

A Comparative toxicity study on the morphological and behavioural response of detergents on a freshwater fish, *Clarias batrachus* (Linnaeus)

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ABSTRACT

The pollutant can disrupt the biological balance or cause deleterious effects on the aquatic ecosystem. In this study, fishes were exposed to lethal and sublethal concentrations of two types of detergent Det-I and Det-II to observe morphological and behavioural response. For the experiment, the average length of fish was 15 to 20 cm and the average weight was 90 to 100 gm. Fishes are exposed for 96 hours for those 8 plastic tubs used for exposure, 3 tubs of sublethal concentration of Det-I and other 3 tubs of Det-II, and 2 tubs for control. Each tub was stocked with 6 fish and three replicates were conducted. Fishes show morphological and behavioural responses such as swimming, jumping, walking on the floor, Discoloration and lesions on the skin, Mucus secretion, Depositing of detergent on the body, Bleeding, Barbell damage, etc.

Keywords: Morphological, Behavioural response, detergent, *Clarias batrachus* (Linnaeus)

INTRODUCTION

Pollutants enter into water bodies they produce harmful effects, The presence of these pollutants causes different degrees of effect, depending on the species of affected fish (Rao and Murty, 1982). The presence of pollutants affects age, size, reproduction, and general physical condition. The effect of pollution depends upon exposure time concentration and the type of toxicant released in the environment. Environmental and health assessment of substances in household detergents and cosmetic detergent products are capable of destroying the external mucus layers that protect the fish from bacteria and parasite infection (Madsen et. al. 2001). when the pollutants are discharged in low concentrations with an increase in discharge rate in the ecosystems, there is an accumulated effect which in turn may be hazardous.

Behavioural changes have been used successfully as rapid as sensitive indicators of toxic stress in fish (Sprague et. al. 1963; Thatcher, 1966). The behaviour of living organisms is related to physiological function with

ecological processes, when physiological functions are disturbed automatically body shows the different types of morphological and behavioural patterns. Behavioural indicators of toxicity appear ideal for assessing the effects of pollutants on fish. With the various concentrations of detergents, fish show various types of behavioural changes, such as slow and fast swimming movement, cornering, secretion of mucus from the skin, and epithelium of gills. Death of the fish due to bleeding, fast opercular movement, surfacing, jerking, jumping, and change in colour.

MATERIAL AND METHOD

In this study, fishes were exposed to lethal and sublethal concentrations of two types of detergent Det-I and Det-II to observe morphological and behavioural response. Tests were conducted in laboratory conditions, for which fishes were collected from District Gumla, Jharkhand and treated with 1% potassium permanganate for a disinfectant and acclimatized in a glass aquarium in laboratory condition for 15 days as per the guideline as described in APHA, 1995. Fishes fed with dry prawn powder. The average size of fish was 15-20 cm and the average weight was 90-100 gm. During the experiment crowding was avoided, Temperature, pH, Dissolved Oxygen, and Free Carbon dioxide, were frequently checked and water was changed after the regular interval of 24 hrs.

Fishes are exposed for 96 hours for those 8 plastic tubs used for exposure, 3 tubs of sublethal concentration of Det-I and other 3 tubs of Det-II, and 2 tubs for control. Each tub was stocked with 6 fish and three replicates were conducted.

RESULTS AND DISCUSSION

Fishes are exposed to detergent I to find out the acute toxicity during the exposure period abnormal behaviour expressions were observed and are recorded in Tables No. 1 and 2.

During the 24 hours of exposure fast swimming, jumping, cornering, and walking on the floor was observed later on fishes exhibited slow swimming activity. Ambient water became yellow-brown in colour and turbid, slimy with a foul smell. The opercular movement was fast. Detergent particles

were deposited on the body, fins were torn. After 48 hrs fishes swim slowly and settle down at the bottom for some time and again swim. Fishes died with mouth and operculum open and clotting of blood on gills, skin, etc., fins were torn, and body colour changed to the whitish, slimy layer. After 72 hrs exposure period they exhibited a very slow response water became slimy with a foul smell. In higher concentrations, barbells became loose and hung. The colour changed from blackish brown to pale yellowish and slightly whitish, scattered bleeding spots were observed on the body.

