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COMPARATIVE TOXICITY OF SOME DETERGENTS ON AN ESTUARINE FISH, AMBASIS COMMERSONII

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ABSTRACT

The comparative toxicity was evaluated using four detergents, viz., linear alkylbenzene sulfonate (LAS), branched alkylbenzene sulfonate (BAS), sodium sulfonate (SS) and alfa-olefin sulfonate (AOS) on an estuarine fish, *Ambassis commersonii*, abundant in Kali estuarine system. Standard toxicity bioassay method was followed as per APHA (1980). AOS concentration in 'Mega' soap was determined by the standard MBAS method described in APHA (1980). The results indicate that LAS was the most toxic detergent to fish relative to the other types and the order of toxicity was LAS > AOS > SS > BAS. The LAS was more toxic than BAS by 1.2 times, AOS by 2.8 - 2.9 times and BAS by 4.8 - 5.3 times at all LC levels. A significant correlation was seen between observed and calculated mortalities for all the detergents. Some behavioural responses of fishes to all detergents were also observed. Considering the increasing threat from the detergents, more detailed studyk is stressed.

INTRODUCTION

Almost in every household and in industries, various types of detergents are used and their use is ever on the increase. This has resulted in greater stress being exerted on the aquatic environment, for they enter the system as a part of sewage. Detergent preparations contribute about 16-35% of the total phosphorus in natural waters, which obviously enhance the risk of eutrophication in natural waters. Besides, detergent molecules are also known to be toxic to biota. Toxic effect of detergents on freshwater organisms has been well documented. (Abel,

TABLE 1 : OBSERVED AND CALCULATED MORTALITIES (%) OF A. COMMERSONII ON EXPOSURE TO VARIOUS DETERGENTS

Detergent Conc. (mg/1)	LAS ≠≠ Mortality		BAS $ Mortality		S.S. Mortality		AOS Mortality	
	Obs.	Calc.*	Obs.	Cal.	Obs.	Calc.	Obs.,	Calc.
0.21	0	0						
0.37	0	14						
0.49	5	39			20	24		
0.56	65	54			40	36		
0.65	85	73			50	51		
0.75	100	95			70	68		
0.95	(r = 0.94)				100	102		
1.25					(r = 0.99)		20	28
1.35							40	35
1.45							50	43
1.95			15	13			70	81
2.10			25	21			100	93
2.80			40	54			(r = 0.96)	
3.20			80	74				
3.70			100	98				
			(r = 0.98)					

* values rounded off

≠≠ Shanmukhappa et al (1988) Poll. Res. (in press)

$ Shanmukhappa et al (1988) Proc. Symp. Estuarine Management, Trivandrum, 4-6, June, 1987 (in press).

Obs.- Observed

Cal.- Calculated

TABLE 2 : COMPARATIVE TOXICITY VALUES OF FOUR DETERGENTS ON EXPOSURE TO AMBASSIS COMMERSONII

Detergent Type	Conc. Range (mg/l)	Hrs. of exposure	LC_{50}	LC_{18}	LC_{84}	LC_{100}	Experimental Error* (%)	Regression
			(all values in mg/l)					
LAS	0.21 - 0.75	48	0.54	0.39	0.70	0.78	-1.0	Y = -64.93 + 212.74 X
BAS	1.95 - 3.70	48	2.71	2.05	3.41	3.74	-1.1	Y = -80.75 + 48.27 X
Sodium Sulfonate	0.49 - 0.95	48	0.64	0.46	0.85	0.94	1.1	Y = -58.74 + 168.73 X
AOS	1.25 - 2.10	24	1.54	1.13	1.99	2.19	-4.3	Y = -68.44 + 76.82 X

	LAS : BAS : SS : AOS
LC_{50}	1 : 5.0 : 1.2 : 2.9
LC_{18}	1 : 5.3 : 1.2 : 2.9
LC_{84}	1 : 4.9 : 1.2 : 2.8
LC_{100}	1 : 4.8 : 1.2 : 2.8

* Difference between concentration at which 100% mortality occurred and calculated LC_{100}

1974; Artur, 1970; Dave **et al.**, 1986; Divo, 1976; Henderson **et al.**, 1959; Hokanson and Smith, 1971; Linori and Takita, 1979; Tatcher and Santner, 1966). Very scanty information is available on the effect of detergents on estuarine (Baisler, 1965; Bhat **et al.**, 1988; Shanmukhappa **et al.**, 1988 a; b) and marine (Eisler, 1979) organisms.

