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Acute Toxicity Tests of Cassava and Rubber Effluents on the Ostracoda *Strandesia prava* Klie, 1935 (Crustacea, Ostracoda)

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Abstract: Acute toxicity of cassava mill and rubber processing plant effluent to the ostracoda *Strandesia prava* were evaluated. Cassava LD_{50} values for 24, 48 and 96 h was 0.4786, 0.311 and 0.2818% effluent concentrations, respectively, while LT_{50} were 169.82, 346.74, 446.68, 562.34 and 2754.23 min for 25, 12.5, 6.25, 3.125 and 1.5625% effluent concentrations, respectively. Rubber waste water LD_{50} values for 24, 48 and 96 h was12.59, 11.89 and 11.22% effluent concentrations, respectively. All were significant at $p<0.05$. Rubber LT_{50} was 239.88, 794.33, 1584.89 and 3548.13 min for 100, 50, 25 and 12.5% effluent concentrations, respectively. Cassava mill effluent were more toxic than rubber processing mill effluent and caused ostracod mortality faster within short exposure time. Pretreatment of cassava effluent in holding tanks before discharge into the aquatic ecosystem would possibly reduce its toxic impact.

Key words: Toxicity, rubber, cassava, effluent, ostracoda

INTRODUCTION

Industrial effluent discharges are worldwide sources of potential pollution (Ajao, 1985). Acute toxicity tests give firsthand information on the effects of such discharges on organisms and the ecosystem as a whole and are valuable in creating awareness as to the potential harmful effects of such industrial discharges to the environment. The continuous increase in supply and demand for cassava (*Manihot esculenta*) in developing countries has accentuated the negative impact of cassava processing on the environment and biodiversity (Arimoro *et al*., 2008). Studies on the effects of human activities and industrial effluents on Nigerian biota have focused on various macrobenthic invertebrates and fish (Ajao, 1985; Arimoro *et al*., 2008; Edokpayi, 1993) but none has addressed the effects on freshwater ostracod crustaceans. Published records of Nigerian freshwater ostracoda have also focused on their ecology and taxonomy (Onyedineke, 2000; Victor, 1981). Garri, a Nigerian staple food and cassava starch used by the textile and paper mill among other usage are end products from the cassava mill plants. Effluent resulting from the cassava mill plants are often directly or indirectly discharged into aquatic system without any prior treatment. Cassava wastewater contain unextracted starch, cellulose carbohydrates, nitrogenous compounds and cyanoglycosides. Cyanogens and glycosides are easily hydrolysed into hydrogen cyanide which is toxic to aquatic animals and pose serious treat to the environment (Abiona *et al*., 2005). Effluent from rubber processing plants also find their way into the aquatic systems. Wastewater from rubber processing plants contain organic and inorganic matter that originate from the natural latex rubber and from chemicals used in processing, such as

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ammonia, formic acid, sodium metabisulphite and sodium sulphite (Kantachote *et al*., 2005). There are no available records of the toxicity of rubber processing wastewater on crustaceans. Ostracods are important components of the aquatic food chain. Knowledge of the toxic effects of these effluents and response of crustaceans to them would be useful indicators and parameters for protecting our freshwater bodies from pollution.

This study examines the response and toxic effects of cassava and rubber plant effluents on the freshwater ostracoda *Strandesia prava*.

MATERIALS AND METHODS

Ostracoda

The experimental crustacean ostracod *Strandesia prava* were collected into 18 L plastic buckets from a stagnant freshwater pond located at Ujoelen, Ekpoma, Edo State, Nigeria., Nigeria (6°19'N and 6°20'E) with bolting silk nets (mesh 65 μm). Agile ostracoda were placed in pondwater in Petri dishes to acclimatize for two days prior to use in bioassay. Groups of ten agile ostracoda were thereafter exposed in 20 mL of test solution with varying concentrations of effluent wastewater. Adequate levels of dissolved oxygen were ensured in the test solutions according to APHA (1989).

