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Effect of house hold detergent on the brain histology of fresh water murrel *Channa punctatus*

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Abstract

In India detergent is widely used for cleanliness and hygiene at domestic and industrial level. Detergent accumulates in aquatic ecosystems and exerts toxic effects on aquatic animals. Present study aimed to investigate effects of surf excels detergent in water on brain tissue of Channa punctatus. Treatments including 0 (control), 17 and 30mg/L for 7 days. Histopathological analysis was performed after 3, 5 and 7 days of exposure. No significant changes were observed for control and exposure to 17mg/L for 3 days whereas structural degeneration, hypertrophy, hyperplasia observed in 17 mg/L concentration treatment after 5 and 7 days, 30mg/L concentration treatment showed structural degeneration, hypertrophy, hyperplasia, vacuolization, fissure and congestion after 3, 5 and 7 days of exposure.

Keywords: Household detergent, *Channa punctatus*, Brain, Histology, Toxicity.

Introduction

Flourishing industrialization and urbanization processes have led to changes in aquatic ecosystem due to the input of pollutants. Among the contaminants domestic agents are with greatest impact, it is estimated that 2 billion kg per year are used worldwide. Bodies of water serve as sinks for hazardous pollutants originating from industrial, domestic, and agricultural effluents. Washing textiles and garments is one of the most common and important tasks in every home today. Soaps and detergents are necessary for maintaining clean and hygienic homes as well as public places such as schools, hospitals, hotels, and restaurants. They are also used for protecting and restoring the appearance of clothing and providing people with a general sense of well-being[1]. Among this, concern has been shown on issues arising to the environment from detergent's composition and its production[2].

After washing clothes in the home, the wash water is discharged into the sewage treatment system or directly into the environment, such as through a septic tank in rural areas. The potential impact of such releases is determined by the inherent chemical properties as well as the amount used for washing and eventually discharged into the environment. Detergents are organic chemicals used as cleansing agent at domestic industrial level. A laundry detergent generally comprise of six groups of substances: surfactants, builders, enzymes, fillers, bleaching agents, and other minor additives such as, fabric softening clay, dye-transfer inhibiting ingredient, and optical brighteners[3]. Surfactants are the most important ingredients in laundry and household cleaning products (15% to 40% of the total detergent formulation)[4].

Detergent contains many non-biodegradable chemicals substance in its composition which form a layer of foam which expand with water and ultimately leads to pollution[5,6]. Solid waste in the form of sludge is also generated from wastewater treatment upon use of laundry detergents[7]. Detergents cause eutrophication which results in reduced oxygen and transmission of light in water. This reduces the fresh water quality, changes the pH and affects ultimately the fauna and flora of water bodies[8-10].

Fishes are the one of the important aquatic animals. Fisheries in India is growing sector with more than 14.50 million people depending on it for their livelihood security[11]. India is the second largest fish producing country[12]. However, increasing detergent contaminants in water bodies affect fish population adversely and therefore it is important to study the effect of detergent on fish due to its economic important. Fishes are sensitive to toxic contaminants in aquatic environment such as detergents which are capable to cause hematological, physiological, biochemical and molecular stresses[13]. Fishes are the most reliable experimental model to study the effect of contaminants and their toxicity. As a primary consumer, fish can metabolize and store pollutants in their bodies. Fresh water fish *Channa punctatus*is an excellent model species due to its wide distribution easy maintenance and availability throughout the year[14]. The Brain is highly prone to oxidative stress because of its high oxygen consumption rate and lipid content[15]. Stress-related physiological and behavioral responses in fish are regulated by the brain and neurotransmitters[16]. Hypothalamo-pituitary-gonad (HPG) axis hormones is predominantly controlling the reproduction in fish.

Stress on brain causes adverse effect on brain function and consequently on reproduction[17]. Reduction in reproduction rate causes economic deprivation.

Mechanism of xenobiotics in fishes leads to formation of reactive oxygen species (ROS). There is inherited antioxidant defensive mechanism which helps to neutralize this reactive oxygen species[18]. Depletion of antioxidant defensive enzyme or excessive ROS leading to oxidative stress consequently damage[19].

