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*SHORT COMMUNICATION*

# ASSESSMENT OF THE ACUTE TOXICITY OF TEXTILE EFFLUENT AGAINST *CLIBANARIUS AFRICANUS* (DECAPODA: PAGURIDAE) AND *POECILIA RETICULATA* (TELEOSTEI: POECILIIDAE)

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**ABSTRACT:** Static assessment of the acute toxicity of textile effluent against hermit crab *Clibanarius afrianus* and fish *Poecilia reticulata* was conducted in the laboratory. The effluent was found to be differentially toxic to the test species, the computed 96h $LC_{50}$ values being 333.311 ml/l and 70.711 ml/l for *C. africanus* and *P. reticulata,* respectively. It was more toxic against *P. reticulata* than *C. africanus*. Computed toxicity factor/ratio based on the 96h $LC_{50}$ values indicated that *P. reticulata* was 4.7 times more sensitive than *C. africanus* when tested against the textile effluent. The physical and chemical characteristics of the textile effluent were much higher than the prescribed effluent limitation standards for the OECD (Organization for Economic Cooperation and Development). The BOD and COD were 6 and 3 times, respectively, higher than the respective values of 20 mg/l and 80 mg/l, prescribed as limitation standards.

**Key words/phrases**: Acute toxicity, *Clibanarius africanus*, *Poecilia reticulata*, Textile effluent.

## INTRODUCTION

Industrial effluents constitute one of the major sources of pollutants into the environment. The growing concern for public heath and the progressive deterioration of the aquatic environment has resulted in the establishment of legislation to control the quality of effluents and receiving waters (Hellawell, 1989; Bervoets *et al*., 1996). Determination of the minimum concentration of industrial effluents which kill fish in a particular period is necessary when setting up standards for the safe disposal of such wastes (Trivedi and Dubey, 1978).

Most of the industrial waste water effluent discharged into the environment contains organic and inorganic pollutants in dissolved, suspended and insoluble forms. Fiber residues make textile waste water high in BOD and

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suspended solids and a wide variety of chemicals. According to Aina and Adedipe (1996), the textile mills in Nigeria empty their waste waters into natural water ways via public drainage with little or no treatment. This is in defiance to the pollution abatement legislations of the Federal government of Nigeria and the stipulated effluent limitations guidelines of the Federal Ministry of Environment. Textile effluents are known toxicants which inflict acute disorders in aquatic organisms (Karthikeyan *et al.*, 2006). The consequences of waste water effluent pollution have been studied by some researchers. Ajao (1985) used bioassay technique to determine the harmful effects of some of these effluents against aquatic organisms and also suggested safe levels of discharge permissible in the aquatic ecosystem such as the Lagos lagoon. Trivedi and Dubey (1978) reported that effluents from caustic rayon industries diluted forty times were found to be lethal to fish. The US Environmental Protection Agency undertook a series of freshwater and marine studies to examine the relationship between ambient toxicity and in-stream impacts (e.g. Mount *et al*., 1985, 1986; Norberg-King and Mount, 1986). These and other studies (Eagleson *et al.*, 1990; Dickson *et al.*, 1992; Khan *et al*., 1994) found good correlations between the effluent and ambient toxicity and the effects on the aquatic communities. Bervoets *et al*. (1996) reported that dilution of industrial effluent to a level at which the measured toxicant concentrations comply with European regulations still showed significant effects on *Daphnia magna* reproduction.

This study was designed to evaluate the acute toxicity of textile effluent against *C. africanus* and *P. reticulata*; to compare the acute toxicity values of the effluent against the test animals; and also compare the sensitivity of the test animals to the test effluent.

## MATERIALS AND METHODS

The acute toxicities of textile effluent against *C. africanus* and *P. reticulata* were assessed to determine the 96h $LC_{50}$ in static bioassay.

*C. africanus* (hermit crabs) specimens were hand picked from the Lagos Lagoon shore line off the University of Lagos Lagoon front where the biological garden is located. In the laboratory, the crabs were kept in holding glass tanks (40 x 40 x 70 cm) half filled with Lagoon water, with bottom sand from the site of collection, acting as substrate. The lagoon water in the tank was continuously aerated with a U-TECH 1000 aerator. The hermit crabs, fed with pieces of shrimps, were kept in the holding tanks for at least seven days, to allow them acclimatize to laboratory conditions ($28^0$c ± $2^0$c) before using them in bioassays. About 100 individuals were kept in each holding tank. The water and substratum was changed once every 48 hrs to avoid accumulation of toxic waste metabolites from the specimens and remnants of food particles. *P. reticulata* (fish) was collected with a hand net from a drainage along Bilikisu street, Onike Yaba, Lagos into a plastic bucket holding the drainage water. In the laboratory, the fish were kept in holding glass tanks (50 x 40 x 40 cm) half filled with dechlorinated tap water and acclimated under the same conditions as for *C. africanus*, and fed with NIOMR fish feed. About 150 fish were kept in each holding tank. The fish were collected under near-pristine conditions prior to their use in toxicity tests. The sites of collection were not in industrial areas and had no record of toxicant inputs.

