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Impact of Vellalore municipal sewage water on the gill, liver and kidney of Freshwater fish, *Cyprinus carpio*

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ABSTRACT

Water pollution induces pathological changes in fish.As an indicator of exposure to contaminants,histology represents a useful tool to assess the degree of pollution.The municipal sewage sample was collected from Vellalore station of sanganur canal(open drainage)at Coimbatore.The Freshwater fish, *Cyprinus carpio* were selected as the test animal.$1/10^{th}$ of 72 hour LC50 was taken as sublethal concentration for sewage water.After the stipulated period of exposure (72hrs, 10days, 20days) fishes were sacrificed and tissues viz gill, liver and kidney were isolated and used for histopathological studies. It was found that degeneration of epithelial lining in gills.The liver and kidney showed severe necrosis and enlargement of Bowman's space.

Keywords: Vellalore, *Cyprinus carpio,* sublethal, histopathology.

Water pollution induces pathological changes in fish.As an indicator of exposure to contaminants,histology represents a useful tool to assess the degree of pollution. Tissue damages brought about by water-borne pollutants can be easily observed because the fish gills come into immediate contact with the environment. Tissue changes in test organisms exposed to a sub-lethal concentration of toxicant are a functional response of organisms which provides information on the nature of the toxicant.The polluted water destroys the suitable conditions needed for reproduction and also disrupts the metabolism of fishes leading to the large-scale mortality for a number of times.

The main aim of histopathology is to focus on the study of the altered functions of the body at tissue level and clarification of the physiological functions from the view point of cellular correlation.The purpose is to diagnose abnormal situation or disease from pathological changes in tissue.In the present study an attempt has been made to determine pathological changes induced by Vellalore municipal sewage water.

The Sanganur canal,an open drainage in Coimbatore has its origin from the Western Ghats,namely Kuridimalai Hills and flows from west to east and enters Coimbatore city limit at Coimbatore-Mettupalayam Road and flows for about 10 km within the city. It is a major open drainage system which has intricate linkage with storm water supply, domestic sewage and industrial effluent disposal (forming municipal sewage).Sewage and Sullage from adjoining areas,flow in this drain and finally confluences with singanallur pond and Noyyal river at the upstream of checkdam at Vellalore. The municipal sewage sample was collected from Vellalore station of sanganur canal(open drainage) of Coimbatore.Plastic containers were used for collection and the samples were immediately brought to the laboratory and refrigerated at 4°C.

The fresh water fish,*Cyprinus carpio* were selected as the test animal and healthy specimens of fishes were procured from a local fresh water pond in Coimbatore.The fishes were acclimatized to laboratory conditions for a period of fifteen days at room temperature. During the period of acclimatization fishes were fed regularly with conventional diet (rice bran and oil cake-1:1 ratio). Feeding was stopped one day prior to the start of the experiment.

Fishes of uniform size were taken and static bioassay method was adopted.Desired concentrations of Vellalore municipal sewage water was prepared.Pilot study was conducted to find the range of concentrations that resulted in 10-90 per cent mortality. After the range finding tests,10 fishes from the stock were exposed to each of different concentration of the Vellalore municipal sewage water,a control was also run simultaneously.Mortality was recorded at every 12 hours of interval and the dead fishes were removed immediately.

The LC_{50} values were determined for 72 hours by probit Analysis[1]. $1/10^{th}$ of 72 hour LC_{50} value was taken as sublethal concentration for sewage water. Fishes were divided into four groups,each group consisted of 10-15 fishes.After the stipulated period of exposure, fishes of all the four groups were sacrificed and tissues viz gill,liver and kidney were isolated and used for the histopathological studies.

Gill, liver and Kidney tissues excised from fishes of the control and experimental groups were fixed in 10 per cent formalin solution.After proper dehydration by graded alcohols,paraffin blocks were prepared and 4-5µ thick ribbons were cut in rotary microtome and were stained with Eosin and Haematoxylin. The histopathological changes observed were photographed.

