Techniques and Clinical Chemistry* (3rd edn.) (Illinois: Charles C Thomas Publishers)

Rand G M 1977 The effect of exposure to a subacute concentration of parathion on the general locomotor behaviour of the goldfish; *Bull. Environ. Contam. Toxicol.* **18** 259-266

Siva Prasada Rao K and Ramana Rao K V 1979a Effect of sublethal concentration of methyl parathion on selected oxidative enzymes and organic constituents in the tissues of the fresh water fish, *Tilapia mossambica* (Peters); *Curr. Sci.* **48** 526-528

Siva Prasada Rao K and Ramana Rao K V 1979b Toxicity of methyl parathion to the fresh water telecost, *Tilapia mossambica*; *Comp. Physiol. Ecol.* (Communicated)

Zilversmith D B and Davis A K 1950 A simple method for the microdetermination of plasma phospholipids; *J. Lab. Clin. Med.* **35** 155-160