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GLOCAL ENVIRONMENT & SOCIAL ASSOCIATION

International Journal of Biological Innovations
http://ijbi.org.in | http://www.gesa.org.in/journals.php
https://doi.org/10.46505/IJBI.2025.7109
IJBI 7(1): 74-79 **(2025)**
E-ISSN: 2582-1032

ACUTE TOXICITY AND ETHOLOGICAL RESPONSES OF FRESHWATER FISH *CHANNA PUNCTATA* (BLOCH) EXPOSED TO HOUSEHOLD SYNTHETIC DETERGENT

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Article Info:
Research Article
Received
11.03.2025
Reviewed
03.05.2025
Accepted
15.05.2025

Abstract: The detergents are household chemical cleaning compounds used in a wide range of our daily life for diverse purposes. 'Ghari' is a common detergent used largely in India. The present study examined the effects of a commercial household synthetic detergent 'Ghari' on the mortality and behavioural changes in the freshwater fish *Channa punctata*. The median lethal concentration (LC_{50}) of this detergent was determined using probit analysis software (SPSS version 26) at 95% confidence limit. The 96h LC_{50} value for *Channa punctata* was found to be 20.121 mg/L. Toxicity increased significantly with higher detergent concentrations and longer exposure periods. Morphological changes observed after 96 hours of exposure included body and gill discoloration, damaged fins, and excessive mucus secretion. Behavioural alterations in detergent-exposed fish included erratic swimming, restlessness, aggression, hyperactivity, and frequent movement near the bottom of the tank. Further research is recommended to explore the physiological effects for a better understanding of environmental impacts.

Keywords: Acute toxicity, *Channa punctata,* Detergent, Ethological responses, Ghari, LC_{50}.

Cite this article as: Upadhyay S. and Singh D. (2025). Acute toxicity and Ethological responses of freshwater fish *Channa punctata* (Bloch) exposed to household synthetic detergent. *International Journal of Biological Innovations*. 7(1): 74-79. https://doi.org/10.46505/IJBI.2025.7109

INTRODUCTION

Detergents are complex mixtures of surface-active compounds or surfactants, builders and bleaches. The contaminations of aquatic ecosystem by detergents depend upon the amount and nature of their active ingredients. The active ingredients are also known as builders, which mostly consist of a mixture of sodium salts, borate, phosphates, carbonates, carboxymethyl cellulose, sulphates, silicate, perborate, etc. (Neil, 1985). Modern detergents possess high cleaning efficiency, primarily due to the presence of surfactants, which reduce the surface tension of water (Singh and Pandey, 2023).

The input of detergents particularly in freshwater aquatic ecosystem is causing pollution and the pollution is harmful for biodiversity (Singh *et al.,* 2023). This has reached a point of serious concern as reports suggesting their adverse effect on water quality, aquatic organisms including

fishes, eutrophication of natural waterbody due to presence of large amount of phosphates in detergents, reducing primary productivity of waterbody. It has been established that even insignificant amount of detergents reduce the resistance of fish enabling parasitic fungi to develop on them causing destruction of their fins. Detergents also impede the food source locating ability of fishes.

Some of the detergent constituents show high biological activity and has a tendency to accumulate in organisms, making adverse effects possible even at very low level of exposure (Prakash and Verma, 2018). Fishes are good bioindicator as these are very sensitive to changes in the aquatic medium and thus, play an important role in the monitoring of water pollution (Srivastava *et al*., 2010). The freshwater fish like *Channa punctata* (Bloch) is highly sensitive to the household detergents and other toxic chemicals (Goel *et al.,* 2022). A number of researches have also been done regarding the impact of various toxic substances on fishes (Shukla and Arya, 2017; Prakash and Verma, 2020a). Besides, several workers like Prakash and Verma (2014 and 2020b), Masih (2021), Aborisade and Atuanya (2023) and so on worked a lot on the effect of different pesticides on fish biology.

Detergents together with their ingredients and metabolites constitute the biggest groups of anthropogenic pollutants. The ability to these compounds to form foam is a serious problem because the organic contaminants or pathogenic micro-organisms are accumulated in the foam thereby posing an epidemiological threat. In addition, foaming also reduces aeration and causes hypoxia (Vasanthi *et al.,* 2013; Prakash and Singh, 2020; Tasmin *et al.,* 2023).

In consideration of the above facts and keeping in view the lack of systematic and correlative details, the present study is meant to determine the LC_{50} value of commercial detergent 'Ghari' and its effect on freshwater snake headed fish, *Channa punctata*, by using SPSS and also to study the ethological responses due to its toxic effects. The study will provide a baseline data that could be useful contribution in eco-toxicity risk assessment to the fish.

MATERIALS AND METHODS

Acclimatization of Test Fish

The freshwater fish, *Channa punctata* (Bloch) were collected from local freshwater bodies and the healthy fish of uniform length (9.5±0.2 cm) and weight (10.0±5g) were selected for the acute toxicity test. Then these fishes were brought to the laboratory in plastic container to avoid injury during transportation. The collected fishes were washed with 1.0 % solution of $KMnO_4$ for 5 minutes to remove any dermal infection. Fish were acclimated to laboratory conditions for 10 days at room temperature (26 ± 1.5°C) prior to experimentation. For the first week, the acclimatized fishes were given artificial air by aerator. All of the fish were given commercial food pellets on a regular basis, and the medium (tap water) was changed every two days to get rid of food remnants and faeces. Feeding was stopped 24 hour prior to the toxicity test.