Therefore, in the present study a commonly used detergent, surf-excel has been used to observe its effect on the brain tissue of *Channa punctatus.*

Materials and methods

Test chemical: Detergent used in this experiment is surf excel manufacture by Hindustan Unilever LTD. It is composed of clearing agents (anionic and non-ionic surfactants, enzymes), such as - Water softners (sodium carbonate and sodium aluminosilicate), fabricwhitener, and sodium perborate, anti – redeposition agent, perfume, washer protection agent (sodium perborate, anti – redeposition agent, perfume washer protection agent (sodium silicate) and processing aids (sodium sulphate).

Experimental design: Adult specimens of the Indian freshwater murrel, *Channa punctatus* of body weight 100 to 150 gm were collected from the backwaters of the mula-mutha river in pune and maintained in Zoology Department laboratory of Nowrosjee Wadia College at 25°±4°C for 7 days prior to commencement of the experiments. The water of aquarium was changed twice a day to avoid the accumulation of any debris and synthetic diet was given to the experimental fishes. Feeding was stop prior to experiment.

Five fish were placed in each of the three plastic aquaria, in which one was kept as control and two experimental. Fish maintained in dechlorinated water (no detergent was added to the water) serve as control group 1 whereas experimental 1 (group 2) and experimental 2 (group 3) in which Experimental 1 and experimental 2 were exposed with 17mg/L and 30mg/L detergent respectively. After 3 days fish was decapitated and brain was surgically removed. Similar procedure is repeated after five and seven days.

Sample preparation for Histology: Brain tissues were isolated from fish, rinsed and cleaned in physiological saline solution (0.75% NaCl). Tissues were then fixed infreshly prepared bouin's solution for 24h and processed through graded series of alcohols. After clearing in the xylene, tissues were finally embedded in paraffin wax before being sectioned at 7 µm. Eosin and haematoxylin stains were used for the tissue staining. The prepared sections were observed under light microscope.

Results and discussion

The control group showed normal histology of brain tissue indicating no abnormalities, however region of hypertrophy, increased vascularization in the brain tissue of those exposed to detergent showed that detergent is neurotoxic.

