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ACUTE TOXICITY OF QUA IBOE LIGHT CRUDE OIL ON A FRESH WATER FISH, *Oreochromis niloticus*

UDEME U. UDOFIA

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ABSTRACT

The process of Crude oil exploration and exploitation is known to result in wide ranging negative environmental impacts, despite its huge benefits. Oil spillage, in particular, has been implicated in the pollution of aquatic and terrestrial environments resulting in severe harm and damage to organisms inhabiting them. The degree of pollution is measured by the damage potential or toxicity of the crude oil. The knowledge of toxicity of a particular blend of crude oil facilitates proper management of its spillages as has been widely reported in the Nigeria aquatic ecosystem.

Acute toxicity of Qua Iboe Light Crude Oil against a fresh water fish, *Oreochromis niloticus* was determined in laboratory bioassay.

Toxicity measurement based on 72hrs LC_{50} and 96hrs LC_{50} showed an average toxicity of 1.25ml/l. Specifically, 96hrs LC_{50} value was shown to be 1.069ml/l while 72hrs LC_{50} value was 1.432ml/l.

The relevance of acute toxicity studies against sensitive aquatic organisms in the management of oil pollution events in the Niger Delta region of Nigeria is discussed in the paper.

KEY WORDS: Acute toxicity, Qua Iboe Light Crude Oil, *Oreochromis nilotilus.*

INTRODUCTION

Crude oil is an extremely complex mixture of hydrocarbon, small amounts of sulphur, oxygen, nitrogen compounds and trace amount of inorganic and organometallic compounds like those of Vanadium, Nickel, Arsenic and Lead. Typical chemical composition of crude oil consists of carbon (84-87%), hydrogen (13%), sulphur (3%), nitrogen (1%), oxygen (2%), water (1%), heavy metals (0.1%) (DPR,1991). Basically, crude oil contains general classes of hydrocarbons: paraffin (straight chain saturated hydrocarbons), napthalenes (branched or simple ring hydrocarbons) and aromatic hydrocarbons. Since the turn of this century, crude oil has been the major source of energy superceeding other sources, such as coal, nuclear, hydro and solar sources of energy. Currently, oil contributes more than 80% of Nigerian's foreign exchange, employs a significant percentage of the nation's workforce and stimulates economic and socio-economic development in other sectors of the economy. (Inyang,1995). Despite the huge benefits, it is well established that all aspects of the petroleum industry are prone to accidental spillages of crude oil and the refined products apart from the deliberate emission of the refinery effluent. The entry of large quantities of oil through accidental spillages into the aquatic and terrestrial environments, has created some negative environmental problems which are considered as pollution. Statistics show that between 1970 and 1982, Nigeria recorded 1,581 incident of oil spillage which caused considerable ecological and physical damage to environmental resources; lands, soil, water, air, and vegetation especially in the fragile ecosystem of the Niger Delta (NEST, 1992). Notable among the pollution was the Funiwa No 5 oil well blow out in 1980 that resulted in the release of more than 140,000 barrels of oil in the mangrove environment. The Oyakama oil spillage occurred in 1980 and about 30,000 barrels of crude oil were spilled into seasonal swamp environment. Others include: Bodo West field spill (1980), Oshika oil spill incident of 1983 (10,000 barrels), Forcados terminal oil spillage (1979) 570,000 barrels. Kontagora (1991) reported that between 1976 and 1990, a total quantity of 21,105,393 barrels of oil spilled into the Nigerian terrestrial, coastal and marine environment. Currently, almost on a daily basis, the problem of contamination from oil activities is highlighted by the host communities, NGOs and the press. The causes of spills are many including equipment failure, human errors, freak accident, inclement weather to unreliable hardware. Recorded causes of spills in the petroleum industry in Nigeria between 1976 and 1986 according to Ifeadi and Nwankwo (1987) include: well blowout, sabotage, corrosion of equipment malfunctioning, operations and maintenance error, natural causes (rain, flood) and unknown. Biological studies of the impact of petroleum industry on the Nigerian environment has been chronicled in the literature by Ekekwe, (1981), Imevbore (1981), Adeniyi (1983), Izeougu (1986), Alo (1992) and Igwe (1993) etc. The biological impact of oil spill depends on the type and amount of oil spilled and the amount of change the oil has undergone while in or on sea (Boesch *et al,* 1974). Oyewo (1992) identifies the type of environment, prevailing meteorological and oceanographic conditions, seasonal and tide induced changes in salinity, temperature, pH as other factors conditioning the effect of spillage. The toxicity of oil is generally a function of chemical composition. The higher the number of carbon atoms in a molecule, the higher its boiling point and the less volatile it is. Boesch, *et al* (1974) reported that low boiling alkanes produce anesthesia and narcosis at low concentrations and at high concentrations can cause cell damage and death among a wide variety of lower invertebrate while higher boiling alkanes may mildly affect chemical communication and interfere with metabolic processes. Low boiling aromatic compounds are thought to be the

