Comparative Toxicity of Four Detergents on a Prawn *Metapenaeus dobsoni* (Miers)

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The toxicity bioassay experiment was conducted using four detergents, namely, linear alkylbenzene sulfonate (LAS), branched alkylbenzene sulfonate (BAS), alfa olefin sulfonate (AOS) and sodium sulfonate (SS.) on *Metapenaeus dobsoni* juveniles. The results indicated that, LAS was most toxic and AOS the least and were in the order: LAS > SS. > BAS > AOS. The LC_{16}, LC_{50} and LC_{84} concentrations for all the detergents were calculated for 24, 48, 72 and 96 hours. The 95% confidence limits for LC_{50} and slopes were also calculated by probit analysis.

The rapid expansion of synthetic detergent industry to commensurate the growing need for more effective and cheaper cleaning products, has led to formulation of a variety of surfactants without paying much attention to the environmental impacts. The structure, chemistry and biodegradation of various types of detergents in natural waters has been reviewed by Swisher (1970). However, much works on the toxicity and biodegradation of linear alkyl benzene rulfonate (LAS) and branched alkyl benzene sulphonate (BAS) in natural waters have been reported (Abel, 1974; Arthur, 1970; Chattopadhyay & Konar, 1985; Dave *et al.*, 1986; Divo, 1976; Henderson *et al.*, 1959; Hokanson & Smith, 1971). Still the effects of these and other detergents on aquatic organisms (specially estuarine and marine) needs detailed investigation. Very scanty information is available on the effects of detergents on estuarine and marine organisms (Bhat *et al.*, 1988; Eisler, 1965 & 1979).

In the present study, four detergents LAS, BAS, sodium sulfonate (abbreviated as S.S.) and a commonly available household washing soap 'Mega' in Indian markets, which claimed to have alfa olefin sulfonate (AOS) in it were selected to compare the toxic effect of each type on juveniles of a prawn, *Metapenaeus dobsoni*. This species is abundant in the coastal waters of Kali estuary at Karwar, Central West coast of India. Since *M. dobsoni* is a commercially important shellfish of this region, there is a need to evaluate the toxicity levels of various types of deter gents entering directly or indirectly through the sewage. Special attention was focussed on AOS, since the environmental acceptability of this type of detergent is wanting, as there are no reports about its toxicity on estuarine and marine organisms, particularly on young and sensitive ones.

Materials and Methods

The juveniles of *M. dobsoni* were procured from the hatchery with an average length of 2.2 cm. Uniform hydrological parameters (salinity 27.0 ± 0.3 ‰, temperature 25 ± 0.2°C, pH 8.0 ± 0.2 and D.O. 3.8 ± 0.3 mg/l) were maintained at all stages of the experiment. The toxicity bioassay experiment was conducted as per Standard Methods (APHA, 1980). The range of concentrations selected in this study were derived from a range finding test for each detergent. All the experiments were carried out upto 96 h with 20 animals in each case and a control was maintained, in which no mortality occurred upto 96 h. Seven concentrations ranging from 2.8 to 6.5 ppm for LAS, seven concentrations ranging from 4.9 to 8.5 ppm for BAS, eight concentrations ranging from 3.2 to 7.6 ppm for S.S. and six concentrations ranging from 6.5 to 12.5 ppm for AOS were selected for toxicity testing. Artificial aeration was provided only during acclimatisation (48 h) and not during bioassay to avoid the foaming. All the containers were covered with nylon net.

For the determination of AOS content in 'Mega' soap, the standard NBAS procedure (APHA, 1980) was followed using LAS as a standard. One gram of oven dried (at 100°C) soap was dissolved in water and this solution was used for the determination of AOS concentration. The AOS concentration of 187 mg/1 was obtained by the above method and this solution was used for the toxicity bioassay. The data were analysed by Litofield & Wilcoxon (1949) method.

Results and Discussion

Fig. 1 shows the toxicity curves (LC_{50}) for the four detergents on exposure to *M. dobsoni* juveniles. All the curves show almost a similar trend in toxic effects with time. It was noticed that, LAS was most toxic detergent when compared to other types (Table 1). This agrees with the earlier observations (Dave *et al.*, 1986; Eisler, 1965; Gard-Terech & Palla, 1986; Henderson *et al.*, 1959) where LAS was found to be the most toxic detergent on aquatic organisms than other types. However, one advantage with LAS is that it degrades faster (Swisher, 1970) whereby loses its toxicity considerably.