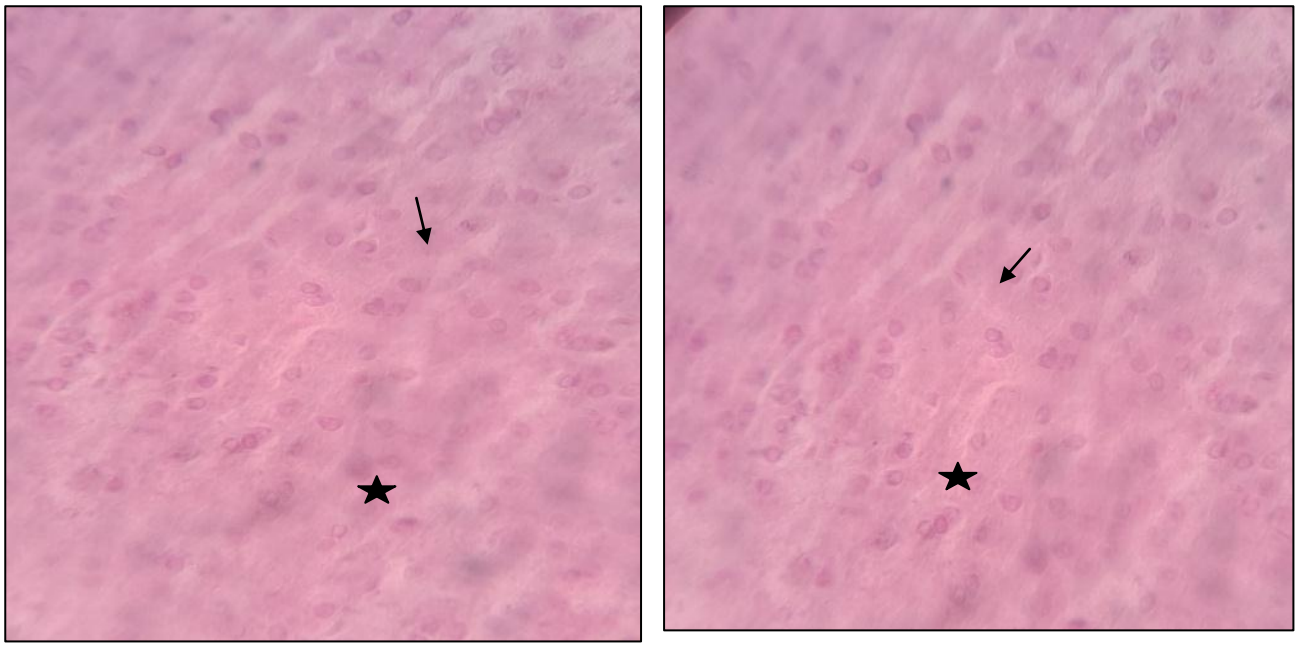

Figure-1: Transverse sections of *Channa punctatus* brain (control) showing small neurosecretory cells (black arrow), no change in cyto-architecture (black star).

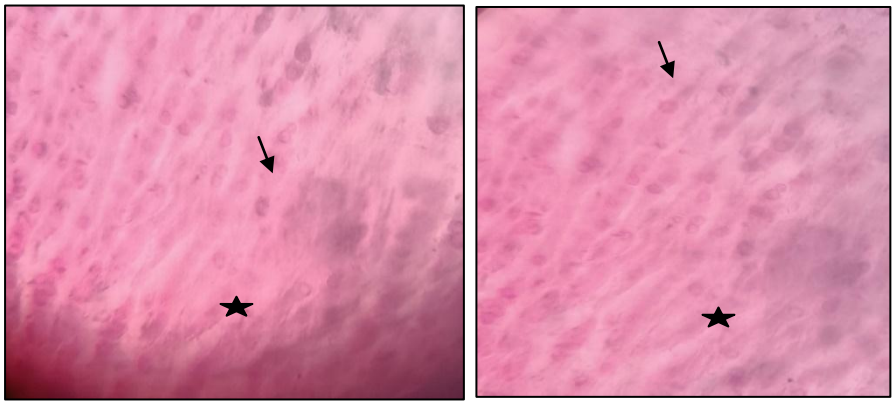

Figure-2: No significant changes were observed in transverse section of *Channa punctatus* brain treated with 17 mg/L of detergent for 3 days compared to control. (Black arrow) small neurosecretory cells, no changes in cyto-architecture (black star). (40x magnification).

