e-ISSN: 2455-667X

Annals of Natural Sciences
Vol. 2(4), December 2016: 17-21
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

Annals of Natural Sciences

ORIGINAL ARTICLE

Histological Changes in Brain of *Channa punctatus* (Bloch.) due to Sugarmill Effluent Toxicity

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ABSTRACT

Histological biomarkers can be indicators of the effects on organisms of various anthropogenic pollutants on organisms and are a reflection of the overall health of the entire population in that ecosystem. The alterations in cells and tissues in fish are recurrently used biomarkers in many studies as such changes occur in all the invertebrates and vertebrates inhabiting aquatic basins. Histological biomarkers embody tissue lesions arising as a result of a previous or current exposure of the organism to one or more toxins.Hence it is necessary to explore the toxic effects of chhata sugar mill effluents on brain histology of fish Channa punctatus (Bloch.).

Key words: *Historical changes. Brain, Channa punctatus, Sugarmill*

Received: 6th June, 2016, Revised: 4th September 2016, Accepted: 10th September 2016

How to cite this article:
Prakash S., Capoor A. and Sharma H.N. (2016): Histological Changes in brain of *Channa punctatus* (Bloch.) due to Sugarmill Effluent Toxicity. Annals of Natural Sciences, Vol. 2[4]: December, 2016: 17-21.

INTRODUCTION

Fishes are very sensitive to changes in the aquatic environment including an increase in pollution. Fish health may thus, reflect, and give a good indication of the health status of a specific aquatic ecosystem. Early toxic effects of pollution may, however, only be evident on cellular or tissue level before significant changes can be identified in fish behaviour or external appearance. Histological analysis appears to be a very sensitive parameter and is crucial in determining cellular changes that may occur in target organs, such as the gills, liver and gonads. A histological investigation may therefore prove to be a cost effective tool to determine the health of fish populations, hence reflecting the health of an entire aquatic ecosystem.Histological biomarkers can be indicators of the effects on organisms of various anthropogenic pollutants on organisms and are a reflection of the overall health of the entire population in that ecosystem. The alterations in cells and tissues in fish are recurrently used biomarkers in many studies as such changes occur in all the invertebrates and vertebrates inhabiting aquatic basins. Histological biomarkers embody tissue lesions arising as a result of a previous or current exposure of the organism to one or more toxins. Well-documented lesions based on experimental data in liver, ovary, skeleton system and skin have been used as biomarkers to date. Histological biomarkers are closely related to other biomarkers of stress since many pollutants have to undergo metabolic activation in order to provoke cellular change in the affected organism; for example, the action mechanism of several xenobiotics could initiate the formation of a specific enzyme that causes change in the metabolism at cellular level leading to cellular intoxication and death whereas this manifests as necrosis, i.e. histological biomarker on a tissue level. Also after chemical treatment histological lesions may arise from infectious diseases and parasites, provoking necrotic and degenerative alterations to which the

organism responds with an inflammatory defensive reaction. An increased number of macrophagic aggregates can be found in the liver, kidney and spleen in the fish exposed to chemical pollutants, bacteria, fungi or parasite which is a secondary defensive measure.
The building blocks of the brain and central nervous system are the neurons; a neuron is a specialized cell that transmits information to other nerve cells, muscles or glands. Neurons consist of a cell body containing the nucleus and two types of processes viz. an axon which can be depolarized to conducts the nerve signal away from the cell body. The axon may give rise to several smaller collateral fibres before ending at nerve terminals. Another extension of the cell body includes dendrites, one or more in number which extend from the cell body and receive the incoming signal from other neurons and receptors i.e. their function is to conduct a nerve impulse toward the cell body.The impulses are generated by a complex interaction of electrically charged sodium and potassium ions, which move in and out between the neuron and ECF through the cell membrane, creating a mild positive potential difference which can be conducted as a wave of depolarization, the nerve impulse. Several studies have confirmed that pesticides exposure changes the structure and function of nervous system. There are several ways by which pesticide causes functional damage to the central nervous system.Sugar mill effluents induce apoptosis, while apoptosis is a necessary process during the development of the brain, the studied effluents induces this process with the result that the neurons die prior to normal time causing uncoordination and death in fish.

MATERIALS AND METHODS

EXPERIMENTAL FISH:

The air breathing teleost *Channa punctatus* (Bloch.) have been selected for the present investigation (Plate-1). Fishes were collected from Government Fish Farm, Laramada village, Agra and other local fresh water resources. The experiments were done at Research Laboratory of Zoology Department, Agra College, Agra.