Udeme U. Udofia, Department of Zoology and Environmental Biology, University of Calabar, Calabar, Nigeria.

most toxic compounds found in virtually all oils. They are quite soluble in water and can be even toxic at low dilutions while higher boiling aromatics (especially multi-ring compounds) are long term poisons and some are known carcinogens (Boesch *at al*, 1974). Heavy fuel oils generally do more mechanical damage to inter-tidal life by smothering or physically removing organisms. The differences in the physical and chemical properties of fuel oils have been used to explain the disparity in observed effects of oil spills. Several articles describing the acute toxicity of crude oils against marine animals abound in literature, with fewer reports on oil pollution effects on freshwater fish (Idoniboye, 1985). Imevbore *et al* (1985) determined the toxicity of seven Nigerian crude oils against brackish and freshwater organisms to identify the sensitive and tolerant species.

In a related work with three Nigerian crude oils; Forcados Blend (FB), Bonny Light (BL) and Bonny Medium (BM) against freshwater and brackish water shrimps, Forcados Blend was found to be most toxic to fresh water shrimps at concentrations as low as 2.75µg/l. for brackish water shrimps, Bonny Medium (BM) was shown to be more toxic than Forcados Blend as acute toxicity could occur at a concentration of 4.17µg/l.

There is need to study the effect of more blends of crude oil on many more aquatic species to assist in managing spillages which has been widely reported in the Nigerian aquatic ecosystem.

The water bodies in the Niger Delta region are inhabited by a wide range of flora and fauna of economic importance such as *Clarias gariepinus, Tympanotonus fuscatus* (Periwinkle), shrimps, crabs and especially tilapia species. Tilapia is a robust fish, small in individual sizes and abundant in number. Their abundance in number is as a result of the fact that they breathe rapidly: spurn 5 times yearly and there is usually a high degree of parental care (Nielson (1976), Udofia(1986)). *Oreochromis niloticus* is micro and macro herbivorous feeding on algae, phytoplankton and detritus (Ezenwa, 1979).

They are probably the most abundant teleost fish in the River Nile and its tributaries and are the fish of preference in terms of human consumption (Ibrahim and Babiker, 1979). Tilapia species has been used for various research works as biological indicators. This work is aimed at evaluating the acute toxicity of Qua Iboe Light Crude Oil on Oreochromis niloticus. The knowledge acquired will be useful in the management of the various spill incidents in Qua Iboe Terminal and its environs.

MATERIALS AND METHODS

MATERIALS

Oreochromis niloticus fingerlings (live weight 0.4±0.4g and mean length 1.0±0.8cm) were obtained from Niovas Fish Farm in Ojo Local Government Area of Lagos where they had been held in pond cultures for several generations. The fingerlings were obtained with the aid of dragnets in the early hours of the Morning to avoid heat stress and transported to the laboratory in the Department of Zoology, University of Lagos, in Polythene bags containing aerated pond water.

Fingerlings were in two glass holding tanks (30 x 40x70)cm for at least 12 days in order to allow them acclimatize to the prevailing laboratory conditions (temperature 29^{o}c ± 2^{o}c, relative humidity 77% ± 4%). Fish were held in tanks three quarters filled with dechlorinated tap water which was continuously aerated with air pumps (whispers-100).

During acclimatization, fingerlings were fed on prepared fish feeds, changing the water in the holding tanks once every 2 days to avoid accumulation of toxic waste metabolites and food. Tap water was dechlorinated by aerating and allowing to stand for 24 hours before use. This was done to avoid stress caused by chlorine in tap water.

