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Histopathological changes in the retina of the fish *Clarias batrachus* exposed to untreated and treated sago effluent

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Abstract

The histopathological changes are observed in the retina of the fresh water fish *Clarias batrachus* exposed to different concentrations of untreated and treated sago effluent. The concentration chosen for untreated effluent and treated effluent were 50% and 100%. The histology of retina showed various degrees of deterioration when compared to control. The deterioration was very much reduced in the treated sago effluent when compared to the untreated sago effluent.

Keywords: *Clarias batrachus*, Sago effluent, Histopathology

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1. Introduction

A thorough knowledge of normal histology is essential for the understanding of the altered structure seen in the various conditions of disease. The off target movement of chemicals used in industry and agriculture are usually unavoidable, these chemicals get into natural water and may cause significant tissue damage in fish (Mckim et al., 1970; Reichenbach-Klinke, 1972; Horavath and Stammer, 1979; Rojik et al., 1983; Bennedeczky et al., 1984).

Generally industrial wastes includes a wide variety of chemicals all of these chemicals of industrial waste are toxic to animals and may cause death or sub lethal pathology of liver, kidneys, reproductive system, respiratory system or nervous system in both invertebrate and vertebrate aquatic animals. Histology acts as an integrated parameter, providing a more complete evaluation of the organisms' health, effectively monitoring the effects of exposure to environmental pollutants (Teh et al., 1997; Van Der Oost et al., 2003). Fish are sensitive indicators of pollutants present in water. These pollutants cause various physical and physiological alterations in fishes (Trivedi et al., 2002).

The present investigation was an attempt to evaluate the potential toxic effects of sago effluent to the fish *Clarias batrachus.*

2. Materials and methods

Fingerlings of healthy *Clarias batrachus* procured from Bangalore and were brought to the laboratory and acclimatized for 15 days. The fish were well fed during the acclimatized period. Feeding was stopped one day before commencement of the experiment. The test individuals were killed by narcotization method. Eyes were dissected out and removed from the fishes. Histological studies were done using standard microtechniques.

3. Results

3.1. Control

Retina is the location in the brain where vision begins. This surprisingly thin, amazingly complex and highly ordered nervous tissue converts photons of light into the neural signals that the brain uses to perceive the visual world. As the entry point of visual information into the brain, injuries or diseases that affect the retina have the power to block the vision at its source. If injury or disease results in death of photoreceptors or neurons, the loss of vision is permanent.

The retina lying inside the choroidea within the vitreous body is divided into ten distinct layers, Pigment epithelium layer, Photoreceptor cell layer, External limiting membrane, External nuclear layer, External plexiform layer, Internal nuclear layer, Internal plexiform layer, Ganglion cell layer, Nerve fibre layer and Internal limiting membrane. Visual images are relayed from the rods and cones of the photoreceptor cells to the nerve fibre layer which in turn synapses with the optic nerve. Visual information is conveyed via the optic nerve to mesencephalon of the brain (Figure.1).

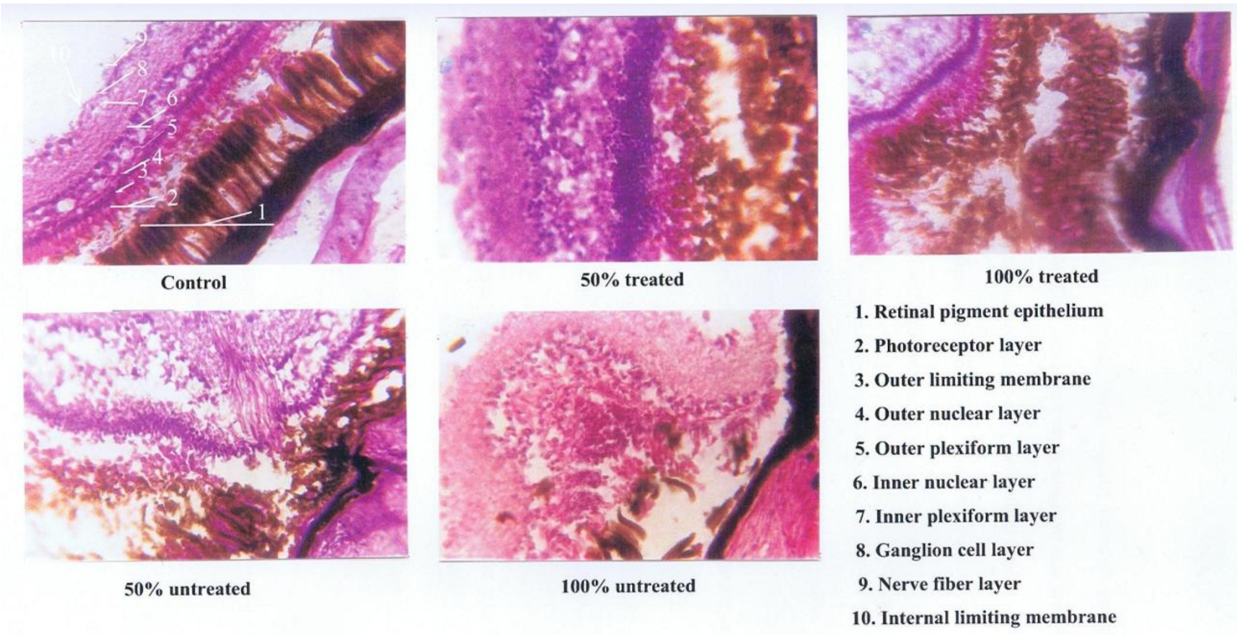

Figure 1. Retinal histology of *Clarias batrachus* exposed to control, 50% treated, 100% treated, 50% untreated and 100% untreated sago effluent

