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Studies on the Effect of Biocides on Changes in Physiological Profiles in a Teleostean Fish, *Mystus cavasius* (HAM.)

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Abstract:
The present paper deals with the effects of certain biocides on the haematology and respiratory metabolism in an air breathing fish, Mystus cavasius (Ham.). DDT. Metacid and Unizeb cause anaemia (i.e. decrease in RBC counts and Hb content) whereas the treatment of Endrin, Urea and Phenol brings about polycythemia (i.e. an increase in RBC counts and Hb content) in this fish. Endrin elevates the oxygen consumption of this fish by nearly 40% while the treatment of DDT, Unizeb and Metacid causes significant decrease in oxygen consumption. The effect of different biocides on the physiological changes were more pronounced in fishes of smaller size as compared to large speciemens. The value of TLm (median tolerance limit) of different biocides have also been measured. In polluted water the frequency of surfacing (i.e. they depend more on aerial respiration) increased in contrast to gill respiration. The reason for and mechanism of such changes are discussed in this paper.

Keywords: Biocides, Blood parameters, Fish, Oxygen consumption.

INTRODUCTION

The contamination of fish habitat by pollutants is of great concern as run off of these substances pollute the fishery reservoirs, sometimes causing heavy mortality of a localized fish population and their food organisms. The biocides contain the toxic substances which alter the physio-chemical condition of the aquatic environment and destroys the utility and beauty of the fresh water. Effect of different pollutants on the histopathological changes on various fish tissues have been studied by a number of investigators but the available literature indicates that our information on the effect of different pollutants on the blood and oxygen consumption in fishes are very limited (Kumar, 1999; Dixit et al. 2004; Raju and Sadhu, 2009; Mishra and Trivedi, 2017; Prabhakar, 2019). The present work is an endeavour to study the effect of certain biocides, if any, on the blood and oxygen consumption in a fresh water teleostean fish, *Mystus cavasius* (Ham.).

MATERIAL AND METHODS

Live specimens of *Mystus cavasius* (Ham.) were procured from the local fish fish dealers at Siwan. The fishes were kept in a big glass aquarium (30-L) in the laboratory for a week for proper acclimatization. In the laboratory they were fed on the pieces of goat liver. Fishes of almost the same body weight (35-40g) were used in the present study.

The TLm (median tolerance limit) of different biocides were determined prior to any experiment at the water temperature 29.0 ± 1.0°C. At this temperature the values of TLm (for 24 h) were 0.4mg/L for DDT (Dichloro Diphenyl Trichloro ethane or 1, 1, 1-Trichloro-2,2 Di,P-chlorophenyl); 2.6 mg/L for Metacid (Methyl parathion-0, 0-dimethyhl o-P-nitrophenyl phosphorothiodate); 0.00019 mg/L for Endrin; 15000 mg/L for Urea; 12 mg/L for Unizeb (Zinc ethylene bisdithiocarbamate) and 20 mg/L for Phenol. Though the fishes do not die at 8.0 and 18.0 mg/L of Unizeb and Phenol respectively but 1.2 mg/L of Unizeb and 15 mg/L of Phenol were sufficient to bring about significant physiological changes in this fish were studied at slightly lower concentration of pollutants which are recorded in Table 1. The reason for taking lower concentration of pollutants is discussed below.

The details of the methods employed in the determination of oxygen consumption through gills were those of Munshi and Dube (1973) who used a cylindrical glass respirometer (3-L capacity) with provision of continuous water flow and removal of enclosed air. It has been marked that in polluted water the frequency of surfacing increases in fishes i.e. they depend more on aerial respiration as compared to gill respiration. The air breathing of the fish is stopped while measuring oxygen consumption through gills in specially designed respirometer. Under these circumstances the different dosage of pollutant mentioned above proves lethal for the fish and they die within an hour inside the respirometer. Therefore, to keep the fish alive for 5-7h inside respirometer the dosage of different pollutants were lowered while measuring oxygen consumption through gills. The details of the methods employed in the study of different blood parameters were those of Pandey et al. (1976a). The readings of oxygen consumption and blood were taken after 16-24 h of treatment of different pollutants. The difference of significance, if any was calculated by student's t-test at the level of 5% ($P<0.05$).

RESULTS

The data showing the effect of different biocides on the oxygen consumption, red blood cells (RBC) counts, haemoglobin (Hb) content, and packed cell volume (PCV) in this fish has been summarized in Table 1. A perusal of Table 1 indicates that almost all the biocides used at different concentrations except endrin have depressing effect on the oxygen consumption. Treatment of endrin brought about nearly 40% increase in oxygen consumption of this fish. Metacid at lower dose (1.0 mg/L) failed to bring any significant change in oxygen consumption, though a tendency of decrease in it was clearly marked out. Of the different biocides used endrin was the most effective (in terms of dose) followed by DDT, Unizeb and Metacid. The treatment of DDT, Metacid and Unizeb causes anaemia (i.e. decrease in RBC counts, Hb content and PCV) while endrin, urea and phenol seem to be associated with polycythemia (i.e. an increase in RBC counts, Hb content and PCV) in this fish. The effects were more contrast in fishes of smaller weight (15-16g) as compared to larger specimens (25-26g).

Table 1: Effect of different Biocides on the Blood and Oxygen Consumption (VO_2) in *Mystus cavasius* (Ham.) at 29.0 ± 10°C; Body wt. = 37.0 ± 1.5g; N=6.