The textile effluent was collected from a textile mill located at Oba Akran Road, Ikeja, Lagos. It was collected from a discharge pipe in front of the gate of the industry. Samples were collected in 12 litre jerry cans when the factory was actively producing. The effluent sample was stored in a deep freezer to reduce rate of degradation before analysis and use in bioassays.

Clean plastic bowls (2.5 l volume, 15 cm bottom diameter and 8.5 cm depth) were employed in all the bioassays, as containers. Bottom soil from the natural habitat of the hermit crab was provided at the bottom of each bioassay container in test involving *C. africanus* to simulate the natural habitat of the benthic animal. The sand was spread on a wooden board and dried for up to 7 days. The sundried sand was weighed out and spread evenly on the bottom as substrate before introduction of test media. A predetermined volume of the test compound was pipetted into a measuring cylinder and made up to ½ l (for *C. africanus*) and 1 l (for *P. reticulata*) by adding appropriate units of filtered lagoon water for *C. africanus* and dechlorinated tap water for *P. reticulata* as diluent, to achieve the desired concentration of the test compound. Active specimens of about the same size (2.5 ± 0.5 g mean weight for *C. africanus*, and 1.53 ± 0.07 cm mean length and 41.7 ± 0.4 mg mean weight for *P. reticulata*) were randomly assigned to bioassay containers, already containing the test media prepared. In all bioassays, a total of 10 active animals were placed in each container. Tests were run at several concentrations or untreated controls. In each treatment there were two replicates. Test animals were exposed to several concentrations of each test compound after range finding bioassays were carried out. *C. africanus* was exposed to concentration range of 257–500 ml/l in 10 concentrations, while *P. reticulata* was exposed to concentration range of 50–76 ml/l in 8 concentrations.

Mortality assessments were made by examining each animal separately once every 24 hours over a four-day period. *C. africanus* was taken to be dead if it failed to come out of its shell over observation period of 5–10 minutes, or failed to withdraw feet outside shell when probed with a glass rod. *P. reticulata* was taken as dead if it failed to move any part of its body when probed with a glass rod.

Adopting standard methods (APHA *et al*., 1985), a number of physical and chemical characteristics of the test effluent were determined. Temperature was measured *in situ* using a simple mercury-in-glass thermometer, colour was noted by visual observation, pH was measured with a sensitive pH meter (Jenway model 3050, serial number 4210, biochemical oxygen demand (BOD) was determined titrimetrically, while chemical oxygen demand (COD) was determined by open reflux method.

The toxicity data based on mortality was analysed by probit analysis, after Finney (1971). The analysis, including the equation for probit line, was achieved via a computer-run program dependent on maximum likelihood weighted regression as adopted by Don-Pedro (1989). Indices of toxicity/susceptibility level were based on the 96h $LC_{50}$ values.

## RESULTS

The results of the physical and chemical characteristics of the textile effluent are shown in Table 1.

Table 1. Some physio-chemical characteristics of the textile effluent.

| Parameter | Effluent value |
|---|---|
| Temperature $^0$C | 28 |
| pH | 8.13 |
| Colour | Dark brown |
| BOD (mg/l) | 125 |
| COD (mg/l) | 254 |

The textile effluent was moderately and differentially toxic to the test species, *P. reticulata* and *C. africanus* under static bioassay, based on the 96h $LC_{50}$ values (Table 2). The textile effluent was found to be more toxic against *P. reticulata* (with 96h $LC_{50}$ value of 70.711 ml/l) than *C. africanus* (with 96h $LC_{50}$ value of 333.311ml/l)

Table 2. Comparative toxicities of the textile effluent against *C. africanus* and *P. reticulata* in bioassays.

| Test Species | 96h $LC_{50}$ (CL) ml/l | Regression equations (Probit response) |
|---|---|---|
| *C. africanus* | 333.311 (349.009 – 318.317) | Y = -31.674 + 14.907x |
| *P. reticulata* | 70.711 (72.890 – 68.597) | Y = -35.454 + 22.640 x |

*P. reticulata* was found to be more sensitive to the textile effluent than *C. africanus*. Computed toxicity factor/ratio based on the 96h $LC_{50}$ values indicated that *P. reticulata* was 4.7 times more sensitive than *C. africanus* when tested against the textile effluent.

## DISCUSSION

Textile effluents show moderate toxicity to some, but not all aquatic species (Chen *et al.*, 2001). The physical and chemical characteristics of the textile effluent were much higher than the prescribed effluent limitation standards of the OECD (Organization for Economic Co-operation and Development) test method standard (APHA *et al*., 1985). The BOD and COD were 6 and 3 times, respectively, higher than the respective values of 20 mg/l and 80 mg/l prescribed as limitation standards. Similarly, the pH is outside the prescribed value of 6.9. The implication of this is that the effluent being discharged into the environment is not properly treated or not treated at all. This observation confirms the report of Aina and Adedipe (1996) who reported that effluent of textile industries in Nigeria are insufficiently treated and capable of causing harm to aquatic organisms. The high BOD and COD values in particular are potentially harmful in the recipient aquatic environment, as they are likely to bring about depletion of dissolved oxygen. This will cause oxygen stress to any aquatic species and may lead to asphyxiation or death (Odiete, 1999).