Determination of Acute toxicity (LC_{50})

The experiments were carried out in glass aquaria of 15 litre capacity in laboratory conditions. The stock solution was prepared by dissolving 'Ghari' detergent in tap water. The range finding tests or exploratory tests were conducted to ascertain the final concentrations to be used in definitive test by following the standard method (APHA, 2005). Prior to the 96h static bioassay test, a range-finding test was carried out to determine the range of concentrations to be used. The range finding test was conducted using a broad concentration range (1, 10, 20, ….and 100 mg/L) and the test was terminated after 24 h. Concentrations of the detergent that caused death within 30 minutes were not considered for the further definitive toxicity test / LC_{50} test.

In the definitive test, the concentrations selected were based on the mortality values obtained with the range-finding test and were in appropriate logarithmic dilution series. Three replicate test tanks for each concentration (5, 10, 15, 20, 25, 30, 35 and 40 mg/L) contained a total of 5.0 L of the test solution and 10 test fishes. The percentage of mortality of the test fish after 96 hours exposure

to each concentration was calculated separately using the formula: mortality (%) = no dead/ total number tested×100%. The dead fishes were removed immediately from the aquaria. The control experiment contained the tap water. LC_{50} value of detergent for freshwater fish, *Channa punctata* was determined by using probit analysis software (SPSS version 26) at 95% confidence limit.

RESULTS AND DISCUSSION

Fish acute toxicity studies play a vital role in environmental risk assessment and hazard classification, as they provide preliminary estimates of the relative toxicity of different chemicals across various species. In the present study, acute toxicity tests usually provide estimates of the exposure concentration of 'Ghari' detergent causing 50 % mortality (LC_{50}) to test species *Channa punctata* within 96 hours of exposure.

It is clear from the data that detergent toxicity was increased with increasing the concentrations of detergents. At 96 h, when the test was terminated, mean mortality in response to 12 mg/L, 14 mg/L, 16 mg/L, 18 mg/L, 20 mg/L, 22 mg/L, 24 mg/L, 26 mg/L and 28 mg/L of 'Ghari' detergent was 10%, 20%, 20%, 30%, 40%, 50%, 70%, 80% and 100%, respectively (Table 1). The LC_{50} value of the 'Ghari' detergent to *Channa punctata* was found to be 26.215 mg/L, 24.479 mg/L, 21.927 mg/L and 20.121 mg/L for an exposure period of 24, 48, 72 and 96 hr, respectively (Table 2). The 96h LC_{50} value of Surf excel and Nirma for fresh water fish *Mystus montanus* were 20.0 mg/litre and 23.5 mg/litre respectively (Chandanshive, 2014). The LC_{50} value of the common household synthetic detergent to *Catla catla* was found to be 14.20 ppm for an exposure period of 96 h (Arivizhivendhan *et al*., 2014). The Fig 1a-1d shows that mortality percentage was increased significantly with increase in log concentration of Ghari detergent and exposure period. The same kind of toxicity effect was observed by some workers (Bhaskaran, 1991; Maruthanayagam *et al*., 1994).

Table 1: Percentage of mortality of Fish, *Channa punctata* (Bloch) at different concentrations of 'Ghari' detergent (mg/L).

Concentration of detergent (ml/L)	Log conc. of detergent	No. of Test fish	Percent mortality at different exposure period (hours)			
			24	48	72	96
Control (0.0)	-	10	0	0	0	0
10	1.000	10	0	0	0	0
12	1.079	10	0	0	0	10
14	1.146	10	0	0	10	20
16	1.204	10	0	10	10	20
18	1.255	10	10	20	20	30
20	1.301	10	10	20	30	40
22	1.342	10	20	30	40	50
24	1.380	10	30	40	60	70
26	1.415	10	40	50	70	80
28	1.447	10	50	60	90	100
30	1.477	10	70	80	100	-
32	1.505	10	90	100	-	-
34	1.531	10	100	-	-	-

The alterations in the behavioural pattern are the most sensitive indication of potential toxic effects. The behavioural alteration observed in fish, *Channa punctata* increased with the dose and duration. The fish exposed to 10.0 to 34.0 mg/L detergent concentrations exhibited

Table 2: LC_{50} values with 95% confidence limits for *Mystus vittatus* (Bloch) exposed to 'Ghari' detergent at different exposure period.