After 96 hrs fish doesn't respond to touch and settles at the bottom. Barbells were broken and in some, they hung down. The opercular movement was slow, and mucus secretion and rough skin were observed. Bleeding and clumping of gills deposition of detergent on the body. The eye colour changed to milky white at the centre. Death occurs with the mouth open the body becomes slimy, body colour changes to yellow. Blood clotting was observed, and fins were torn. The water became more turbid with a dirty odour.

Fishes exposed to detergent II (Table No. 3 and 4) show the effect of detergent 'Vanish' on behavioural and morphological changes in freshwater fish, *Clarias batrachus* (L).

Fast swimming, jerking, jumping, and walking on the floor were observed in lower concentrations whereas in higher concentrations activity was slow. Water became slimy and turbid and the odor was foul. In higher concentration they became restless. Opercular movement was fast fins were torn.

In higher concentrations, fishes swim slowly and settle down at the bottom for some time and again swim. Loss of balance was also noted when they dashed to the wall of the aquarium. They died with open mouths and operculum. Blood clotting was observed, and the Body colour changed to white. Fins became hard and torn.

The movement of fish was very slow. Restlessness and loss of balance were also observed. The colour changed to pale yellowish and slightly whitish. Bleeding spots were observed on the body. Barbells were damaged. Blood clotting spots on dead fish, gills dark red coloured, turbidity, and a foul smell of the water were observed.

Table 1: Shows the behavioural responses of freshwater fish, *Clarias batrachus* (Linnaeus) to a detergent, Det-I.

Sr. No.	The sublethal concentration of detergent Det-I.	Behavioural responses	Exposure Period (hrs)			
			24	48	72	96
1	Control	Restlessness	-	-	-	-
		Loss of balance	-	-	-	-
		Opercular movement	-	-	-	-
		Response to taping	-	-	-	-
		Jumping out	-	*	*	*
		Active Walk on Floor	-	*	*	-
		Swimming behavior	-	-	-	-
		Settle at the bottom	-	-	-	-
2	17.5 mg/L	Restlessness	-	*	*	**
		Loss of balance	-	-	-	*
		Opercular movement	*	*	*	**
		Response to taping	*	*	**	**
		Jumping out	*	*	**	**
		Active Walk on Floor	*	*	**	**
		Swimming behavior	*	*	**	***
		Settle at the bottom	-	-	*	**
3	35.5 mg/L	Restlessness	-	*	**	**
		Loss of balance	-	-	**	***
		Opercular movement	-	*	**	***
		Response to taping	*	**	***	-
		Jumping out	*	*	*	-
		Active Walk on Floor	*	*	-	-
		Swimming behavior	*	*	**	***
		Settle at the bottom	-	*	*	**
4	52.5 mg/L	Restlessness	*	*	***	****
		Loss of balance	-	**	***	****
		Opercular movement	*	**	***	****
		Response to taping	*	**	-	-
		Jumping out	*	*	-	-
		Active Walk on Floor	*	*	**	-
		Swimming behavior	**	***	***	****
		Settle at the bottom	***	***	***	****

Symbol (-) = Normal or No response, (*) = Abnormal response, (**) = Mild increase response, (***) = Moderate increase response, (****) = Maximum increase response

Fish settled down at the bottom at the lateral side, when touched they showed a very slow response, restlessness, loss of balance, and equilibrium was noted. Body colour changed to whitish. The opercular movement was very slow, secretion of mucus on the skin, broken barbells, bleeding, and clumping of gills were observed. In dead fish operculum was open, their eyes became black, and their fins were rough and torn. Water became more turbid. Fishes show more abnormal behaviour in D-I than in D-II.