Rubber and Cassava Effluent

Effluent were collected in 2 L plastic containers from a cassava (*Garri*) processing plant at Ujoelen, Ekpoma and rubber processing plant at Tepoga, Benin City, Nigeria. The physico-chemical parameters of the pondwater, cassava and rubber effluents were determined prior to bioassay.

Test solutions containing various percentages of the effluent by volume based on a suitable logarithmic series were prepared using aerated dilution pondwater.

Bioassay

The study was conducted September, 2006. Glass dishes each containing 20 mL of test solutions were used. Rubber effluent concentrations by volume used were 100, 50, 25, 12.5, 6.25, 3.125 and 0.00% (control). All ostracoda died within 1 h in a preliminary bioassay with cassava concentrations >50% and so lower concentrations were used for the experiment. The cassava concentrations by volume used were 12.5, 6.25, 3.125, 1.5625, 0.78125 and 0.39062%. Behavioral changes were recorded and mortality recorded every 2 h for 32 h and thereafter every 6 h till 96 h.

Data Analysis

Lethal dose (LD_{50}) for ostracoda and lethal time (LT_{50}) for effluent were calculated using Probit Analysis (Finney, 1971). Best fit lines of expected probits were calculated by regression. A one way Analysis of Variance (ANOVA) was used to determine the significance of the regression coefficient of probit on dosage. All levels of statistical significance were determined at $p<0.05$ (Zar, 1998).

RESULTS

Physico-chemical characteristics of dilution pondwater and typical effluent discharges from the cassava and rubber plant on any working day are shown in Table 1.

Table 1: Physico-chemical characteristics of pondwater and wastewater effluents from the cassava and rubber plant

Characteristics	Pondwater	Cassava	Rubber
Temperature (°C)	27.00	33.00	34.000
pH	6.45	4.42	4.500
Turbidity (NTU)	414.12	1693.00	141.000
Conductivity (µS cm^{-1})	16.00	148.00	2.500
Total dissolved solids (mg L^{-1})	340.00	9320.00	23.100
Dissolved oxygen (mg L^{-1})	-	-	1.788
Biological oxygen demand (BOD)	-	-	6.640
Chlorine (mg L^{-1})	12.28	-	78.000
Nitrate (mg L^{-1})	1.37	17.01	0.010
Sulphate (mg L^{-1})	1.80	18.69	0.210
Phosphate (mg L^{-1})	6.24	24.66	0.910
Potassium (mg L^{-1})	5.62	21.44	-
Sodium (mg L^{-1})	18.72	6.10	-
Calcium (mg L^{-1})	1.00	-	20.020
Magnesium (mg L^{-1})	0.61	-	-
Total iron (mg L^{-1})	0.71	8.28	0.050
Mercury (mg L^{-1})	-	-	0.003
Copper (mg L^{-1})	-	-	0.970
Zinc (mg L^{-1})	-	-	0.350
Chromium (mg L^{-1})	0.40	1.02	nd
Cadmium (mg L^{-1})	0.34	0.02	-
Lead (mg L^{-1})	2.10	0.00	0.000

nd: Not determine

The cassava and rubber waster water were more acidic than the pondwater. Turbidity, conductivity, total dissolved solids, nitrate, sulphate, phosphate, potassium and total iron content were higher in the cassava than in the rubber wastewater.

Colour and Behavioral Changes

The ostracoda exhibited degrees of restlessness, random motion, overturning (loss of balancing), sluggishness and eventual death with the degrees of this behavior increasing as the effluent concentration increased. There were no color change, the greenish color of the animals were retained even after death in the rubber and cassava effluents.

Bioassay

Cassava

All test animals died after 1 h in the 100 and 50% concentrations of the cassava effluent. There were no deaths in the control (0% effluent concentration).

Figure 1-3 show the results of probit analysis for 24, 48 and 96 h exposure time, respectively. LD_{50} values for 24, 48 and 96 h was 0.4786, 0.311 and 0.2818% effluent concentrations, respectively. Cassava effluent was highly toxic to the ostracods even at very low concentrations. All were significant at $p<0.05$. LT_{50} were 169.82, 346.74, 446.68, 562.34 and 2754.23 min for 25, 12.5, 6.25, 3.125 and 1.5625% effluent concentrations, respectively. Survival time increased only at very low concentration (1.5625%).

