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IMPACT OF WATER SOLUBLE FRACTIONS OF CRUDE OIL ON GROWTH PERFORMANCE OF THE CATFISH *Heterobrancuhus bidorsalis*

A. A. Nwabueze[1] and O. M. Agbogidi[2]
[1]Department of Animal Science and Fisheries, Delta State University, Asaba Campus, Delta State, Nigeria
[2]Department of Forestry and Wildlife, Faulty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria
E-Mail: omagbogidi@yahoo.com

ABSTRACT

An investigation on the impact of sub-lethal concentrations (0-control, 12.5, 25, 50 and 100%) of water-soluble fractions (WSFs) of crude oil on the performance of the catfish *Heterobranchus bidorsalis* fingerlings was carried out in 2005 under laboratory conditions in Asaba, Delta State, Nigeria, during a 10-week period of exposure in a renewal static bioassay system. Growth of *H. bidorsalis* was observed to reduce significantly ($P \geq 0.05$) with increasing time of exposure and concentrations of WSFs of crude oil when compared with control fish. Fish weight was observed to significantly ($P \geq 0.05$) reduce with increasing concentrations of WSF. A slight increase in length of fish with increasing period of exposure was observed in all the groups. The condition factor (k) of *H. bidorsalis* after 10 weeks exposure to 12.5 and 25% concentrations of WSF also showed significant ($P \geq 0.05$) reduction only in the exposed groups. Mortality was recorded in the 50 and 100% WSFs. Although, no mortality occurred in the control and other exposed groups, fish in the 12.5 and 25% WSFs were less active in swimming and feeding when compared with the control fish. The dissolved oxygen of the medium was significantly reduced ($P \geq 0.05$) while the biological oxygen demand was significantly ($P \leq 0.05$) increased with increasing level of the WSFs. This study has demonstrated that the water-soluble fractions of crude oil have a highly significant effect of reducing the growth performance of *H. bidorsalis*. The study has also showed that *H. bidorsalis* can serve as a bio-indicator of crude oil contaminated water bodies.

Keywords: catfish, growth performance, crude oil, water-soluble fractions.

INTRODUCTION

Oil pollution, one of the environmental consequences of crude oil exploration and exploitation activities produces aqua-toxicological effects, which are deleterious to aquatic life (Kori-Siakpere, 2000; Agbogidi *et al*., 2005). A variety of pollutants including crude oil and its products are known to induce stress conditions, which impair the health of fish (FEPA, 1991). Ekweozor (1989) reported that frequent spillages of crude oil and its products in creeks and rivers of the Niger Delta have resulted in a marked reduction in the number of both freshwater and marine creatures. Earlier reports have also shown that oil pollution impact negatively on fishery resources (Edwards, 1972; Kilnhold, 1980; Afolabi *et al.,* 1985). There has therefore, been a regular and constant increase of contamination of the natural environment and most especially the aquatic ecosystems. Ajoa *et al*. (1981) and Azad (2005) observed that eggs and young stages (fingerlings) of fishes are especially vulnerable to the toxic effects of water-soluble components of crude oil and its refined products. This according to Kilnhold (1980) and Adeola (1996) has resulted in the decimating rich fisheries in the Nigerian coastal waters. Jacka *et al*. (2005) reported that significant levels of total hydrocarbons in shellfishes in crude oil polluted stations in the Niger Delta area when compared with unpolluted sites. The eco-physiological effects of crude oil on *Machaerium lunatus* had also been reported by Bamidele and Agbogidi (2006).

Although, many workers have reported on the effects of crude oil and its water soluble fractions on shrimp (Baden, 1982), *Oreochromis niloticus* (Dede and Kaglo, 2001) and *Clarias gariepinus* (Ofojekwu and Onah, 2002), there is paucity of information on the effects of water soluble fractions of crude oil on *Heterobranchus bidorsalis. Heterobranchus bidorsalis* is a catfish common in Nigerian waters that has not been well studied as other catfishes of the same family Clariidae. Members of the genus *Heterobranchus* have been reported to have a higher growth rate and more resistance to environmental stress factors than other catfishes especially with regards to disease conditions (Holden and Reed, 1978). The role of fisheries in human diet cannot be underestimated since it is a cheap source of protein in the Niger Delta area, the hub of oil industrial activities in Nigeria. The present study has been undertaken to evaluate the impact of water-soluble fraction of crude oil applied at various concentrations on the growth of *Heterobranchus bidorsalis* fingerlings.