MAINTENANCE AND FEEDING OF EXPERIMENTAL FISH:

The experimental fishes *Channa punctatus* (Bloch.) were kept in clean large glass aquaria measuring 75 cms X 37.5 cms X 37.5 cms. The water, used for keeping fishes, was stored before one week to remove unfavourable gases. Dechlorinated water was used throughout the experiment. Fishes were kept in aquaria at the temperature ranging from 30^0C to 35^0C. The experimental fishes were acclimatized to the laboratory conditions for one week prior to experiment. The water of aquaria was changed every alternate day.The fishes were fed on readymade fish food. The food was given daily two times and feeding was disrupted 24 hours prior to the experiment.

EXPERIMENTAL CHEMICAL:

Sugar mill effluents collected from Chata Mill, Mathura which contains various organic and inorganic effluents was used for the histochemical experimentation.

TISSUE COLLECTION:

The control and experimental fish; *Channa punctatus* (Bloch.) were killed under light chloroform anesthesia. They were dissected carefully and the brain was taken out for histological examination accordingly.

HISTOLOGICAL STUDY:

All the tissues were fixed in the Bouin's solution. After washing and dehydration, the tissues were embedded in paraffin wax. The sections were cut at 5 micron and stained with haemotoxylin and eosin (Humason, 1979). Sections were examined under trinocular research microscope and photomicrographs were taken.

