IMPACTS OF CRUDE OIL ON FRESHWATER FISH FAUNA, ITS CONTROL AND MANAGEMENT MEASURES

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ABSTRACT

Crude oil or petroleum is a complex liquid mixture of hydrocarbons, though a major source of revenue for Nigeria contaminates water through sources such as oil spills and refinery effluents. The impacts of crude oil or petroleum are many and have been enumerated in this review work to include-necrosis of the gut, histopathological changes in liver and gills, reduced feeding and growth, general intoxication, hyperglycaemia, hypoglycaemic response and death. Control measures suggested include strict supervision of loading and off-loading of oil tankers, repairing of oil pipelines and damaged tankers, placing stringent measures on oil and oil-related industries and oil refineries conducting assays to assess the effect of refinery effluents on aquatic life. This work concludes by indicating that oil in water is lethal leading to impairment of fish physiology. As a result, mortality increases and fishery resources decrease.

Keywords: Crude oil, Petroleum, Kerosene, Freshwater fish

INTRODUCTION

Oil has been a major source of revenue for Nigeria since 1970 after the civil war (Oladimeji, 1987). As a modern society, she runs on energy, which mostly comes from petroleum fuels. Petroleum is sometimes called 'black gold' in recognition of its importance in the twentieth century (Seager and Slabaugh, 1977). It is a complex liquid mixture of hydrocarbons (McMurry and Castellion, 2003) formed by the anaerobic decay of organic materials originally buried in sediments but now found in underground deposits (Fessenden and Fessenden, 1984). Crude oil or petroleum, a viscous dark-brown liquid (Chang, 1998) is composed of thousands of different organic compounds: straight-chain and branched-chain hydrocarbons, saturated hydrocarbons, cyclic hydrocarbons, sulphur-nitrogen and oxygen-containing organic compounds (Fessenden and Fessenden, 1984; Umland and Bellama, 1999). Apart from providing energy, Umland and Bellama (1999) indicated that petroleum provides most of the organic chemicals that are used to make everything from adhesives, analgesics and antifreeze to zip-lock bags and zippers.

The conversion of crude oil to useable products is called refining (Fessenden and Fessenden, 1984). The crude oil is separated into three main fractions according to boiling points: straight-run gasoline (bp 30 – 200 ^{o}C), Kerosene (bp 175 – 300 ^{o}C), and gas oil (bp 275 – 400 ^{o}C) (McMurry and Castellion, 2003). Oil products may also contain toxic compounds such as polynuclear aromatic hydrocarbons (PAHs), PCBs and metals, especially lead (Mason, 1996). Nigeria is blessed with abundant petroleum, and the daily exploitation and same lead to discharge of petroleum and its products into our aquatic ecosystem. In the light of the above, this study was conducted to assess the effects of crude oil on the freshwater fish fauna and proper possible control and management measures.

MATERIAL AND METHODS

A detailed literature search was made from the internet and main libraries of University of Nigeria, Nsukka and Anambra State University, Uli. Data obtained from journal articles, textbooks, proceedings on conferences and seminars on petroleum industry and the Nigeria environment were analyzed in pros and tabulated.

RESULTS AND DISCUSSION

Despite their usefulness, crude and refined oil pollute water bodies. Pollution from crude and refined oil is common place world wide and particularly endemic in countries whose economies are dependent on the oil industry (Gabriel *et al.,* 2007). Nwankwo and Ifeadi (1983), Oladimeji (1987) and Ihunweze (2012) summarized oil spills in Nigeria between 1970 – 1982 and 1998 – 1999, respectively (Tables 1 and 2).