1) Retinal Pigment Epithelium (RPE): It is the outer layer of the retina. It is single layer of simple columnar epithelium containing melanin. Apical processes inter digitalizing with the outer segments of vitamin A, phagocytes of shed outer rod and cone segments and metabolic/physical support for photoreceptors.
2) Photo receptor layer: This layer contains the rods and cones. They contain intricately stacked flattened vesicles filled with visual pigment. Fish see colours and can distinguish shapes. Research has shown that fish are responsible to the colour spectrum and can see many shades of colour. Higher evolved fish such as trout and salmon can see reds and blues better than humans. Scientists have proven that Salmonidae can see colours in the infrared and ultraviolet wavelengths that are beyond human perception. The rods on the fish's retina, which are fifty times as sensitive as the cones, work well in dim light. The cones are colour sensitive and are used in day time light levels. Both rods and cones retract in opposite light conditions.
3) Outer Limiting Membrane: These are dense junctional complexes.
4) Outer Nuclear Layer: This includes the nuclei and cell bodies of photoreceptors.
5) Outer Plexiform Layer: It includes the synapses between photoreceptor cell processes and bipolar neurons and horizontal cells.

6) Inner Nuclear Layer: This includes bipolar cells, horizontal cells and amacrine cells.
7) Inner Plexiform Layer: Include synapses between bipolar cells, axons and ganglion cells.
8) Ganglion Cell Layer: These are large cell bodies that represent the terminal link of the neural retina network.
9) Nerve Fiber Layer: These are ganglion cell axon which project and merge the optic disc to form the optic nerve and the internal limiting membrane.
10) Internal Limiting Membrane.

3.2. 50% Treated Sago Effluent

In the 50% treated effluent exposed fishes, the impact is not very well pronounced. The outer retinal pigment epithelium (RPE) is damaged to a smaller extent. The photoreceptor layer containing rods and cones are not distinct. The other layers are not much damaged, slight variations are observed.

3.3. 100% Treated Sago Effluent

The RPE is seriously injured. The stacking vesicles of photoreceptor layer are also damaged. The RPE layer is seen over the photoreceptor layer and it shows the signs of damage. The external limiting membrane and outer nuclear layer are not affected much. The outer plexiform layer and inner nuclear layer are not clearly seen and have signs of damage in few areas. Some lesions are found in the other four layers (inner plexiform layer, ganglion cell layer, nerve fiber layer and internal limiting membrane). So there must be a problem in linking.

3.4. 50% Untreated Sago Effluent

The retinal layers are severely damaged in untreated effluent when compared to the control and treated effluents. In the 50% untreated effluent exposed fish the RPE layer is disintegrated in many places. The photoreceptor layer is not distinct; a cut of this layer is seen. The outer nuclear layer is not affected much but it is curved. The other layers are also shown many variations, and damages are observed in several places.

3.5. 100% Untreated Sago Effluent

In this group, the impact is quiet obvious. There are lesions in several places. The outer retinal layer RPE is disintegrated to a larger extent. Disappearance of this layer in few places created huge vacuoles. A severe damage has been inflicted in the other layers of the retina. The arrangement of the layers has also been disturbed.

4. Discussion

The histology of the retina of *Clarias batrachus* suggests varied degrees of damage in corresponding with increasing concentrations of sago effluent. Polluted media having direct contact to the eyes cause serious injury to the eyes of the fish. Schaerer and Krischfeld (2000) observed that gold fish failed to have eye movements in polluted waters.

Hofer and Gatumu (1994) have observed the trout *Oncorhynchus mykiss* exposed to sub lethal concentrations of nitrite. The eyes of most of the sub lethal trout were severely affected. Alterations ranged from necrosis of single retinal neurons to complete destruction of the retina. The striking reaction of the retina may be attributable to its high oxygen demand. Kavitha (2000) observed that the thickness of the visual cell layer in the retina is an indicator of toxicity in the fish *Labeo rohita.*

Rippled pigmented epithelium was observed in the fishes exposed to the industrial pollutant polychlorinated biphenols by Mallika Lavakumar (2003) lowered cell densities in fishes exposed to the chemical arochlor was observed by the above investigator. Nagarajan and Suresh (2005) have studied the histology of the retina of *Cirrhinus mrigala* exposed to sago effluent. Varied degrees of damages were observed in the retinal layers with increasing the concentrations of the effluent. Nagarajan and Bhuvaneswari (2009) have studied the retinal histology of *Clarias batrachus* exposed to untreated and polyelectrolyte treated tannery effluent. The degree of deterioration was very much reduced in the treated effluent when compared to untreated effluent. Similar findings were found in the present investigation.

5. Conclusion

The above findings and the results of the present study indicate that the retina, being one of the sensitive tissues gets affected easily by the pollutants. The retina exposed to untreated effluent exhibited marked histopathological changes when compared to treated effluent. The severity increased with higher concentrations of effluent. So the untreated effluent has more effect on fish *Clarias batrachus* than the treated effluent.

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