Condition	Dose (mg/L)	VO_2 (cc/kg/h)	RBC in (million/cm)	Hb content (g percent)	PCV (%)
Control	-	117.39 ± 4.21	2.58 ± 0.13	12.5 ± 0.34	21.3 ± 1.24
DDT	0.4	68.09 ± 5.34*	-	-	-
DDT	1.0	31.6 ± 2.68*	2.05 ± 0.06*	9.2 ± 0.54*	15.3 ± 1.33*
Endrin	0.00012	167.32 ± 4.12*	3.62 ± 0.15*	15.9 ± 0.14*	33.1 ± 1.28*
Metacid	1.0	111.86 ± 5.24*	2.51 ± 0.18N	11.8 ± 0.61N	19.8 ± 1.12
Metacid	2.0	38.74 ± 6.32*	2.12 ± 0.05*	10.3 ± 0.31*	20.5 ± 1.48
Unizeb	1.0	78.05 ± 3.84*	2.59 ± 0.18N	12.7 ± 0.64N	21.0 ± 1.36
Unizeb	2.0	53.02 ± 6.34*	1.90 ± 0.12*	8.2 ± 0.81*	15.0 ± 1.04*
Urea	15,000	-	3.09 ± 0.10*	14.4 ± 0.28*	32.0 ± 2.11*
Phenol	15.0	-	3.18 ± 0.11*	14.6 ± 0.16*	32.4 ± 1.08*

N-120 for each group; ±=Standard at $p<0.05$.

DISCUSSION

In the last to decade the effect of different biocides on the fishes has been studied variously in relation to toxicity, survival and tolerance, growth and development, behaviour and reproduction and histopathological changes in different body tissues but a perusal of literature indicates that the effect of different pollutants on the haematology and respiratory metabolism in fishes has not been studied in detail so far, except some fragmentary reports (Bolier et al., 1973; Pandey et al., 1976b; Panigrahi, 1977 and Saad et al. 1973). There are mainly three groups of insecticides namely organochlorine, organophosphate and carbamate which are used for selective killing of a pest in a biological community. It is very interesting to note that all the different groups of pesticides or even the different biocides of the same group do not have the same effect on fishes. The mode and site of action of different biocides also differ and therefore, it is very difficult to generalize the effect of different biocides in fishes unless a detailed investigation is carried out. In the present investigation it has been found that Metacid (an organophosphate) at lower conc. (1 mg/L) failed to bring any significant change in oxygen consumption in Mystus cavasius (Ham.) though a tendency of decrease in oxygen consumption was clearly marked out but at a concentration of 2.0 mg/L. Metacid brings about significant decrease in oxygen consumption in this fish. Pandey et al. (1976b) have also reported a significant decrease in oxygen consumption after the treatment of 1.2 and 2.5 mg/L Malathion (an organophosphate). Though exact reason of decrease in oxygen consumption could not be understood but Chambers (1976) has stated that the mode of action of organophosphorous insecticides is the irreversible inhibition of acetylcholinesterase, with death in vertebrates usually attributed to respiratory failure from paralysis of the respiratory muscles. Similar explanations may be followed here. Waiwood and Johanson (1974) have stated that Methoxychlor (an organochlorine) at low concentration has no effect on oxygen consumption of white sucker but at high concentration it increases the oxygen consumption in this species. O' Brein (1967) is also of the opinion that DDT (organochlorine) causes a sharp and substaintial increase in oxygen consumption in insects. He observed a progressive increase in oxygen consumption, with a peak at 1-h, about 4 times the normal value; thereafter it declined, reaching normal level at 10h. In the present work it has been found that DDT causes a significant decrease in oxygen consumption and stands in contrast to the endrin which elevates the oxygen consumption by nearly 40%, though both these biocides belong to the same group of pesticide. At this stage it is very difficult to say why the two biocides belonging to the same group affected the fish in two different ways. It needs further investigation. The increase in oxygen consumption after the treatment of endrin may be explained on the assumption; (I) that excessive muscular activity takes place which in turn was caused by excessive nervous activity resulting from endrin and (2) that oxidative phosphorylation is uncoupled and thereby more oxidation is required to produce the required phosphorylation product (ATP). Treatment of Unizeb (carbamate) brings about significant decrease in oxygen consumption in this fish; the reason for this could not be understood.

The values of RBC counts and Hb content (Table 1) obtained in the present study in control group of M. cavasius are well within the range reported by Pradhan (1961). Several investigators (Bolier et al., 1973; Pandey et al., 1976b; Panigrahi, 1977 and Saad et al., 1974) have studied the effect of different biocides on the blood of fishes. In the present study it has been observed that most of the blood parameters decreased in animals treated with DDT, Metacid and Unizeb. The decrease in haematologic values and oxygen consumption after the treatment of those biocides in M. cavasius is consistent. Pandey et al. (1976b) have also reported decrease in RBC counts and Hb content in C. punctatus after the treatment of Malathion. Similarly the increase in oxygen consumption and blood parameters after the treatment of Endrin is also consistent in this species. The treatment of urea and phenol brings about polycythemia in the fish. Kawatski and Mc Donand (1974)(have reported that in the presence of 1.0 mg/L, 3-trifluromethyl 1-4 nitrophenol that rate of respiration by trout brain increased significantly and thus the increase in different blood parameters in Mystus cavasius (Ham.) after the treatment of phenol seem to be quire meaningful. In the present study it cannot be said with certainly that the increase or decrease in various blood components after the treatment of different biocides are due to increased haemopoietic intensity or haemolysis respectively. Whether such changes are direct or due to increase and decrease in total plasma volume is yet to be ascertained.

CONCLUSION

So far, the toxicity of different biocides are concerned chlorinated hydrocarbons are more toxic as compared to organophosphate, carbamate, urea and phenol in this fish. Finally, it can be said that so far the effect of different biocides on the physiology of fish concerned, there is no universal or generalized effect rather different pollutants even of the group affect the fish in different ways.

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