Hence, all over the world this detergent is widely used in the manufacture of soap. But, even if a very small concentration persists, it would damage sensitive organisms, especially so in estuaries and seas, as the toxic effect of detergents is enhanced in hand water (Hokanson & Smith, 1971), eventhough the degradation rate of this and other detergents remain unhanged in freshwater, estuary or the sea (Eisler, 1965).

The toxicity of four detergents on *M. dobsoni* was in the order; LAS > S.S. > BAS AOS (Table 1) at LC_{16}, LC_{50} and LC_{84} levels. Further, LAS was more toxic than BAS by 1.0 to 1.6 times, S.S. by 1.3 to 1.5 times and AOS by 2.0 to 2.5 times at LC_{50} levels. It was reported by Gard-Terech & Palla (1986) that, LAS is 2 to 4 times more toxic than BAS. For other types, no comparative toxicity values are available.

Table 1. *Comparative toxicity values of four detergents on exposure to Metapenaeus dobsoni*

Time h	LC_{16} ppm	LC_{50} ppm	(with 95% confidence limits)	LC_{84} ppm	Slope (with 95% confidence limits)
LAS					
24	5.69	7.15	(6.707– 7.263)	8.61	1.2304 (1.2042–1.2566)
48	4 66	7.25	(6.591– 7.975)	9.85	1.4572 (1.3586–1.5558)
72	3.72	5.36	(5 033– 5.703)	7.01	1.3473 (1.3078–1.4409)
96	2.19	3.74	(3.428– 4.080)	5.29	1.5611 (1.4144–1.7076)
BAS					
24	6.90	8.81	(8.335– 9.312)	10.72	1.2468 (1.2168–1.2768)
48	6.22	8.16	(7.735– 8.609)	10.10	1.2748 (1.2377–1.3199)
72	5.60	7.51	(7.139– 7.901)	9.42	1.2977 (1.2543-1.3411)
96	4.24	5.85	(5.535– 6.183)	7.45	1.3266 (1.2735–1.3797)
S.S.					
24	6.66	9.22	(8.435–10.077)	11.78	1.3310 (1.2777–1.3844)
48	5.21	7.60	(7.076– 8.162)	9.99	1.3866 (1.3145–1.4587)
72	4.56	6.49	(6.140– 6.860)	8.42	1.3604 (1.2974–1.4232)
96	2.79	5.37	(4.918– 5.864)	7.95	1.7026 (1.4804–1.9247)
AOS					
24	11.01	17.58	(14.785-20.903)	24.15	1.4852 (1.3737–1.5967)
48	9.00	12.61	(11.505–13.821)	16.22	1.3437 (1.2863-1.4011)
72	7.15	9.68	(9.132–10.261)	12.21	1.3076 (1.2614–1.3538)
96	5.81	7.53	(7.157– 7.922)	9.26	1.2629 (1.2297–1.2960)

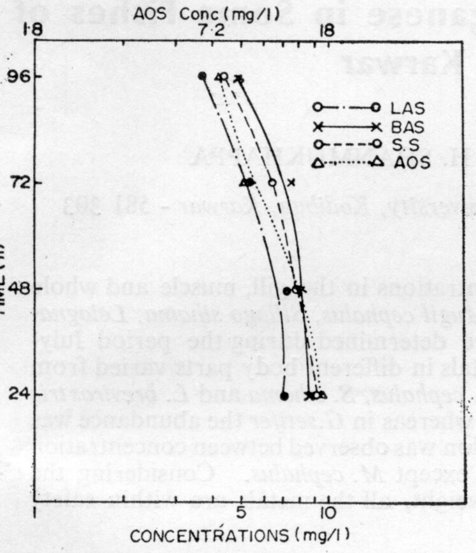

Fig. 1. Toxicity curves of four detergents on *Metapenaeus dobsoni*

Due to continuous discharge of waste water (sewage) containing detergents into the natural waters, certain proportion of detergent molecules tend to adsorb onto sediment particles. Such sediments in some polluted waters are known to contain 5–12 mg of detergents per kg of dry sediments (Ishiwatari *et al.*, 1983) in the top 30 cm. It is also known that, the detergent molecules adsorbed from the water onto sediment particles, retain unchanged toxic effects and can be ingested by detritus feeding benthic and epibenthic animals. It is quite reasonable to assume that, even if low detergent concentration persist in the water column the bottom might have quite higher levels of detergents. Also due to greater hardness of water, even the low concentration may be harmful to atleast young and sensitive animals (Hokanson & Smith, 1971). Hence, the detergent affects on the prawns (which are epibenthic in habitat) by two ways i) by ingestion alongwith the detritus and ii) external contact with respiratory surfaces. Therefore it is imminent to have a close a watch on detergent pollution of any type in coastal waters.

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