Gill histology :

Control: The surface of the gill lamellae is covered with a simple squamous epithelial cells and many capillaries separated by pillar cells run parallel along the surface.Numerous semicircular secondary gill lamellae are lined up along both sides of the primary gill lamellae.The primary gill lamellae consists of centrally placed rod like supporting axis with blood vessels on either side.

Lethal exposure : When the fish was exposed for 72 hours to the lethal concentration of Vellalore municipal sewage water, degeneration of epithelial lining and the fusion of

secondary lamellae with irregular lamellar spaces were noticed.

Sublethal exposure-10 days: There was a considerable degenerative changes when the fish was exposed for 10 days to sublethal concentration of Vellalore municipal sewage water.It showed congestion with infiltration by the chronic inflammatory cellular exudates. Spongiosis or odema in lamellae were found. Clubbing of the gill tips were also noticed.

Sublethal exposure-20 days*:* Under exposure to vellalore municipal sewage water visible damages in the secondary lamellae,with necrosis and heavy mucous exudation towards the tip of filaments were observed.

Liver histology :

Control*:* The hepatic cells are generally roundish polygonal and contains a clear spherical nucleus with a nucleolus, mitochondria, Golgi apparatus, endoplasmic reticulum and other basic organelles are present in the cytoplasm.

Lethal exposure*:* On exposure to Vellalore municipal sewage water the liver showed degenerated hepatocyte cells, prominent vacuolation, hepatic cords and nuclear hypertrophy.

Sublethal exposure-10 days*:* Hepatic cords showed evidence of cloudy swelling.The central efferent vein and sinusoids were dilated.Portal triads were infiltrated with chronic inflammatory cells.

Sublethal exposure-20 days*:* There was rupture in blood vessels and disposition of hepatic cords,degeneration in hepatocytes, necrosis,the disappearance of hepatocyte wall.

Kidney histology :

Control*:* The kidney is a vital organ of body and proper kidney function is to maintain the homeostasis.It is not only involved in removal wastes from blood but it is also responsible for selective reabsorption,which helps in maintaining volume and pH of blood and body fluids and erythropoieses.

Lethal exposure*:* In this 72 hours exposure the changes were dilated renal tubules.contraction of glomeruli and the enlargement of Bowman's space.

Sublethal exposure-10 days*:* Highly degenerative changes were found in haemopoietic tissues (lymphoid tissues) which included severe necrosis and moderately dilated renal tubules with infiltration of parenchyma by inflammatory cells.Bowman's capsule were dilated.

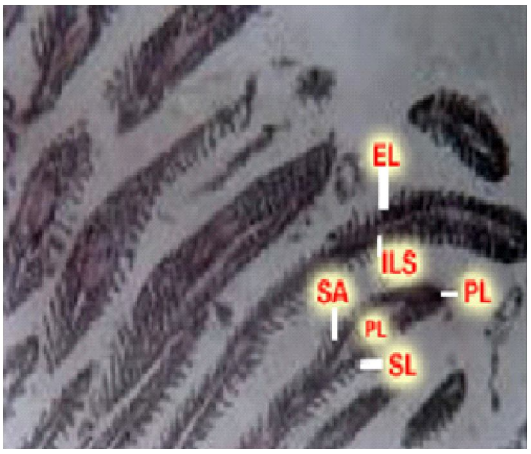
Sublethal exposure-20 days*:* The degenerative changes included the infiltration of parenchyma cells with chronic non-specific inflammatory cells.

Gill*:* The 72 hour LC_{50} value of the vellalore sewage water was 29.56 per cent for the fish *Cyprinus carpio*.In fish gill is the first organ to which the pollutant comes into contact, Hence, it is more vulnerable to damage than any other tissue.