In the present study, four anionic detergents, three of which (LAS, BAS & SS) are comonly used in the manufacture of soaps and other clearing compounds, in India, and a commonly available washing soap in the market **Mega** which is claimed to have alfa-olefin sulfonate (AOS). The environmental acceptability of this detergent (AOS) is needed. These four detergents were selected for the toxicity tests on an estuarine fish, **Ambassis commersoni**, juveniles of which are available in large numbers in Kali estuary (Karwar). The toxic effect (only LC_{50}) of two detergents LAD (11) and BAS (12) on the same fish has already been reported by the present authors and are taken in this study to compare with SS and AOS toxicity. Statistical analysis of all the results were done to understand the comparative toxic effects (which was not done in earlier works of our (Shanmukhappa **et al.**, 1988 a; b).

MATERIALS AND METHODS

The juvenile fishes (average length : 3.5 cm) were collected (during the mid-tide) from Kali estuary with a drag net and were immediately transported to the laboratory and were introduced into acclimatisation tanks having a salinity of 13.67 - 0.35 parts per thousand. Toxicity bioassay experiment was conducted with all the detergents by the Standard Methods (APHA, 1980). All fishes were exposed to various detergent concentrations (as shown in Table 1) upto 48 hrs (except (AOS which was upto 24 hrs). Twenty fishes were taken in each case for the toxicity bioassay test from acclimatisation tanks. A control was also maintained in each case.

AOS concentration in **Mega** soap was determined by the standard MBAS method (APHA, 1980), for which one gram of oven dried soap was dissolved in one litre of water and LAS was taken as a standard. The AOS concentration obtained by the above method was 187.5 mg/1.

RESULTS AND DISCUSSION

The observed and calculated mortalities of four detergents on **A. commersonii** are represented in Table 1 and comparative toxicity values in Table 2. It can be seen from Table 1 that a significant correlation existed between observed and calculated mortalities for all the four detergent types. Table 2 reveals that LAS is more toxic to fish than the other types at LC_{50}, LC_{18}, LC_{84} and LC_{100} levels. Further, BAS was found to be less toxic than the other types. Sodium sulfonate tpxicity to fish was only next to LAS (1.2 times). Hence, the order of toxicity for the four detergents was LAS SS AOS BAS (Table 2).

It has been reported (Gard-Terech and Palla, 1986) that LAS is 2-4 times more toxic than BAS on **Daphnia** sp and zebra fish. In this study, this value was slightly higher (4.8 to 5.3) and was due to its C-14 chain length, which is known to be less toxic. This has been substanciated by Devo (1976) in his experiment on goldfish that a C-12 chain BAS is four times more toxic than a C-14 chain BAS or than a C-12 chain LAS. Hence, the toxicity of detergents to organisms depends on various factors such as the length of carbon chain, position of benzene ring, waste treatment procedures, type of surfactants and species (Swisher, 1970) and numerous environmental and biological parameters. The young ones, particularly the eggs and larvae are more susceptible to detergent lethality than the later life stages.

It was observed during the experiment with all detergents, the fishes started swimming vigorously and tried to escape the water by jumping out for a short while. In the tanks with higher concentrations, uncontrolled movements (specially more with LAS) with small jerks were observed followed by loss of equalibrium and convulsion, became inverted and died. Contrarily, in the control, no such behaviour was noticed.

Hokanson and Smith (1971) observed that the lethal threshold concentrations of LAS for blue-gill varied from 4.0 to 4.5 mg/1 in soft water and 2.8 to 2.9 mg/1 in hard water. Hemce, the toxicity of detergents greately increases in seawater, the hardness of seawater being far more greater than freshwater. So, a particular type of detergent or a mixture of detergents entering the coastal waters does greater harm to the biota than when entering into a freshwater system.

In unpolluted natural waters the total detergent load (measured as MBAS activity) is around 0.5 mg/1 (which is the WHO standard for drinking water) and in highly polluted waters (Dave et al., 1986), at the point of sewage disposal and drainage, it is around 2.0 - 3.0 mg/1. The situation becomes still more serious if heavy metals are present in above normal concentrations, since, the mixture of heavy metal and detergents causes greater damage to biota than either of them individually. Hence, any type of detergent pollution in coastal waters has to be viewed seriously, since the organisms low in the food chain and other sensitive ones will be wiped out even at low concentrations.

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