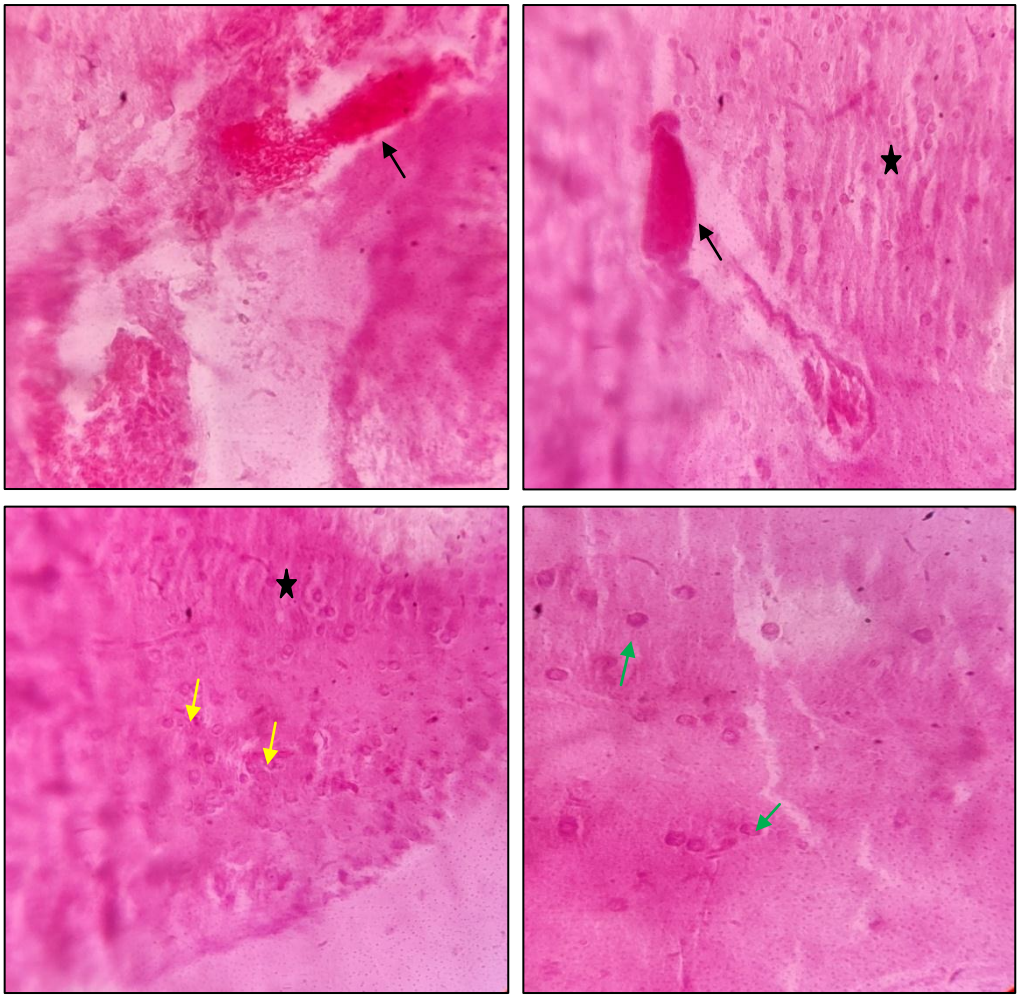

Figure-3: transverse section of *Channa punctatus* brain treated with 30mg/L of detergent for three days shows; (black arrow) congestion, (black star) structural degeneration, (yellow arrow) mild vascularization, (green arrow) hypertrophy (40 X magnification).