Qua Iboe Light crude oil was obtained from Mobil Producing Unlimited, Qua Iboe Terminal, Eket in Akwa Ibom State in tightly covered jerry can. The oil sample was stored in a cool place to avoid loss of volatile compound and used at appropriate time.

GENERAL BIOASSAY PROCEDURES

Plastics bowels (10 litres in volume, bottom diameter 20.5cm) served as bioassay containers. Preliminary trials in which different numbers of test animals were held in varying volumes of dechlorinated tap water showed that 10 test fingerlings survived comfortably without aeration, in 2 litres of water for over 6 days. Therefore test media were always made up to 2 litres holding 10 fingerlings in bioassay containers. Predetermined amount of the oil sample was pipetted out into the bioassay container and made up to 2l by adding tap water to achieve a desired concentration of oil in water medium. The test medium was stirred thoroughly for 10mins with a glass rod to ensure mixing.

Fingerlings of similar age and size (~1.0 ± 0.8cm) were selected out into a holding tank from where they were randomly assigned to bioassay containers with a hand net.

A total of 10 active fingerlings were exposed in each bioassay container to treated and untreated test media. Each treatment including control was replicated twice meaning 20 fingerlings were exposed per concentration and control. The fingerlings were exposed to several concentration of Qua Iboe Light crude oil in dechlorinated tap water (pH 7.0 ± 0.02) as follows: 0.1, 0.5, 5.0, 8.0, 10ml/l and untreated concentration. Fish that did not show any fin, opercular and/or body movement even when probed with glass rod were taken as dead. Mortality assessment was made every twenty four hours over 4 or more days specified under each bioassay.

Dose-mortality data were analyzed by probit analysis after Finney (1971). The analysis, including equation for probit lines was achieved via IBM computer run Programme designed by Ge Le Pattouel Imperial College, London.

Toxicity indices used in evaluation of toxicity level/susceptibility include:

LC_{50} – median lethal concentration that will bring about 50% mortality of the exposed population.

LC_{95} – the concentration that will bring about 95% mortality of the exposed population.

LT_{50} – the time at which 50% mortality of the exposed population occurred and their 95% confidence intervals.

RESULTS

The percentage mortality for 0.01, 0.05, 5.00, 8.00 and 10.00ml/l concentrations of the Qua Iboe light crude oil on the *Oreochromis niloticus* fingerlings were 10, 20, 60, 90 and 100% respectively after 72 hrs exposure. But after 96hrs of exposure, the 0.10, 0.50, 5.00, and 8.00ml/l concentrations elicited 10, 20, 80 and 100% mortality response respectively. Tables 1 and 2.

TABLE 1:

Dose (ml/l)	72hrs Log Dose	Number tested	Number Responding	% Mortality (y)	Probit Value
0.01	-1.00	10	1	10	3.72
0.05	-0.30	10	2	20	4.16
5.00	0.70	10	6	60	5.25
8.00	0.90	10	9	90	6.28
10.00	1.00	10	10	100	8.09

Mortality of *Oreochromis niloticus* treated with Qua Iboe Light crude oil (72hrsLC_{50})

TABLE 2:

Dose (ml/l)	96hrs Log Dose	Number tested	Number Responding	% Mortality (y)	Probit Value
0.10	-1.00	10	1	10	3.72
0.50	-0.30	10	2	20	4.16
5.00	0.70	10	8	80	5.84
8.00	0.90	10	10	100	8.09

Mortality of *Oreochromis niloticus* treated with Qua Iboe Light crude oil (96hrsLC_{50})

On the basis of computed LC_{50} values, the toxicity of the Qua Iboe Light crude oil after 72 hrs of exposure to the fish fingerlings was 1.432ml/l within the confidence limit of 95% while it was 1.069ml/l after 96hr exposure. These are shown in Table 3 and graphically illustrated in figures 1 – 4.