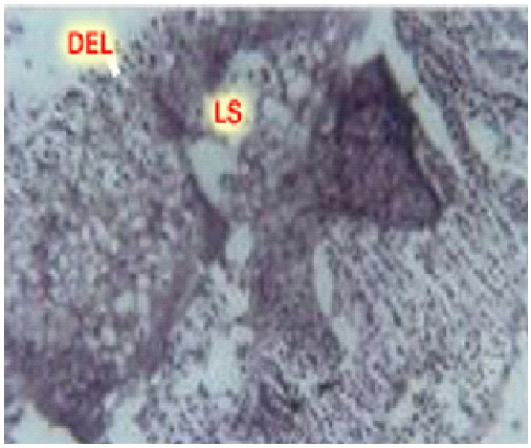
Vijayakumar *et al*.,[5] have observed bulging of tips of primary gill filaments.

Histopathology of gill of *Cyprinus carpio*

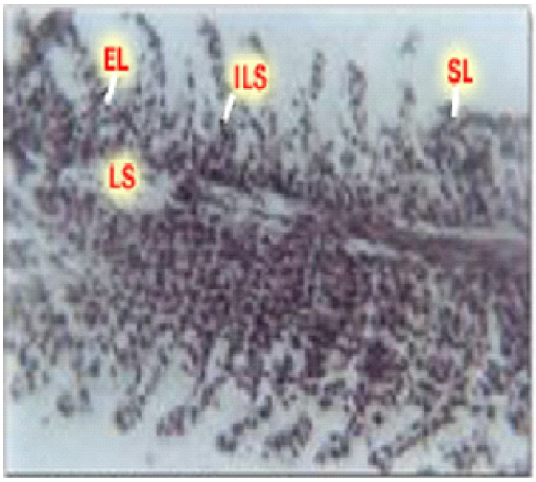
Control gill section of *C. carpio*



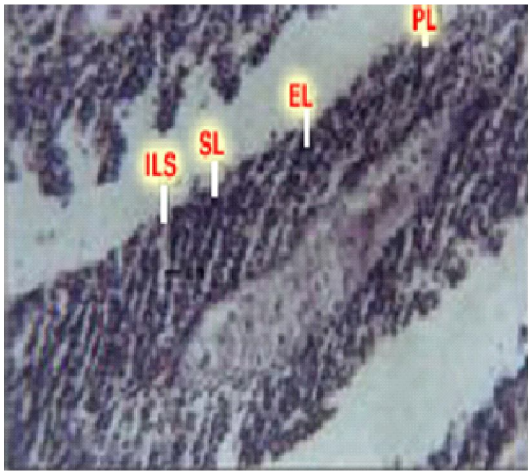
Gill section of fish exposed to 72 hour lethal concentration of Vellalore water



Gill section after exposure to sublethal concentration of Vellalore water for 10 days



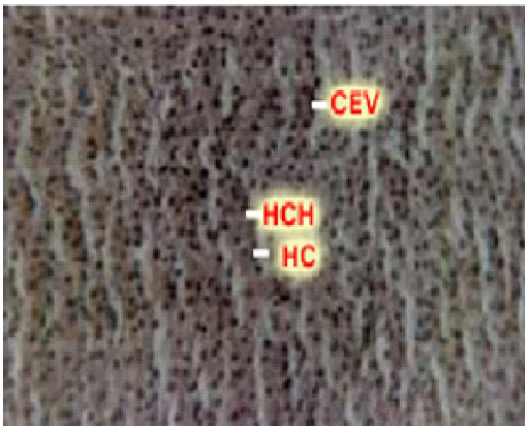
Gill section after exposure to sublethal concentration of Vellalore water for 20 days