Rubber

Seventy ostracods were used for the bioassay. There were no deaths in the control (0% effluent concentration) however; there was 100% mortality after 24 h in the 100% effluent concentration.

Figure 4-6 show the results of probit analysis for 24, 48 and 96 h exposure time, respectively. LD_{50} values for 24, 48 and 96 h was 12.59, 11.89 and 11.22% effluent

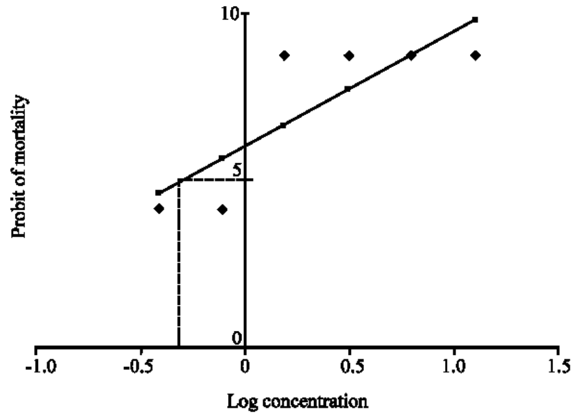

Fig. 1: Twenty four hour probit analysis for cassava wastewater

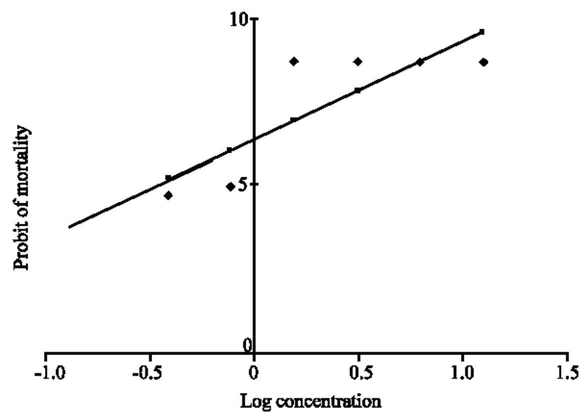

Fig. 2: Forty eight hour probit analysis for cassava wastewater

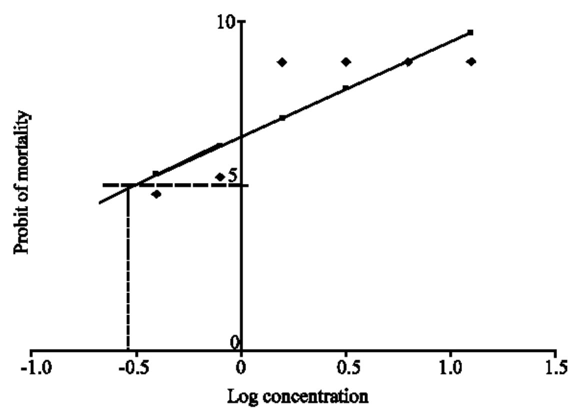

Fig. 3: Ninty six hour probit analysis for cassava wastewater

concentrations, respectively. All were significant at $p<0.05$. The LT_{50} were 239.88, 794.33, 1584.89 and 3548.13 min for 100, 50, 25 and 12.5% effluent concentrations, respectively.