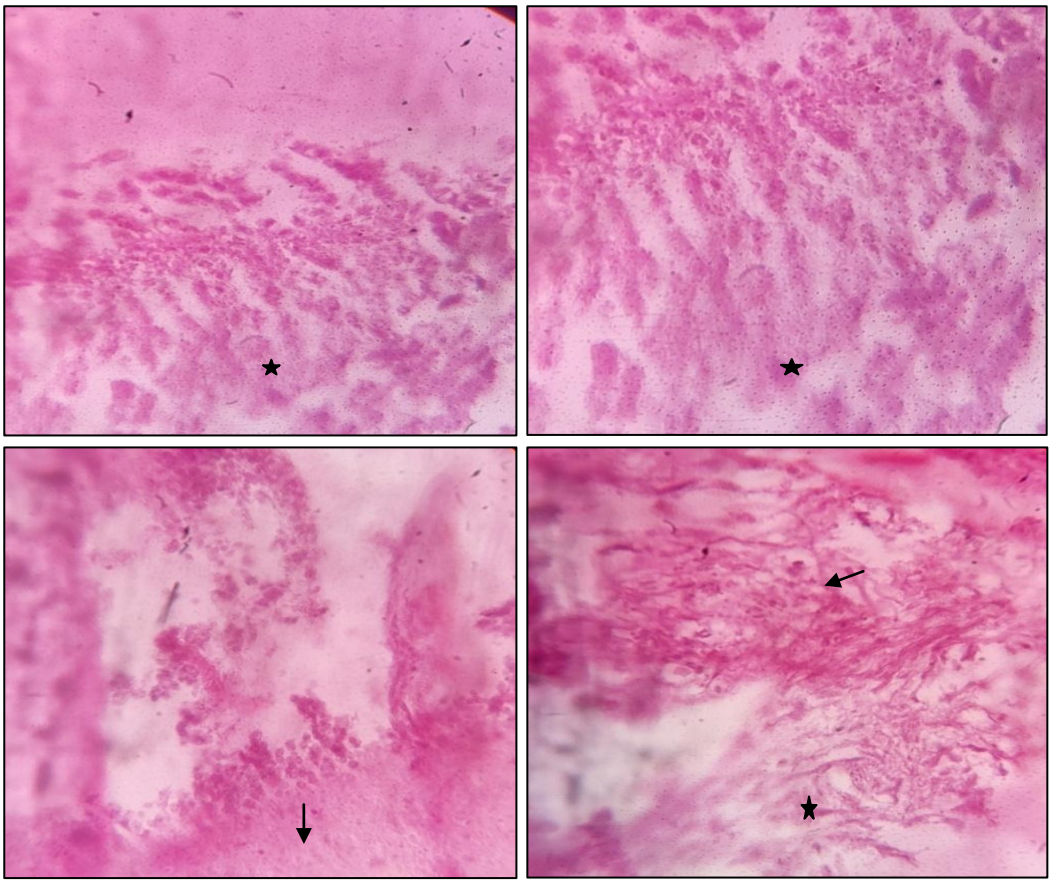

Figure-4: Transverse section of *Channa punctatus* brain, treated with 17 mg/L of detergent for five days shows, (arrow) mild increase in cell size (hypertrophy) and (black star) degenerative changes. (40 X magnification) .

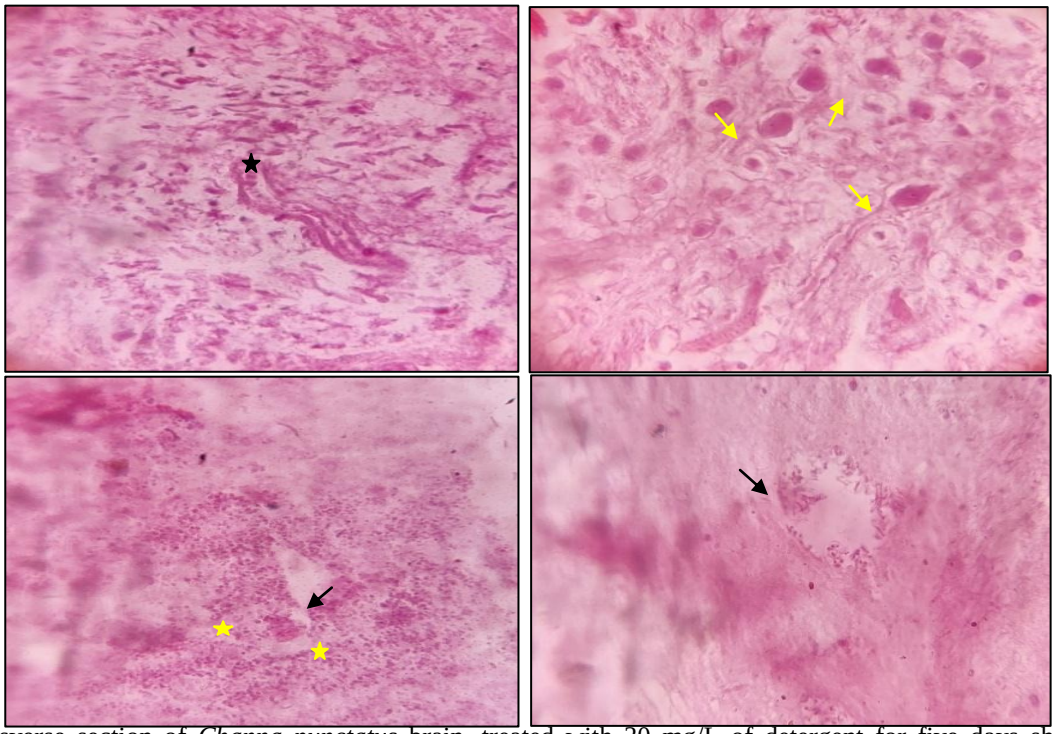

Figure-5: Transverse section of *Channa punctatus* brain, treated with 30 mg/L of detergent for five days shows; (black star) degenerated neurons, (yellow arrow) fissure, (black arrow) vacuolization, (yellow star) hyperplasia (40 X magnification).