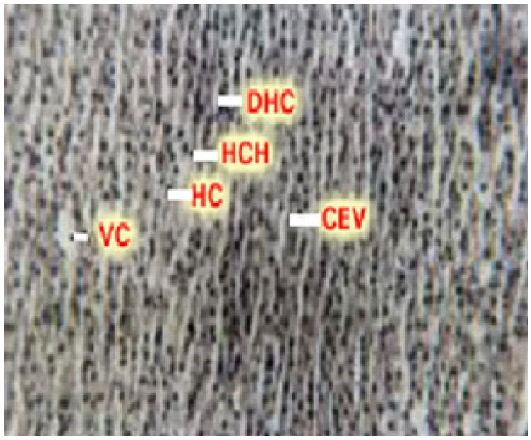
PL – Primary lamellae **SL – Secondary Lamellae**
LS – Lamellar space **ILS – Interlamellar space**
EL – Epthelial lining **SA – Supporting axis**
DEL – Degeneration of epithelial lining

Histopathology of liver of *Cyprinus.carpio*

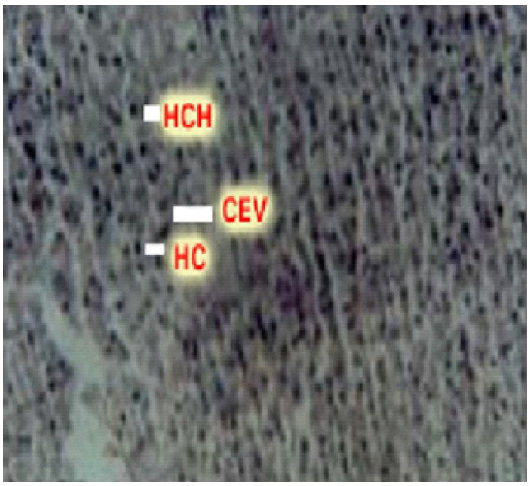
Control liver section of *C. carpio*



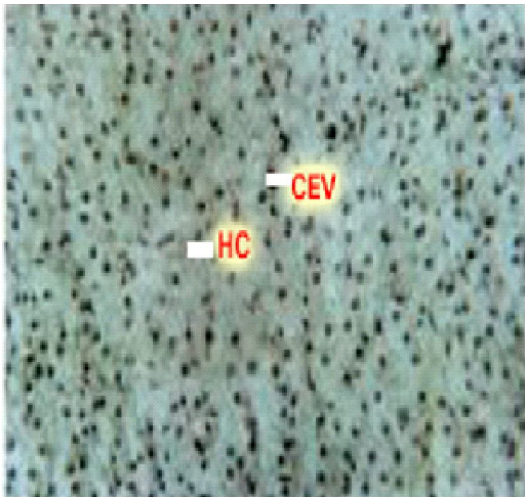
Liver section of fish exposed to 72 hour lethal concentration of Vellalore water



Liver section after exposure to sublethal concentration of Vellalore water for10 days



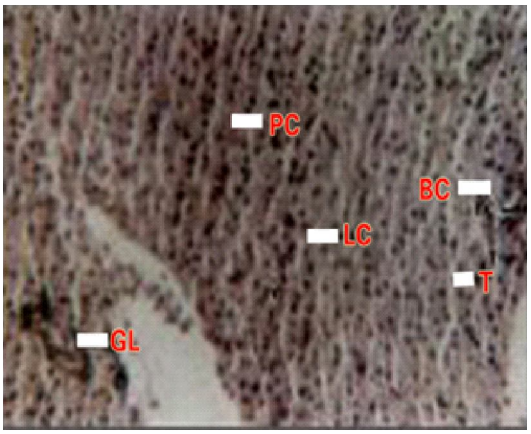
Liver section after exposure to sublethal concentration of Vellalore water for20 days