Table 1: Yearly distribution of oil spills in Nigeria between 1970 and 1982

Year	Number of spills	Net volume Barrels
1970	1	150.00
1971	14	15,111.00
1972	41	51,390.00
1973	59	95,580.00
1974	185	65,714.00
1975	128	56,855.00
1976	128	20,023.00
1977	104	31,144.00
1978	154	97,250.00
1979	157	630,405.00
1980	241	558,053.00
1981	233	22,840.00
1982	216	24,475.00
13 years	1581	1,678 990.00

Sources: Nwankwo and Ifeadi (1983) and Oladimeji (1987)

Sources of Crude Oil in Nigerian Freshwater

a. Oil spills: Oil spill is one of the major sources of oil in Nigerian waters. Spill incidences of various scales involving different kinds of oils are reportedly more rampant (Gabriel *et al.* 2007) in Nigeria. Mason (1976), Awobajo (1981), Oladimeji (987) and Omoregie *et al.* (1997) attributed oil spills to several factors such as: (i) Illegal disposal of used engine oil, (ii) irrigation pumps and boats, (iii) accidents involving transporters, (iv) operation / maintenance error (v) engineering error, (vi) leakages from underground pumps and (vii) sabotage and erosion. Exploration companies were alleged to have made more capital out of willful damage to petroleum installations (Awobajo, 1981; Oladimeji, 1987). They stated further that individuals who felt that they were inadequately compensated for the land used by the oil companies also sabotaged the pipelines.

b. Refinery effluents: The Nigerian National Petroleum Company (NNPC) is a major industry with plants simply located inland. The NNPC refinery Kaduna discharges it effluent directly into inland waters (River Kaduna) (Oladimeji, 1987). Thus waste effluents generated and discharged into aquatic systems causes both short term and long term damage to the ecosystem. Contamination of aquatic environment by crude oil and petroleum products, whether as a consequence of acute or chronic events, constitutes an additional source of stress for aquatic organisms (Omorgie *et al.* 1997) including fishes which are conspicuous members of freshwater animals.

Components of Crude Oil and Effects of Crude Oil on Fish: Seager and Slabaugh (1997) have classified petroleum crude oil into different components (Table 3).

Exposure of aquatic organisms to crude and refined oils, water soluble-and-water accommodated fractions of crude oil have been shown to impact on various aspects of fish physiology and sometimes leading to large scale mortality (Dambo, 1999; Barron *et al.,* 2003; Couillard *et al.,* 2005; Liu *et al.,* 2006; Gabriel *et al.,* 2007). The effects of crude oil on fish are presented in (Table 4).

Control and Management Measures: Oil spills could be controlled through several measures such as: (i) Strict supervision of

Table 2: Oil spillages in Nigeria (1998 and 1999)

Month	Number of oil spills		Volume of oil spilled (Barrels)		Operators involved	
	1998	1999	1998	1999	1998	1999
January	5	-	40,415.0	-	Shell, Mobil and other	-
February	1	13	-	18.4	Chevron	Shell, Chevron, ELF and NNPC
March	7	31	25,000.0	87.5	Shell	Shell, Mobil, ELF, Agip and Chevron
April	-	10	-	331.4	-	Shell, Chevron, Mobil and Agip
May	5	19	72.0	1,110.0	Shell, Mobil	Shell, Agip, ELFand Chevron
June	15	10	306.5	10.0	Shell, Chevron, Agip and Mobil	Shell, Agip, NNPC and Chevron
July	14	-	4,534.2	-	Shell, Chevron and ELF	-
August	24	-	1,127.0	-	Shell, Chevron ELF and Agip	-
September	25	-	652.2	-	Shell, Chevron, Agip, Mobil and ELF	-
October	4	-	1,050.0	-	Shell and Agip	-
November	-	-	-	-	-	-
December	12	-	1,865.0	-	Shell, Chevron, Agip and Mobil	-

Source: Ihunweze (2012)

Table 3: Components of petroleum crude oil

Fraction	Boiling point range (°C)	Molecular range size range	Typical uses
Gas	-164 to 30	C_1 –C_4	Heating, cooking
Gasoline	30 to 200	C_5-C_{12}	Motor fuel
Kerosene	175 to 275	C_{12}-C_{16}	Fuel for stoves and diesel jet engines
Heating oil	Up to 375	C_{15}-C_{18}	Furnace oil
Lubricating oils	350 and up	C_{16}-C_{20}	Lubrication, mineral oil
Greases	Semisolid	C_{18}-up	Lubrication, petroleum jelly
Paraffin (wax)	Melts at 52-57	C_{20}-up	Candles, toiletries
Pitch and tar	Residue boiler	High	Roofing, asphalt