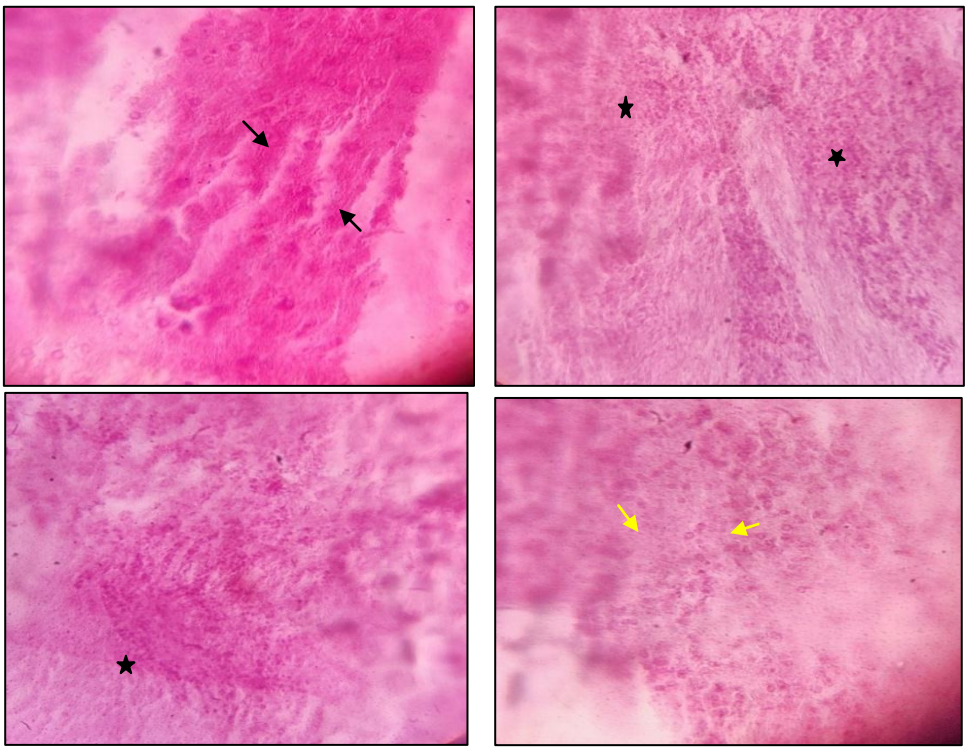

Figure-6: Transverse section of *Channa punctatus* brain treated with 17 mg/L of detergent for seven days shows; (black arrow) degenerative changes, (black star) increased in cell number (hyperplasia), (yellow arrow) slightly increase in cell size (hypertrophy). (40X magnification).