Nayak and Madhyastha (1987), *Rasbora daniconius* exposed to detergent SLS (Sodium Lauryl Sulphate) and 'Point' to lethal and sublethal concentrations observed hyperactivity. When touched dead fishes slippery exhibiting hyper secretion of mucous. The gill exhibited ruptured epithelial cells and the abdomen is enlarged due to the accumulation of air bubbles. Schmid and Mann (1961) observed an increase in several opercular movements in *L. gibbosus* exposed to the detergent Dodecyl Benzene Sulphonate at 20 mg/L concentration.

Table 2: Shows morphological changes in freshwater fish, *Clarias batrachus* (Linnaeus) due to exposure to detergent Det-I.

Sr. No.	The sublethal concentration of detergent Det-I.	Morphological changes	Exposure Period (hrs)			
			24	48	72	96
1	Control	Discoloration of skin	-	-	-	-
		Lesions on skin	-	-	-	-
		Mucus secretion	-	-	-	-
		Deposition of detergent on the body	-	-	-	-
		Bleeding	-	-	-	-
		Clumping of gills	-	-	-	-
		Fin damage	-	-	-	-
		Barbell damage	-	-	-	-
		Turbidity and Foul smell of water	-	-	-	-
2	17.5 mg/L	Discoloration of skin	-	-	*	**
		Lesions on skin	-	-	*	*
		Mucus secretion	**	**	***	***
		Deposition of detergent on body	-	-	-	*
		Bleeding	-	-	-	-
		Clumping of gills	-	*	**	**
		Fin damage	-	-	-	*
		Barbell damage	-	-	-	*
		Turbidity and Foul smell of water	**	***	***	****
3	35.5 mg/L	Discoloration of skin	-	*	**	***
		Lesions on skin	-	*	*	**
		Mucus secretion	-	**	***	**
		Deposition of detergent on body	-	-	-	*
		Bleeding	-	-	*	**
		Clumping of gills	-	*	***	****
		Fin damage	-	-	**	**
		Barbell damage	-	-	**	**
		Turbidity and Foul smell of water	***	***	***	***
4	52.5 mg/L	Discoloration of skin	*	**	**	****
		Lesions on skin	-	*	*	**
		Mucus secretion	***	***	***	***
		Deposition of detergent on body	-	-	*	**
		Bleeding	-	*	**	***
		Clumping of gills	**	***	***	****
		Fin damage	*	**	***	***
		Barbell damage	-	**	***	****
		Turbidity and Foul smell of water	****	****	****	****

Symbol (-) = Normal or No response, (*) = Abnormal response, (**) = Mild increase response, (***) = Moderate increase response, (****) = Maximum increase response.

Varma et al. (1980) studied the toxicity of five synthetic detergents on the behaviour of two freshwater teleost, *Channa punctatus*, and

Saccobranchus fossilis and noted in both the fishes such as restlessness, jumping out, reflected by erratic swimming, and increased opercular movements,

violent actions of pelvic fin and difficulty in respiration. Fishes were more excited in the higher concentration than the lower. Some fishes are frequently dashed to the walls of jars, suggesting the impairment of their sense of balance and subsequently, they become progressively lethargic. They lose their balance possibly due to a disorder in

the central nervous system discernible by the fast and jerky movements before death.

Behavioural patterns of the fingerlings of fish, *Cirrhina mrigala* exposed to synthetic detergent. Muscular expansion and concentration of buccal and opercular activities to maintain a flow of water over gill surfaces were observed in fingerlings (Hazari et al., 1984).

Table 3: Shows the behavioural responses of freshwater fish, *Clarias batrachus* (Linnaeus) to detergent Det-II.