MATERIALS AND METHODS

The study, which lasted for 10 weeks, was conducted in Delta State University, Asaba Campus, Nigeria, in 2005. Four weeks old fingerlings of *Heterobranchus bidorsalis* were obtained from Joel Farm, Jedo, near Warri. Fingerlings were kept in open top glass aquaria containing 2000 cm^3 of borehole water, supplied with oxygen aerator pumps and allowed to acclimatize for two weeks period during which time, fingerlings were fed twice daily (10.00am and 6.00pm) at the rate of 4% body weight with poultry mash in a daily renewal static bioassay system. Crude oil with specific gravity of 0.08768 gcm^3 obtained from the Nigerian National Petroleum Corporation (NNPC), Warri, Delta State was

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used. Water-soluble fractions (WSFs) were prepared following the procedure of Afolabi *et al*. (1985). Briefly, 500cm^3 of crude oil was slowly mixed with 1,500cm^3 of borehole water in 2000 cm^3 borosilicate screw capped conical flask. A Gallenkamp orbital magnetic stirrer with capacity for twenty-four flasks was used. The flask was supplied with 7/1cm magnetic rod and the speed of the stirrer was set at number 7. Each crude oil/water mixture was shaken for 24 hours at room temperature as recommended by Boyd and Lichthoppler (1970). After 24 hours of shaking, the mixture was allowed to stand for a minimum of three hours to obtain clear interphase between oil and water. The oily component was decanted and the mixture was then poured into a glass stopper separating funnel and allowed to settle over night after which most of the oil droplets in the WSF would have settled in the upper layer and only pure and clear WSFs was obtained at the lower part of the separating funnel. The WSFs were siphoned into dark coloured screw-capped Winchester bottles. The WSFs, which was collected is the stock or 100 % WSF. The stock was then diluted with borehole water serially to give 50, 25 and 12.5% strength WSF and stored in screw-capped bottles. The hydrogen ion concentration (pH) was adjusted to 6.5.

The experiment was laid out in a randomized complete block design (RCBD) with five treatments (0% - control, 12.5, 25, 50 and 100% WSFs) and weekly exposure time. The experiment was replicated three times. 700 cm^3 of each diluted WSF including the stock was poured into the different aquaria into which ten fingerlings, each of *H. bidorsalis* with mean weight of 1.22$\pm$0.05g and mean total length of 4.86$\pm$0.5 cm were introduced. Daily renewal of the WSFs was done and weekly measurements of growth parameters including weight and total length of fish were taken. Water quality parameters of the WSFs like temperature, dissolved oxygen and biological oxygen demand were determined using the method of APHA (1985). Data obtained were subjected to analysis of variance (ANOVA) at $P \leq 0.05$ level of significance. While the significant means were separated with the Duncan's multiple range test (DMRT) using SAS (1996).

RESULTS

Growth of *H. bidorsalis* was observed to reduce with increasing time of exposure and concentration of WSFs of crude oil when compared with control fish. Weekly measurements of fish weight, total length and condition factor (K) of fish are presented in Table-1. Fish weight was observed to significantly ($P \geq 0.05$) reduce with increasing concentration of WSFs. A slight increase in length of fish with increasing period of exposure was observed in all the groups. The condition factor (K) of *H. bidorsalis* after 10 weeks exposure to 0, 12.50 and 25% concentrations of WSF also showed that growth was significantly ($P \geq 0.05$) reduced only in the exposed groups. Test fish in the 50 and 100% WSFs did not survive beyond the second week of the experiment. Fish in these concentrations of WSF were observed to be weak, shrunk in appearance and unable to feed as evident from the larger amount of uneaten food observed in the aquaria during daily renewal of WSFs. Swimming activity was also reduced and fish were found to stay close together at one corner of each aquarium. Mortality was first recorded on the third and fifth day of exposure of fish in the 100 and 50% concentrations of WSFs respectively. Figure-1 shows the mortality curves of the fish in the 100 and 50% WSFs. There was no mortality in the control and other exposed groups (12.5 and 25%) throughout the experimental period. Although, no death occurred, fish in the 12.5 and 25% WSFs appeared to be less active in swimming and feeding when compared with the control fish. The values of dissolved oxygen were significantly ($P \geq 0.05$) lowered in the various WSFs when compared with control. Biological oxygen demand was observed to increase with increasing concentration of WSFs of crude oil. Temperature and pH remained unchanged during the study. Table-2 shows the mean values of water quality parameters during 10 weeks exposure to WSFs of crude oil.

Table-1. Mean ($\pm$S.E.) growth and condition factor (K) of *H. bidorsalis* exposed to varying concentrations of WSFs for 10 weeks.

Concentration of WSF (%)	**Initial weight** (g)	**Final weight** (g)	**Weight gain** (g)	**Initial total length** (cm)	**Final total length** (cm)	**Total length gain** (cm)	**Initial K**	**Final K**
0	1.25$\pm$0.02	8.9$\pm$0.41	7.64	4.7	9.1	4.4	1.2	1.2
12.5	1.23$\pm$0.51	4.7$\pm$0.04	3.47	4.8	8.3	3.5	1.1	0.8
25	1.27$\pm$0.67	3.0$\pm$0.09	1.73	4.7	7.6	2.9	1.1	0.7
50	1.29$\pm$0.06	1.18$\pm$0.02	-0.11	4.7	4.7	0.0	1.2	1.1
100	1.28$\pm$0.01	1.02$\pm$0.13	-0.26	4.8	4.8	0.0	1.1	0.9