The low toxicity of the textile effluent compared to other test chemicals can be attributed to the relatively low concentration of toxic components such as dyes, pigments and other coloring agents in the effluents. The differential sensitivity of the test species to the textile effluent conforms with the finding of Taiwo (1999) who reported that mixed industrial effluent was significantly more toxic to *Batanga lebretonics* and *C. africanus*. Onasoga (1999) also reported that the textile effluent from Afprint and Sunflag was 8 times more toxic when tested against *Oreochromis niloticus* and *C. africanus*. Differential suscepitibility of organisms to chemicals depend on factors such as cuticular disposition to penetration by the test toxicant, metabolism, rate of enzymic breakdown to more hydrophilic substances, excretion of the compounds and availability of storage facilities (Don–Pedro, 1989).

## REFERENCES

Aina, A.O. and Adedipe, N.O. (1996). Water quality monitoring and environmental status in Nigeria. Federal Environmental Protection Agency (FEPA) Publication.

Ajao, E.A. (1985). Acute toxicity of waste water effluent from a textile mill and a detergent packing plant on hermit crabs *Clibanarius africanus*. MSc.Thesis, University of Lagos, Lagos, Nigeria.

American Public Health Association (APHA), American Waterworks Association (AWWA) and Water Pollution Control Federation (WPCF) (1985). **Standard methods for the examination of water and waste water.** 16th ed. APHA Washington.

Bervoets, L., Baillieul, M., Blust, R. and Verheyen, R. (1996). Evaluation of the effluent toxicity and ambient toxicity in a polluted lowland river. *Environ. Pollut.* **91**(3): 333-341.

Chen, C.M., Shih, M.L., Lee, S.Z. and Wang, J.S. (2001). Increased toxicity of textile effluents by a chlorination process using sodium hypoclorite. *Water Sci. Technol.* **43**(2): 1-8.

Dickson, K.L., Walker, W.T., Kennedy, J.H. and Ammann, L.P. (1992). Assessing the relationship between ambient toxicity and instream biological response. *Environ. Toxicol. Chem.* **11**: 1307–1322.

Don–Pedro, K.N. (1989). Mode of action of fixed oils against eggs of *Callosobruchus maculatus* (F). *Pestic. Sci.* **26**: 107 – 115.

Eagleson, K.W., Lenat, D.L., Ansley, L.W. and Winborne, F.B. (1990). Comparison of measured instream biological responses with responses predicted using *Ceriodaphnia dubia* Chronic Toxicity Test. *Environ. Toxicol. Chem.* **9**:1019-1028.

Hellawell, J.M. (1989). Biological indicators of freshwater pollution and environmental management. Elsevier, New York.

Karthikeyan, S., Jambulingam, M., Sivakumar, P., Shekhar, A.P. and Krithika, J. (2006). Impact of textile effluents on freshwater fish *Mastacembelus armatus* (Cuv. and Val). *E-J of Chemistry* **3**(13): 303-306.

Khan, A.A., Barbieri, J., Sweeney, F. and Khan, S.A. (1994). Estimation of ambient chronic toxicity in a polluted creek system. *Environ. Pollut.* **83**:379-382.

Mount, D.I., Norberg-King, T.J. and Steen, A.J. (1986). Validity of effluent and ambient toxicity test for predicting biological impact. Naugatuck River Watsbury, Connecticut. EPA/600/8-86/005. Environmental Research Laboratory, Duluth, MN, USA.

Mount, D.I., Steen, A.E. and Norberg-King T.J. (1985). Validity of effluent and ambient toxicity test for predicting biological impact on Five Mile Creek. Birmingham, Alabama. EPA/600/8-85/015. Environmental Research Laboratory, Duluth, MN, USA.

Norberg-King, J.J. and Mount, D.I. (1986). Validity of effluent and ambient toxicity test for predicting biological impact, Skeleton Creek, Enid, Oklahoma, EPA/600/8-86/002. Environmental Research Laboratory, Duluth, MN, USA.

Odiete, W.O. (1999). **Environmental Physiology of Animals and Pollution.** Diversified Resources Limited, Lagos, Nigeria. 259 pp.

Onasoga, A.S. (1999). **Acute toxicity of textile effluent and bioaccumulation of its iron (Fe) content by *Tilapia nitoticus* and *Clibanarius aficanus*.** MSc.Thesis. University of Lagos, Nigeria.

Taiwo, A.E. (1999). **Monitoring biological action of mixed industrial effluent by multiple toxicity test against *Batanga lebretonis* and *Clibananus africanus* over successive periods.** MSc.Thesis, University of Lagos, Nigeria.

Trivedi, R.C. and Dubey, P.S. (1978). Evaluation of toxicity of some industrial wastes to fish by bioassay. *Environ. Pollut.* **17**: 75-80.