Drilling fluid and diesel fuel induced histopathological alterations in the gill and liver tissue of *Oreochromis niloticus*

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Abstract: In this study the effect of sub lethal concentrations of drilling fluid, 6.1062 ml, and diesel fluid, 0.2742 ml, (1/100th of the 96hr LC50) on the gill and liver tissue of *Oreochromis niloticus* was investigated. The fishes were exposed to sub lethal concentration of both treatments for twenty eight days. The toxic effects of the drilling fluid and diesel fuel was time dependent and significant histological alterations observed were inflammations and deposition of pigments on the epithelial mucosa of the two tissues. The histological alterations induced by these 2 fluids in the gill and liver are reliable biomarkers for the aquatic environment.

Key words: Drilling fluid, diesel fuel, Histological alterations, Inflammation, Pigment deposition and *Oreochromis niloticus*

Introduction

Drilling operations are sources of pollution on land and in recipient surface water bodies. Over the last four decades evidence increased that some type of drilling waste discharges have undesirable effects on the local ecology especially shallow waters.


Recent reports on the toxicity of drilling fluid on aquatic organisms include that of Vincent-Akpu et al. (2010), Anagboso et al. (2010), and Saliu and Salami (2010). The toxicity of drilling fluid has been attributed to the presence of hydrocarbons (Parrish and ward 1988; Neff et al., 2000).

Reports of the toxicity of diesel on aquatic organisms also abound and this includes Dede and Kaglo (2001), Samuel et al. (2008), Smith et al. (2010), Esenewo and Ugwumba (2010) and Saliu and Salami (2010). Few reports however exist on the histopathological alterations induced by drilling fluid and diesel on recipient species.

*Oreochromis niloticus* (Nile tilapia) is the most widely cultured species of tilapia in Africa because they spawn easily and feed on a wide variety of natural foods as well as artificial feeds. They are particularly tolerant to poor water quality and grow rapidly in warm temperature.

This present study was undertaken to evaluate the histopathological alterations induced in *Oreochromis niloticus* when exposed to drilling fluid and diesel.

Materials and Methods

Exposure to sub-lethal concentration: This was conducted by exposing fish species to sub-lethal concentrations of drilling fluid, 6.106 ml, and diesel fluid, 0.2742 ml, (1/100th of LC50 values). Twenty test organisms of *Oreochromis niloticus* were exposed to the sub-lethal concentrations for a period of 28 days in the laboratory.

Histopathological examination: On every 7days, five organisms were harvested from each test tank containing sub-lethal concentration of drilling fluid and diesel; also five organisms were taken from the Control tank which contained no test chemical. The abdominal cavities and operculum of the sacrificed fishes were opened and organs (livers and gills) were removed respectively. The organs were fixed in 10% buffered formalin, processed in automatic tissue processor, embedded in paraffin wax and sectioned at 5µm on a rotary microtome. Sections were stained with haematoxylin and eosin (Roberts, 1978).

Results and Discussion

The histological investigation in this study revealed normal gill and liver morphology in the control specimens of *Oreochromis niloticus* (Fig.1 and 2). However, severe histological alterations such as inflammation and deposition of pigments on the epithelial lining of the mucosa of the gills and liver tissues of fishes exposed to both drilling fluid and diesel was observed (Fig. 3 – 18). The toxic effects of the drilling fluid and diesel on the gill and liver tissue of *Oreochromis niloticus* was time dependent, as the severity increased with the period of exposure.
(A) Histological sections of Gills and Liver of Control *O. Niloticus* and those exposed to drilling fluid over a 28days period under laboratory conditions

**Fig. 1:** Gills filament of Control fish [The histological section of gills showing gill arches, filament, pseudobranchial lamella and pseudobranchial vessels (all normal)]

**Fig. 2:** Liver of Control fish [The histological section of liver tissue revealing central vein, hepatic artery, vein, bile duct and numerous hepatocytes (all normal)]

**Fig. 3:** Gill filaments of exposed fish at 7day

**Fig. 4:** Liver of exposed fish at 7day

**Fig. 5:** Gill filaments of exposed fish at 14day

**Fig. 6:** Liver of exposed fish at 14day
(B) Histological sections of Gills and Liver of *O. niloticus* exposed to diesel over a 28days period under laboratory conditions.
Inflammatory reactions have been known to occur in fishes but little information is available on the mechanisms of this process. Inflammation is known to trigger off vasodilatation, increased vascular permeability, and activation of blood clotting and infiltration of phagocytic cells into injured tissue. This is as a result of an attempt by a complex group of molecular and cellular events to clear injured tissues, facilitate their repair and protect the host from microbial invasion.

The induction of histological alterations in the gill and liver tissues by toxicants has long been an issue of great interest in the field of aquatic ecology. Histological alteration such as epithelial lifting necrosis, hyperplasia, lamellae disruption or fusion, hyperemia, hypertrophy of lamellar epithelial cells and mucus cell proliferation in gills of fishes exposed to drilling fluid and diesel has been previously documented by (Oladimeji and Onumwene, 1988, Dede and Kagoe, 2001, Nero et al., 2006, Vincent-Akpu et al., 2010 and Majid et al., 2011).

Structural changes such as degeneration, dilation edema, congestion, thrombosis formation in hepatoporal blood vessels, melanomacrophages centers, hemorrhage, lymphocytic infiltration between the hepatocytes, necrosis and fibrosis in hepatocytes are known to have been induced in liver tissues by drilling fluid and diesel (Atif et al., 2009, Kakkar, et al., 2011). Histological records of attempts by individual cells to combat these toxicants remain scanty. Inflammation however is one such attempt.

Petroleum hydrocarbon induced alterations in the gill and liver morphology and histology can therefore be used very reliably as biomarkers and efficient diagnostic tools to monitor the aquatic environment.

Fish diseases and histopathology with myriads of causes are increasingly being used to indicate environmental stress in the aquatic ecosystem. However detailed investigations such as ultra structural evaluations of the gills and liver tissues of fishes exposed to drilling fluid and diesel should be carried out. These will certainly yield more valuable information that can be used as a tool to effectively monitor the aquatic environment and its resources.

References
Fig. 3 – 18: shows histological alterations in the gills and the liver. These alterations include inflammation of the respective tissues which increased in rate with the days of exposure and deposition of pigments on the epithelial mucosa. The deposition began with a light blue colour and changed to blue black on day 21 and to a dark brown colour on day 28. No cellular abnormality was observed all through the sub lethal exposure.