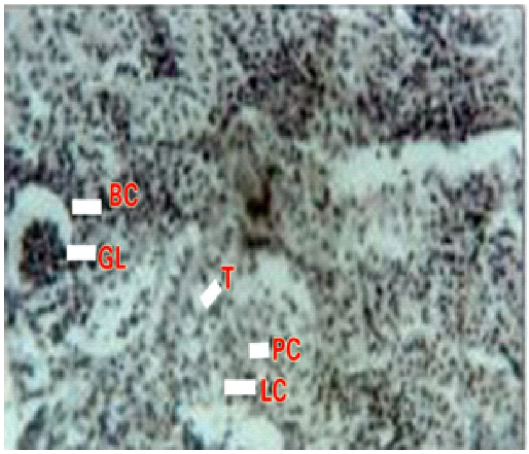
GC-Glissen's capsule
VC – Vacuoles
DHC – Degenerated Hepatocytes cells
HCH – Hepatic Cords
CEV – Central Efferent vein

Histopathology of kidney of *Cyprinus carpio*

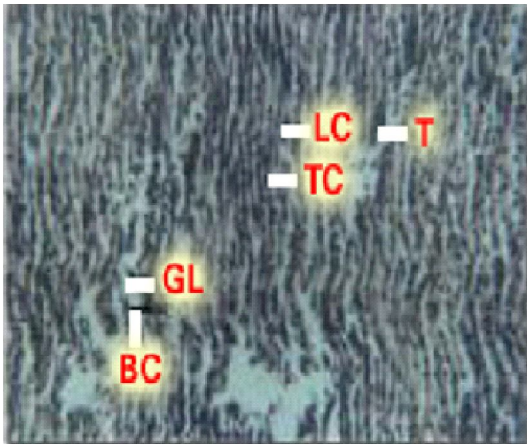
Control kidney section of *C.carpio*



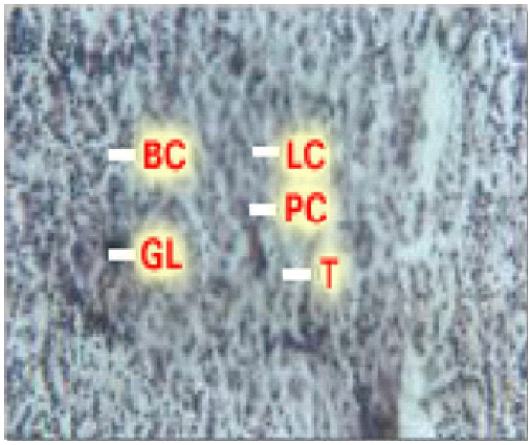
Kidney Section of fish exposed to 72 hour lethal concentration of Vellalore water



Kidney section of fish exposed to sublethal concentration of Vellalore water for 10 days



Kidney Section of fish exposed to sublethal concentration of Vellalore water for 20 days



BC – Bowman's capsule
GL – Glomeruli
PC – Parenchyma cells
LC – Lymphoid cells
T – Tubules

Shortened and clubbing of ends of the secondary gill lamellae,fusion of adjacent secondary gill lamellae and necrosis in the primary lamellae were well marked.

Hypertrophy and destruction of lamellar architecture and hyperplasia that resulted in the fusion of many lamellae[2].

Liver: It is the largest and important organ of the body during several physiological functions.

Suneetha,[9] have noticed vacuole formation;hepatocytes became indistinguishable giving rise to a number of intracellular empty spaces with mesh like appearance.This may be probably due to disintegration of lattice fibres which support the hepatic cells.

Disarrangement of hepatic plates and contact loss between hepatocytes.In addition pyknotic nuclei, dilated sinusoids and degeneration of hepatopancreas were observed[2].

Kidney: The kidney is a vital organ of body and proper kidney function is to maintain the homeostasis.

Staicu Andrea cristina *et al.*,[3] have observed the changes in the size and structure of the epithelial cells and the narrow lumen of the renal tubuli could be the consequence of changes in kidney function.

Reduction in glomerulus,resulted in dilation of Bowman's space.Degeneration of some epithelial cells lining the renal tubules in addition to tubular narrowing was also found in the renal tubules[2].

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