Sr. No.	The sublethal concentration of detergent Det-II	Behavioural responses	Exposure Period (hrs)			
			24	48	72	96
1	Control	Restlessness	-	-	-	-
		Loss of balance	-	-	-	-
		Opercular movement	-	-	-	-
		Response to taping	-	-	-	-
		Jumping out	-	*	*	*
		Active Walk on Floor	-	*	*	*
		Swimming behaviour	-	-	-	-
		Settle at the bottom	-	-	-	-
2	50 mg/L	Restlessness	-	*	**	***
		Loss of balance	-	-	-	*
		Opercular movement	*	*	*	**
		Response to taping	*	*	**	**
		Jumping out	*	*	**	**
		Active Walk on Floor	*	*	**	-
		Swimming behavior	*	*	**	***
		Settle at the bottom	-	-	*	**
3	100 mg/L	Restlessness	-	*	**	**
		Loss of balance	-	-	**	***
		Opercular movement	-	*	**	***
		Response to taping	*	*	**	-
		Jumping out	*	*	**	-
		Active Walk on Floor	*	**	-	-
		Swimming behavior	*	*	**	***
		Settle at the bottom	-	*	*	**
4	150 mg/L	Restlessness	*	*	**	***
		Loss of balance	-	**	***	****
		Opercular movement	*	**	***	****
		Response to taping	*	**	-	-
		Jumping out	*	*	-	-
		Active Walk on Floor	*	*	-	-
		Swimming behavior	**	**	***	****
		Settle at the bottom	**	**	***	****

Symbol (-) = Normal or No response, (*) = Abnormal response, (**) = Mild increase response, (***) = Moderate increase response, (****) = Maximum increase response

Table 4: Shows morphological changes in freshwater fish, *Clarias batrachus* (Linnaeus) due to detergent Det-II.

Sr. No.	The sublethal concentration of detergent Det-II	Morphological changes	Exposure Period (hrs)			
			24	48	72	96
1	Control	Discoloration of skin	-	-	-	-
		Lesions on skin	-	-	-	-
		Mucus secretion	-	-	-	-
		Deposition of detergent on body	-	-	-	-
		Bleeding	-	-	-	-
		Clumping of gills	-	-	-	-
		Fin damage	-	-	-	-
		Barbell damage	-	-	-	-
		Turbidity and Foul smell of water	-	-	-	-
2	50 mg/L	Discoloration of skin	-	-	-	*
		Lesions on skin	-	-	*	*
		Mucus secretion	**	**	***	***
		Deposition of detergent on body	-	-	-	*
		Bleeding	-	-	-	-
		Clumping of gills	-	*	*	**
		Fin damage	-	-	*	*
		Barbell damage	-	*	*	**
		Turbidity and Foul smell of water	***	***	***	***
3	100 mg/L	Discoloration of skin	-	-	**	**
		Lesions on skin	-	*	*	**
		Mucus secretion	**	**	***	****
		Deposition of detergent on body	-	-	*	*
		Bleeding	-	-	-	*
		Clumping of gills	-	*	***	****
		Fin damage	-	*	**	**
		Barbell damage	-	-	**	***
		Turbidity and Foul smell of water	***	***	***	***
4	150 mg/L	Discoloration of skin	*	*	**	****
		Lesions on skin	-	*	**	*
		Mucus secretion	***	***	***	****
		Deposition of detergent on body	-	-	*	**
		Bleeding	-	-	-	*
		Clumping of gills	**	**	***	***
		Fin damage	*	*	**	***
		Barbell damage	-	*	**	****
		Turbidity and Foul smell of water	***	***	****	****

Symbol (-) = Normal or No response, (*) = Abnormal response, (**) = Mild increase response, (***) = Moderate increase response, (****) = Maximum increase response