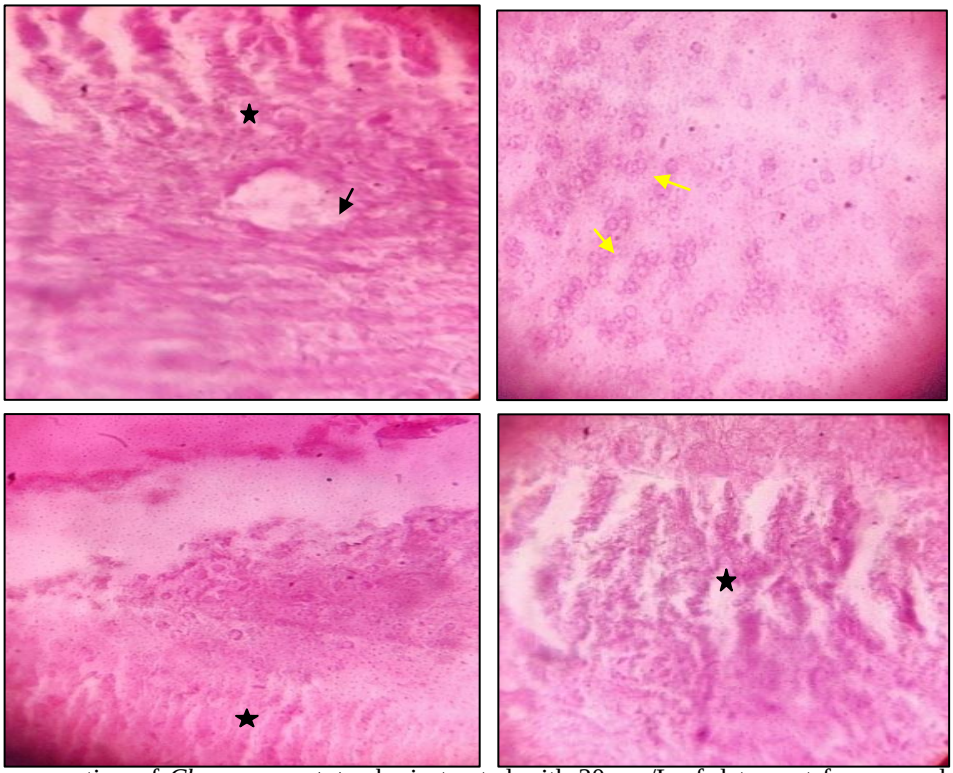

Figure-7: Transverse section of *Channa punctatus* brain treated with 30 mg/L of detergent for seven days shows; (black arrow) vacuolization, (yellow arrow) increased in cell size (hypertrophy), (black star) degenerative changes (necrosis). (40x magnification).

Discussion: The accumulation of toxic pollutants in water bodies affect the nervous system drastically which in turn influence their growth negatively[20]. Therefore, consequences of oxidative damage can be investigated on brain[21].

In the present study, the histological alterations in brain tissues after exposure to the detergent are observed. No significant change has been observed in experimental 1 (17mg/L) of 3 days. In experimental 2 of (30mg/L) 3 days, congestion, structural degeneration, vascularization and hypertrophy have been observed. Five days T. S of brain tissue of experimental 1 showed mild hypertrophy and structural degeneration. Structural degeneration, fissure, vacuolization and hyperplasia have been observed in experimental 2 (30mg/L) of 5 days. Experimental 1 (17mg/L) of 7 days showed structural degeneration, hyperplasia and hypertrophy. Degenerative changes, hypertrophy and vacuolization were observed in experimental 2 (30mg/L) of 7 days.

Intensity of damage increase with increasing concentration of detergent and time of exposure.

Many authors suggested similar impact of various contaminants on different organs of fish. Mehra S. et al., observed change in protein, nucleic acid structure as well as deformities such as necrosis and vacuolization in cerebrum of *Channa punctatus* exposed to 2Napthalene sulfonate[25]. Massive degeneration in cerebrum of *Labeo rohita* after exposure to endosulfan is observed by Sarma J.D. et al.[26]. Eid Z. showed an adverse effect of different concentrations of 4 – nonylphenolin brain of C. *gariepinus* onits oxidative stress indices, neurotoxic biomarkers, enzymatic and non-enzymatic antioxidants, and histopathology [27]. Severe damage in histopathology of liver, gill, and intestine of catfish exposed to Nittol detergent is seen by Ivon E.A. et al.[28]. Lakshmaiah G. noticed degenerative changes, necrosis of neural cells, intracellular odema and congestion in brain of *Cyprinus carpio* after exposure to insecticide[29]. Wang Q. et al. observed arthrosclerosis, Fissures around blood vessels in the telencephalon region and around capillaries in the diencephalon and corpus cerebellum regions after BPA exposure in goldfish brain[30].

Conclusion

In conclusion, the result obtained showed that detergent causes stress, degenerated cytoarchitecture, increased cell size (hypertrophy) and cell number, increased blood vessels (vascularization), formation of fissures and vacuoles (vacuolization) in brain tissue of *Channa punctatus* which ultimately reduces fish population and causes economic loss.

These findings confirm that the presence of detergents in aquatic environments has serious consequences for fish health, making them susceptible to diseases and endangering their lives. To protect the aquatic environment, there should be control and regulation on usage of detergents and its disposal. Furthermore, a pollutant recovery strategy is critical for fish species based on their position in the food web.

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