Source: Seager and Slabaugh (1997)

Table 4: Effects of crude oil on fish

Petroleum products	Fish species	Effects	Author(s)
Oil and oil products	*Sargus anguillaris*	Accelerates death	Mitrovic (1972)
	Crenilabus tinca	Accelerates death	
	Mugil saliens	Accelerates death	
Bunker C oil and no. 2 fuel oil	*Cyprinodont variegatus*	Toxic	Anderson *et al.* (1974)
	Fundulus simulus	Toxic	
	Menidia beryllina	Toxic	
Naphthalene	*Fundulus heteroclius*	Induce necrosis of the gut	Dimichele and Taylor (1978)
Crude oil	*Oreochromis nilotica*	Histopathological changes in liver and gills.	Hijji and Saleh (1994)
Crude oil	*Salmo clarki*	Reduced feeding; reduced growth	Woodland *et al.*(1981) Omoregie *et al.* (1987)
Crude oil	*H. fossils*	Increase in Ht valve	Prasad *et al.*(1987)
Kerosene	*Oreochromis niloticus*	Decrease in valves of Hb, RBC, Ht, Mcv; atrophy or dystrophy, curving, clubbing and fusion of the secondary lamellae; oedema in gills	Omoregie (1998) Gabriel *et al.* (2001) Gabriel *et al.* (2007)
Kerosene	*Clarias gariepinus*	Caused neutrophilia	Gabriel *et al.*(2007)
n-heptane	*Tilapia mossambica*	Toxic	Ghatak and Konar (1990; 1991) Omoregie *et al.* (1997)
Subacute poisoning by phenol	*Salmo gardnerii*	General intoxication of fish organism, inflammatory, necrotic changes of gills, brain, liver, kidneys, spleen and gonads.	Mitrovic *et al.* (1968)
Toluene, naphthalene and water soluble, fractions of Cook Inlet crude oil and no. 2 fuel oil.	*Oncorhynchus gorbuscha*	Hyperglycaemia	Thomas and Rice (1979) Omoregie *et al.* (1997)
Indiane and primiphos methyl	*Oreochromis niloticus*	Reduced growth	Ufodike and Omoregie (1991) Omoregie *et al.* (1997)
Petroleum hydrocarbon	*Tilapia mossambica*	Reduced feeding rate; toxic	Ghatak and Konar (1990; 1991)
Petroleum hydrocarbon	*Morone sexatilis*	Increase in metabolic rate	Omoregie *et al.* (1997)
	Oncorhynchus ishawytscha	Increase in metabolic rate	Brocksen and Bailey (1973)
	Cyprinodon variegatus	Increase in metabolic rate	Anderson *et al.* (1974)
Water soluble fractions of crude oil	*Oreochromis niloticus*	Hypoglycaemic response	Omoregie *et al.* (1997)

loading and off-loading of oil tankers, (ii) placing stringent measures on oil and oil related industries, (iii) employing scientists and ecologists to assess oil and refinery effluents from oil industries, (iv) biologists alerting the nation once they observe the presence of oil in water, (v) ensuring that adequate safety measures be implemented to prevent accidental oil spillage by both producers and users, (vi) repairing leaking oil pipe lines and damaged oil tankers and (vii) oil related industries should have standard laboratories for both water

chemistry, pharmacological and toxicological studies.

Conclusion: This study showed that crude oil and refined oil gain entry into aquatic environment through different sources. Also exposure to both oils in water may lead to impairment of fish physiologically such as alterations in the gills, brain, liver, spleen, etc; degenerate muscle folds, separate muscle fibres; reduce growth, etc as well as increase mortality rate. This greatly reduces the world's fishery resources. The proffered control measures if applied would greatly reduce oil pollution and enhance fishery resources.

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