Exposure period (hrs.)	LC_{50} values of detergent (mg/L)	95% Confidence limits (v/v%)		Regression equation	Chi Square value (P value)	Coefficient of determination (R^2Linear)
		Lower limit	Upper limit			
24	26.215	24.610	28.045	Y= -13.89+9.78X	4.151 (0.965)	0.971
48	24.479	22.686	26.684	Y= -9.79+6.99X	4.234 (0.936)	0.941
72	21.927	20.325	23.721	Y= -11.17+8.32X	3.862 (0.920)	0.926
96	20.121	18.329	22.269	Y= -7.89+9.35X	4.085 (0.849)	0.935

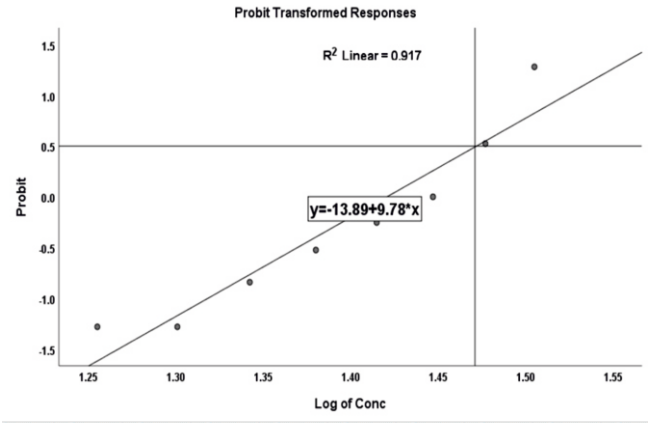

Fig. 1a: Regression line (based on Probit analysis) of Log concentration of 'Ghari' detergent vs % mortality of *Channa punctata* (at 24 hrs).

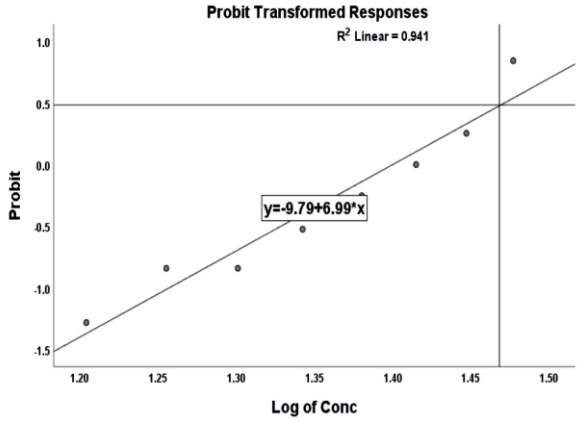

Fig. 1b: Regression line (Based on Probit analysis) of Log concentration of 'Ghari' detergent vs % mortality of *Channa punctata* (at 48 hrs).

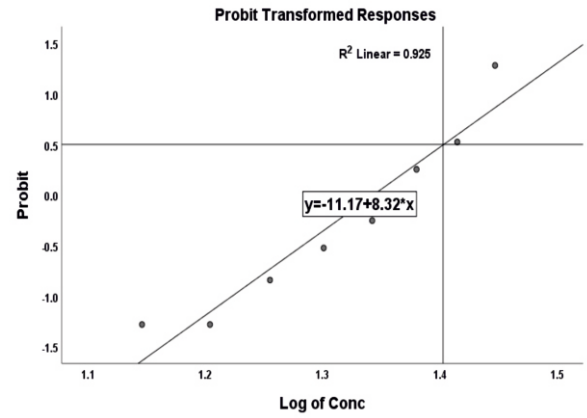

Fig. 1c: Regression line (Based on Probit analysis) of Log concentration of 'Ghari' detergent vs % mortality of *Channa punctata* (at 72hrs).

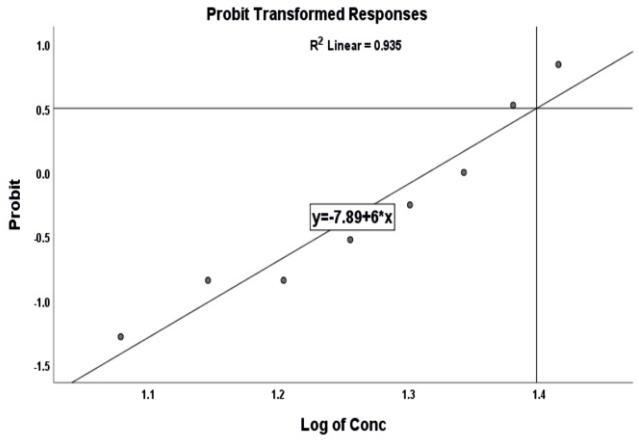

Fig. 1d: Regression line (Based on Probit analysis) of Log concentration of 'Ghari' detergent vs % mortality of *Channa punctata* (at 96 hrs).

abnormal behaviour in the form of erratic swimming, loss of equilibrium and enhanced surfacing behaviour. At the start of the exposure, the fish exposed to the detergent became alert; with the progression of the experiment, the fish stopped swimming and remained in static position in response to the sudden changes in the surrounding environment. Authors observed that the fish experienced progressive surfacing, air gulping, restlessness, escaping movement, erratic swimming, increased mucous secretion lethargic, loss of equilibrium, difficulty in respiration, exhibited convulsions, settling to the bottom before death. There were no behavioural changes observed in the control group.

ACKNOWLEDGEMENTS

Authors are grateful to Principal, S.P. P.G. College, Shohratgarh, Siddharthnagar (U.P.), India for providing necessary laboratory facilities.

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