TABLE 3: Relative Acute Toxicity of Crude Oils against *Tilapia niloticus* Fingerlings

TEST MEDIA	TIME (HR)	LC_{50} (95% CL) Ml/l	LC_{95} (95% CL) Ml/l	LC50 (95% CL) Ml/l	SLOPE	D.F	T.F	REGRESSION EQUATION
QUA IBOE LIGHT CRUDE OIL	72 96	1.432 (2.922-0.598) 1.069 (2.303-0.451)	20.858 (124.499-7.760) 11.196 (85.998-4.395)	0.098 (0.335-0.009) 0.102 (0.284-0.010)	1.418+0.32 1.617+0.38	3 2	1 1	Y=4779=1.418X Y=4.953=1.617X

KEY:

S.E - Standard Error
D.F - Degrees of Freedom
T.F - Toxicity Factor with treatment

$$\frac{\text{24hr LC50 Values}}{\text{24hr, 48hr, 72hr, 96hr LC}}$$

CL - Confidence Limit.

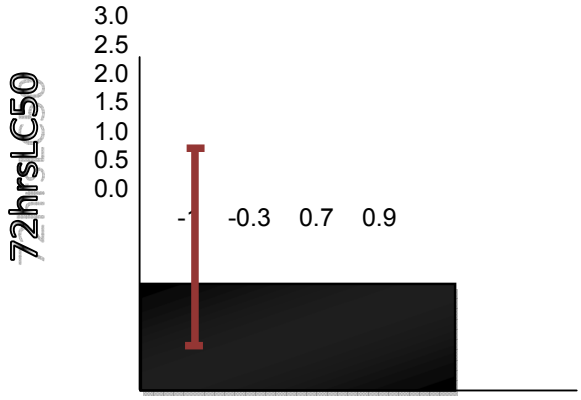

FIG 1: Acute Toxicity of Qua Iboe Light crude oil against *Oreochromis niloticus* (72hrsLC_{50})

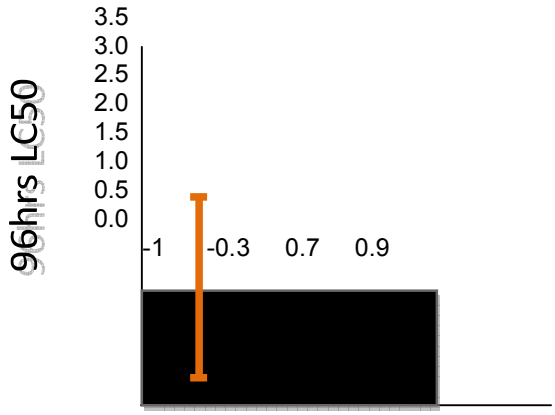

FIG 2: Acute Toxicity of Qua Iboe Light crude oil against *Oreochromis niloticus* (96hrsLC_{50})