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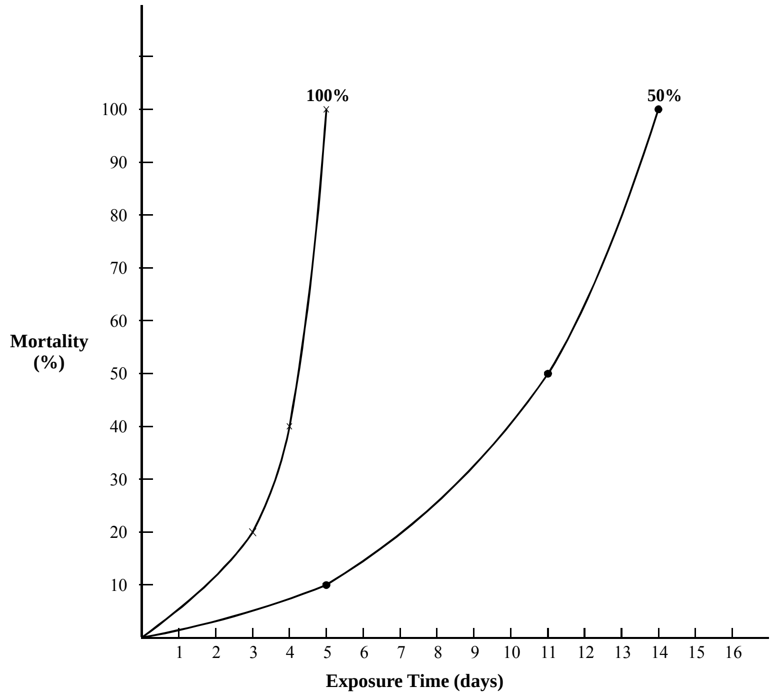

Figure 1: Mortality curves of *H. bidorsalis* in 50% and 100% WSFs of crude

Table-2. Mean value (±SE) of water quality parameter of different WSF of crude oil.

Concentration % WSF	**D.O.** (mg/litre)	**B.O.D** (mg/litre)	**Temp.** (^{o}C)	**pH**
0	7.28±0.02	4.79±0.04	24.3±0.05	6.5
12.5	6.61±0.04	4.93±0.03	24.4±0.06	6.5
25	6.23±0.03	5.42±0.03	24.2±0.05	6.5
50	5.45±0.05	5.66±0.03	24.3±0.03	6.5
100	3.98±0.02	6.71±0.02	24.0±0.07	6.5

DISCUSSIONS

The results obtained from this study indicated that WSFs of crude oil had a negative impact on the growth performance of *H. bidorsalis*. Mortality and reduced growth rate were observed when compared with control fish. The condition factor, which is a manifestation of body condition, was found to be significantly ($P \geq 0.05$) lower in fish exposed to higher concentrations of crude oil. According to Bagenel (1978), the condition factor is a length-weight relationship that indicates the well-being of the fish. The lower the condition factor the poorer the growth of the fish. Exposure of fish to water-soluble fractions of crude oil may have resulted in reduced food intake and thus lower body weight. This finding simulates the work of Kicheniuk and Khan (1987) and Kori-Siakpere (2000), who noted that exposure of fish to WSFs of crude oil, can result in reduced feeding and lower body weight which are reflected in a change in the condition factor. The reduced growth performance observed in this study is also supported by the earlier work of Afolabi *et al* (1985) who also reported that WSFs of crude oil impacted lethargic effects on fish because fish fed less aggressively, moved little and were closely found together. Similarly, Ofojekwu and Onah (2002) reported that fish are known to increase their metabolic rates to metabolize and excrete aromatic hydrocarbons and consequently allocate more energy to homeostatic maintenance than storage, hence a reduction in growth rate.

The observed significant ($P \geq 0.05$) reduction in the values of dissolved oxygen with increasing concentrations of WSFs could be attributed to oxygen stress. The reduced dissolved oxygen content of the WSFs with higher concentration may have caused stress in the fish resulting in reduced feeding activity and suffocation which eventually may have led to the fish kill. This observation supports earlier reports of Baden (1982) that a corresponding increase in biological oxygen demand and a decrease in dissolved oxygen content are typical of water bodies contaminated with crude oil. Boyd and Lichthoppler (1979) reported that low dissolved oxygen content of water could have stressful effects on the growth and behaviour of fish.

Conclusively, this study has demonstrated that the water-soluble fractions of crude oil have a highly significant effect of reducing the growth performance of *H. bidorsalis*. The study has also showed that *H. bidorsalis* can serve as a bio-indicator of crude oil contaminated water bodies. Since there is a likelihood of continuous exploration and exploitation of crude oil in the Niger Delta, further studies to ascertain the tolerance limit of every bio-indicator to environment pollution should be conducted. Particular attention should also be given to crude oil production process aimed at minimizing the environmental hazards due to oil spillage.

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