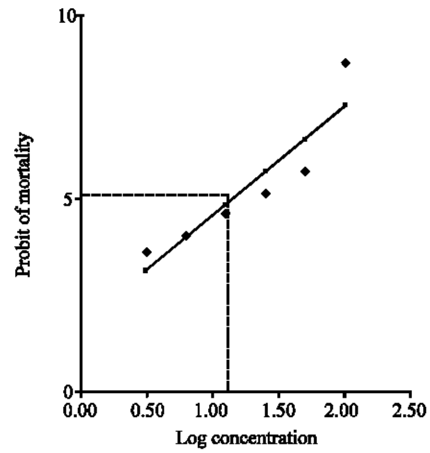

Fig. 4: Twenty four hour probit analysis for rubber wastewater

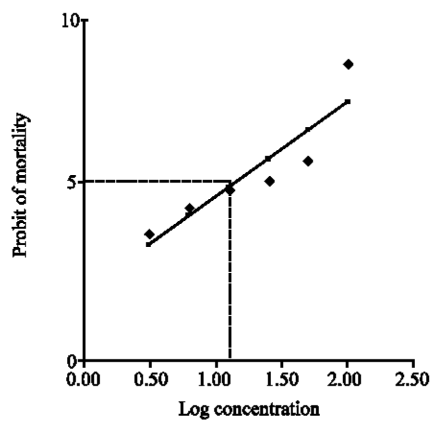

Fig. 5: Forty eight hour probit analysis for rubber wastewater

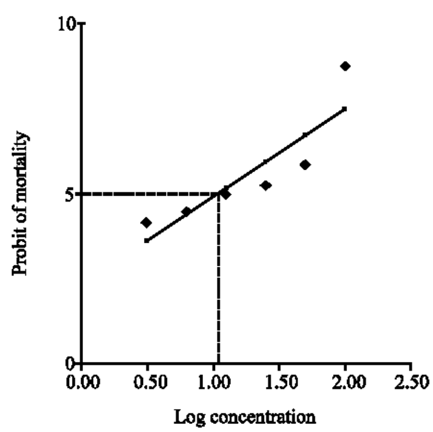

Fig. 6: Ninty six hour probit analysis for rubber wastewater

Ostracods could survive even at 100% effluent concentration, however, survival time increased as effluent concentration decreased.

DISCUSSION

Strandesia prava survived in the control experiment throughout the 96 h of the bioassay indicating that mortality during the bioassay was not caused by time nor container induced stress rather it was toxicant induced. Death of test organisms during bioassay could be as a result of time or container induced stress other than those arising from the toxicant.

Rubber effluent showed higher LD_{50} values than that of cassava, 24 LD_{50} of rubber was 12.59% while that of cassava was 0.4786% at the same time interval. In addition, 1.5625% concentration by volume of cassava effluent caused mortality at a shorter time (LT_{50} = 2754.23 min) than a 12.5% concentration by volume of rubber effluent (LT_{50} = 3548.13 min). These indicate that cassava effluent was more toxic than rubber effluent and produced a high level of mortality rate at low concentrations within a short exposure time. Low values of pH of effluent test water compare well with other waterbodies receiving untreated wastes. Water bodies receiving untreated cassava water have been reported to be highly acidic sometimes with pH as low as 2.6 (Zvauya and Muzondo, 1994; Arimoro *et al*., 2008). The toxic effects of cassava effluent at low concentrations could be due to dissolved hydrocyanic acids indicatng that under field conditions where dilution is possible, ostracod mortality rate would still be high when exposed to low concentrations of cassava effluent even for short periods of time. The acute toxicity of cassava effluent on ostracod crustaceans agrees with the findings of Arimoro *et al*. (2008), who reported that cassava effluent had decimating impact on macrobenthc invertebrates. High values of physico-chemical parameters of cassava effluent as well as the low pH might have caused physiological stress on ostracoda thereby causing high mortality. Arimoro *et al*. (2008) also found out that untreated cassava water caused the absence of crustaceans and mollusks. Rubber effluent mortality on ostracods could also have resulted from physiological stress imposed by low pH. The lower toxicity of rubber on the test animals could be due to the absence of hydrocyanic acids. The results obtained here show that ostracods could survive in rubber polluted waters for a period of time. Ostracods play an important role in the aquatic food chain. Exposure to untreated cassava waters could lead to decimation and extinction. Ostracods could be used as indicator organisms for cassava polluted environments just as harpacticoid crustaceans are used as indicators of endocrine disrupting chemicals (Wollenberger, 2005). The absence of pretreatment measures before these effluents are released into the environment are a cause for concern. Cassava mills are often small scale industries that discharge their effluents directly into the environment, pretreatment in holding tanks before discharge into the environment would be helpful.

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