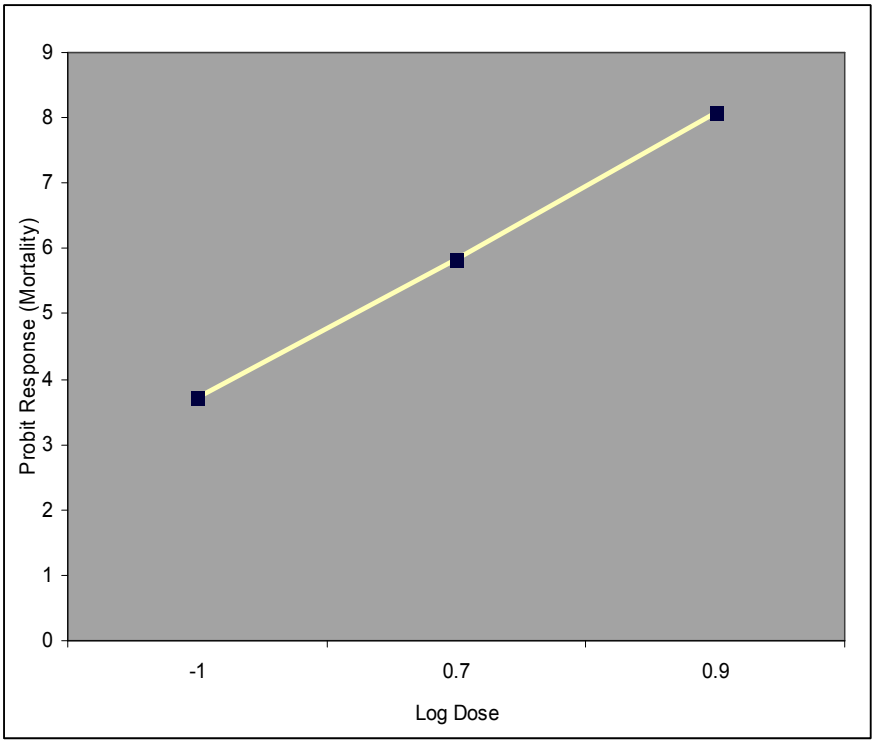

FIG 3: Graph of 72hrs LC_{50} Toxicity of Qua Iboe Light crude oil against ***Oreochromis niloticus*** **fingerlings**

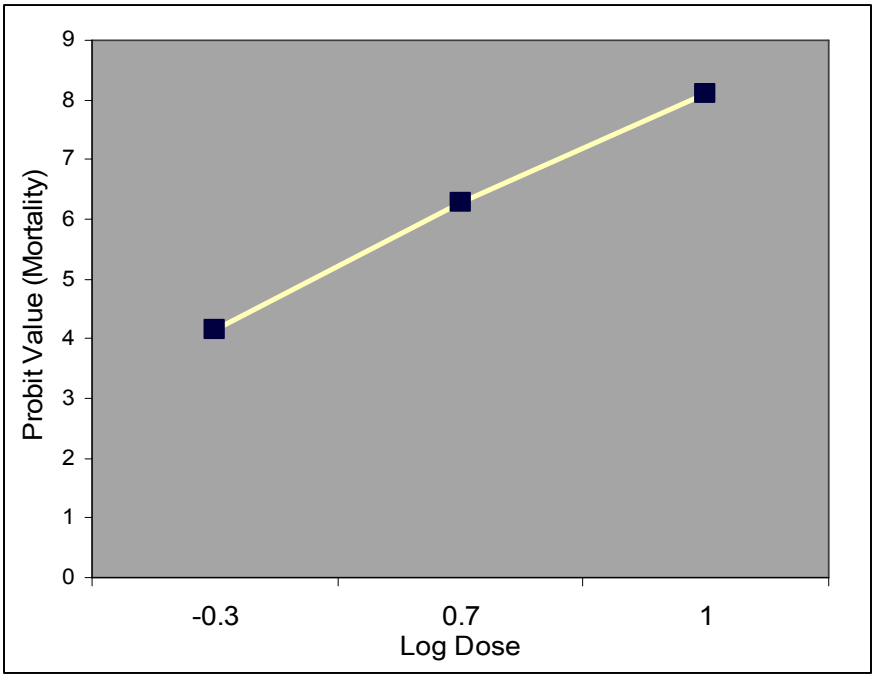

FIG 4: Graph of 96hrs LC_{50} Toxicity of Qua Iboe Light Crude Oil against ***Oreochromis niloticus*** **fingerlings**

DISCUSSION AND CONCLUSION

In this study, on the basis of computed 96hrs LC_{50} values, the toxicity of Qua Iboe Light Crude Oil was shown to be 1.069ml/l while the value for 72hrs LC_{50} was 1.432ml/l. The result confirms the popularly held view that different blends of crude oil vary in their toxicities to different species of animals. Imevbore *et al*,(1985) showed that the 96hrs LC_{50} for Forcados Blend, Bonny Light and Bony Medium crude oils against *Demoscaris trisinosa* was 2.79, 16.22, and 38.02 ug/l respectively. Also, Tokolo (1988) showed highly significant differences in toxicity between Bonny Light, Bonny Medium and Lagomma crude oils when tested against *Tympanosoma fuscastus*.

The observed differential toxicities are mostly attributable to differences in the physical and chemical characteristics of the oil.

The practical implications of this finding is that the different blends of crude oil entering the Nigerian aquatic ecosystem are inflicting different levels of damage to the sensitive organisms inhabiting them. It is therefore imperative to ascertain the damage potential of these blends of crude oil against as many organisms as are possible to be able to set a minimal permissible limit. This knowledge will certainly facilitate the protection and management of our rich and sensitive aquatic resources against the perpetual entry of spilled crude oils into our ecosystem.

The difference in toxicity with the time of exposure is negligible and could be attributable to the behavioural and physiological properties of the exposed organisms.

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