Sarkar and Konar (1993) exposed fish, *Oreochromis mossambicus* to a mixture of detergents, petroleum products, heavy metals, and pesticides, the fishes settled at the bottom and their movement slowed down, with regular surfacing, excessive secretion of

mucous from gill epithelium in response to irritation caused during contact with pollutant mixture. Prakash (1996) Fish show symptoms such as discoloration, damage of gills, distress, and secretion of mucous. In dead fishes' mouths were opened and gill rakers were

raised. He suggested that natural soaps are not harmful as compared to synthetic detergent but it causes damage to the respiratory epithelium. Sannadurgappa (2002) investigated the behavioural response of fish, *Oreochromis mossambicus*, and *Cyprinus carpio* to detergent Sodium Dodecyl Sulphate (SDS), Sodium Lauryl Sulphate (SLS), and Triton X-100 and observed changes in surfacing, gulping, and erratic opercular movements. At higher concentrations, a thin layer of mucous was observed over the body surface. Hemorrhaging from the pectoral fin was observed due to the rupture of blood vessels within the gill filaments. Fishes died with the wide opening of mouths, body colour changed to become yellowish. During sublethal exposure, the fishes were unable to feed regularly and exhibited aimless swimming, and irregular surfacing, and became sluggish.

Topale, *et. al.* (2013) observed in the freshwater Crab, *Paratelphusa jacquemontiil* (Rathbun), Changes in the diet, behaviour patterns, and increased amount of detergent accumulation in the gills, loss of body balance, changes in the colour of carapace were observed. Barbieri (2007) studied metabolism and swimming activity to evaluate the Sublethal toxicity of surfactant (LAS-C12) on *Mugil platanus*. The swimming period throughout exposure was progressively decreased about control. It was considerably decreased at higher concentrations of toxic agent, LAS as longer periods of exposure. Adewoye (2010) observed the abnormal behaviour of *Clarias gariepinus* when exposed to soap and detergent in both fingerlings and adults such as hyperactivity, erratic swimming, and frequent surfacing followed by sinking, loss of equilibrium and colourations and gradual onset of inactivity, slow and uncoordinated movement. The fingerlings exhibited loss of equilibrium, frequent surfacing, discolourations, erratic swimming, and gill movement at all concentrations.

Rosas *et. at.* (1988) studied the effects of sub-lethal concentrations of sodium Alkyl Aryl Sulfonate on 21-day exposure in *Ctenopharyngodon idella* at 3, 5, and 8 ppm. An increase in opercular movements was also noted.

Ribelles *et. al.* (1995) observed morphological and histochemical changes caused by Sodium Dodecyl Sulfate in the *Sparus aurata* and reported marked alteration in the branchial filaments of individuals

exposed to concentrations from 3 to 15 mg/L of SDS. Barbieri *et. al.*, (1998) evaluated the effect of Dodecyl sodium sulfate (DSS) on the metabolism of a fish, *Cyprinus carpio* to study toxicant effects caused by detergents and observed the Swimming performance of fish can indicate deterioration, in several other species the swimming capacity was affected in concentrations between 0.6 to 4.7 mg/L. Morphological and ultrastructural changes induced by an anionic detergent on *Ictalurus* species barbell and taste buds were reported to have damaged the catfish barbell taste buds (Zeni and Caligiuri, 1992 and Zeni *et. al.*, 1995).

Okwuosa and Omoregie, (1995) experimented on the acute toxicity of Alkyl Benzene Sulphate (ABS) detergent to the toothed carp, *Aphyosemion gairdneri*, and showed damage to olfactory epithelium in the nasal capsule, inhibited enzyme activity and cause oxygen stress by affecting the gills. Saxena *et. al.* (2005) studied the toxic effects of four commercial detergents (two washing powders and two cakes) on the behaviour, mortality, and RBC counts of a freshwater fish, *Gambusia affinis*. During acute toxicity studies surface movements of fish increased markedly for 24 hrs, only at higher concentrations of all four detergents. Thereafter, they were lethargic and bottom dwellers similar to those exposed for 30 days in the long-term ecotoxicological studies made on detergent powders at a sublethal concentration (10 ppm). The detergents exposed to fish were found slippery due to mucous secretion. Hemorrhage regions were also found on their gills.

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