RESULTS AND DISCUSSION

Plate 1(a): Control

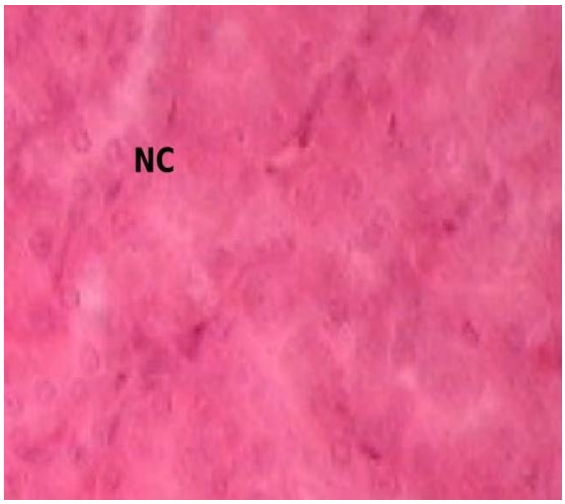

Plate 1(b): 24 hrs

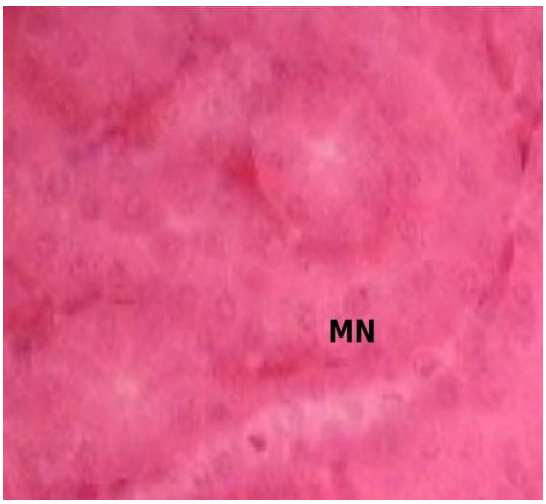

Plate 1(c): 48 hrs

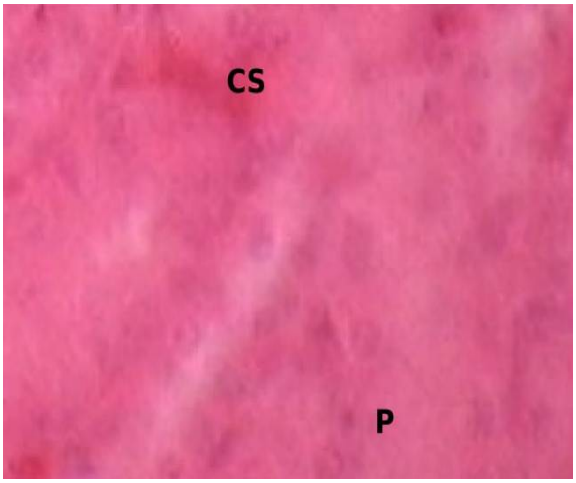

Plate 1(d): 72 hrs

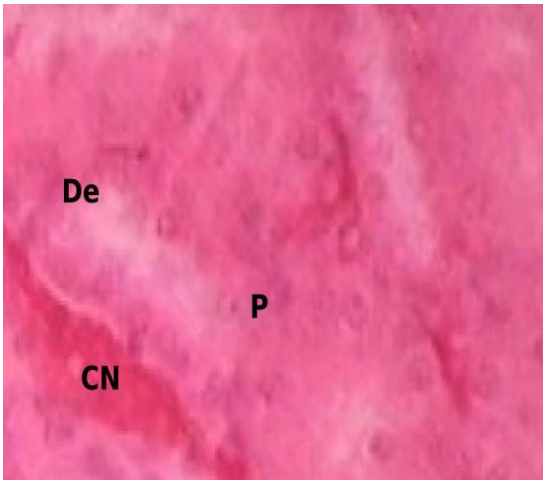

Plate 1(e): 96 hrs

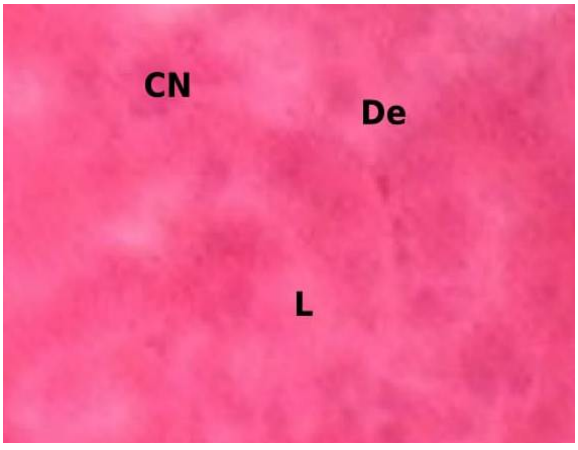

Plate 1(f): 1 week

NC- Normal cells (neurons); MN- Marginal nuclei; CS- Coagulative spot; P- Pyknosis; CN- Coagulation necrosis; De- Degeneration; L- Liquefaction; V- Vacuolization

The building blocks of the brain and central nervous system are the neurons; a neuron is a specialized cell that transmits information to other nerve cells, muscles or glands. Neurons consist of a cell body containing the nucleus and two types of processes viz. an axon which can be depolarized to conducts the nerve signal away from the cell body. The axon may give rise to several smaller collateral fibres before ending at nerve terminals. Another extension of the cell body includes dendrites, one or more in number which extend from the cell body and receive the incoming signal from other neurons and receptors i.e. their function is to conduct a nerve impulse toward the cell body.

The impulses are generated by a complex interaction of electrically charged sodium and potassium ions, which move in and out between the neuron and ECF through the cell membrane, creating a mild positive potential difference which can be conducted as a wave of depolarization, the nerve impulse. Several studies have confirmed that pesticides exposure changes the structure and function of nervous system. There are several ways by which pesticide causes functional damage to the central nervous system.

Sugarmill effluents hinder the formation of axons and dendrites in young fish, Nowak (1992). Sugarmill effluents target the cell structure and disturbs neuron migration, Randi, *et al*. (1996). Exposure to sugar mill effluents is known to cause microtubules to break down and leave the neuron stripped of its protective membrane. These neurons clump together forming aggregates that cannot function normally.The findings of present investigation been supported by the studies of Hall, *et al*. (1992) in *Oncorhynchusmykiss* exposed to bleached kraft mill effluent, Balasubramanian, *et al*. (1999) in fish after urea treatment and Zhang, *et al*. (2005) in gold fish after heavy metal intoxication.Sugar mill effluents induce apoptosis, while apoptosis is a necessary process during the development of the brain, the studied effluents induces this process with the result that the neurons die prior to normal time causing uncoordination and death in fish.

There is scope of better recycling and reuse of water in sugar mills thereby minimizing water consumption and ultimately effluent quantity. The recycling and reuse of hot condensate water can reduce the water consumption to as low as. 100-200 litres as against 1,500-2,000 litres per tonne of cane crushed. Proper housekeeping, periodic checking and maintenance of pipe joints, valves and glands further reduces the water consumption and effluent quantity. The effluents from the sugar industry can be properly treated. The preparation of milk of the lime by conventional biological treatment systems. General, anaerobic biological processes (oxidation ponds and biomethanation) have several advantages over aerobic processes (aerated lagoons, activated sludge). Anaerobic processes are easier to control and operate, produce a lower quantity of sludge and their costs are lower. Anaerobic processes decompose the organic compounds in an atmosphere free of oxygen and consequently require significantly less energy as compared to aerobic processes.

Double sulphitation process, already adopted by most of the sugar industries, reduces the quantity of lime sludge and press mud to a great extent. The lime sludge is usually dumped in low lying areas, whereas press mud is sold to framers as it can be used as manure. Bagasse is either used as fuel or sold to pulp and paper industry which use them as raw materials. Molasses produced in sugar industry is raw materials for fermentation industries. Press mud, which is discarded as a solid waste from sugar mills and used as manure or as a landfill, is found to be a useful substrate for biogas production.

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