Full Length Research Paper

Physicochemical and hydrocarbon content of effluent from Port-Harcourt refining company and its effect on renal function of albino rats

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Abstract

The Physicochemical and hydrocarbon content of Port Harcourt Refining Company effluent and its effect on the renal function of albino rat was investigated. Based on the WHO maximum permission limit, the effluent could be rated as toxic with Biological, Physical and Chemical Parameters ranges as COD (113mg/l), BOD(51mg/l), TDS (136mg/l), Phenol (2.17mg/l), Nitrate (2.7mg/l), Chloride (28mg/l), Phosphorus (0.13mg/l), Sulphate (<0.05mg/l), Zinc (0.20mg/l), Iron (0.21mg/l), pH (6.1). The values of PAH, TPH and THC were 0.25mg/l, 0.5mg/l, 0.973mg/l respectively. Although these values are not above the WHO maximum permission limit, it indicates the presence of Polycyclic Aromatic Hydrocarbon in the effluent. The renal function test showed a significant increase in the level of the renal biomarkers. The results therefore suggest that the effluent from Port Harcourt Refining Company is toxic and could possibly cause adverse effect on the environment and its inhabitants.

Keywords: Effluent, physicochemical, PAH, TPH, THC, renal toxicity.

INTRODUCTION

The alarming rate of ill-health and terminal diseases amongst the inhabitants of the Niger Delta region of Nigeria, West Africa such as renal dysfunctions, hepatic and hormonal dysfunctions leading to infertility, mutations of genes etc and even death of the individuals necessitated this research study. Due to the ineffectiveness of purification systems, liquid effluent may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem [Beg *et al.,*2003, Beg *et al.,*2001). Hence the need to evaluate the composition of the liquid effluent from the refining company.

The problem posed by the pollution of the environment due to anthropogenic activities of the petroleum refining industry is fast becoming a point that should not be overlooked in today's world.(Adeyemi, 2004). This is due to the numerous environmental impacts it leaves behind on the host community and the eco system at large. Liquid effluent released by petroleum refining industries are characterized by the presence of large quantities of crude oil products, polycyclic and aromatic hydrocarbons, phenols, metal derivatives, surface-active substances, sulfides, naphthylenic acids and other chemicals (Suleimanov, 1995).

MATERIALS AND METHODOLOGY

The effluent sample was obtained from the Port Harcourt Refining Company plant at Alesa-Eleme, Rivers State of Nigeria in opaque bottles to prevent photolysis and used within the shortest possible time to avoid microbial activities which may likely affect oxygen content. The effluent was analyzed for concentrations of hydrocarbons, heavy metals, physicochemical parameters and biological parameters. The forms of analytical processes used in this work were of the standards of American standards of testing materials (ASTM), American public health association (APHA), American petroleum institute (API) and Federal environmental protection agency (FEPA).

Table 1: Hydrocarbon/Metal composition of effluent and borehole water

Parameter	Refinery Effluent	Borehole water	WHO
PAH(mg/l)	0.25	<0.01	<0.001
THC(mg/l)	0.97	<0.01	0.2
TPH(mg/l)	0.49	<0.01	<0.001
Phenol(mg/l)	2.17	<0.1	NI
Zinc(mg/l)	0.20	<0.01	1.0
Iron(mg/l)	0.21	0.09	1.5

Table 2: Physicochemical composition of effluent water and borehole water

Parameter	Refinery effluent	Borehole water	WHO
BOD	51	Nil	50
COD(mg/l)	113	5	40
TDS(mg/l)	136	230	250
Ph	6.1	5.5	6.5
Conductivity(µs/cm@25^{0}C)	277	513	2500
Chloride(mg/l)	28	41	200
Sulphate(mg/l)	<0.05	<0.05	400
Nitrate(mg/l)	2.7	4.4	50
Phosphate(mg/l)	0.13	0.05	5
Temperature(^{o}C)	25.9	24.2	NI

Experimental animals

Fifteen wistar albino rats weighing between 163-180g, bred in the Animal House of the Department of Biochemistry, University of Port Harcourt were used for this study. The animals were housed in metabolic cages and fed with commercially sold feed as food and water was given *ad libitum*.

Experimental protocols

The rats were randomly assigned into 3groups of 5rats each and the experiment lasted a period of 14days.
Group 1 animals were fed with feed and water *ad libitum* throughout the period of the experiment. On the 13th day, 0.2ppm standard solution of polycyclic aromatic hydrocarbon was administered to each rat in the group intraperitoneally.
Group 2 animals were fed with feed and effluent water *ad libitum* throughout the period of the experiment.
Group 3 animals used as control were fed with borehole water and feed *ad libitum* throughout the period of the experiment.
    All experimental animals were sacrificed on day 14 of the experiment.

Collection of sample

On day 14 of the experiment, animals were anaesthetized in chloroform vapor and whole blood was collected by direct cardiac puncture from each animal into labeled ice-cold lithium heparinized bottles and centrifuged. The animals were dissected, the kidney were collected for histopathological examination.

Data analysis

Results are expressed as mean ± standard deviation, and all data were subjected to analysis of variance (ANOVA) and significant difference between the treatments means were detected at 5% confidence level.

RESULTS

The result on table 3 shows significant variations among groups 1,2, and 3. at 0.05 levels ($P \leq 0.05$) in the renals after the administration of the sample solution. It shows a progressive increase in the level of the Kidney

Table 3: Effect of PAH and refinery effluent on renal function

GROUP	CREATININE(µmol/L)	UREA(mmol/L)
Group 1 (PAH)	333.50±65.33[a]	16.85±3.31[a]
Group 2 (effluent)	244.40±27.69[b]	12.28±1.28[b]
Group3 borehole (control)	181.80±50.26[b]	10.18±1.12[b]

- *Values are mean ± standard deviation*
- *Values in the same column with different superscript are not significantly different at the 0.05 level (P≤ 0.05)*
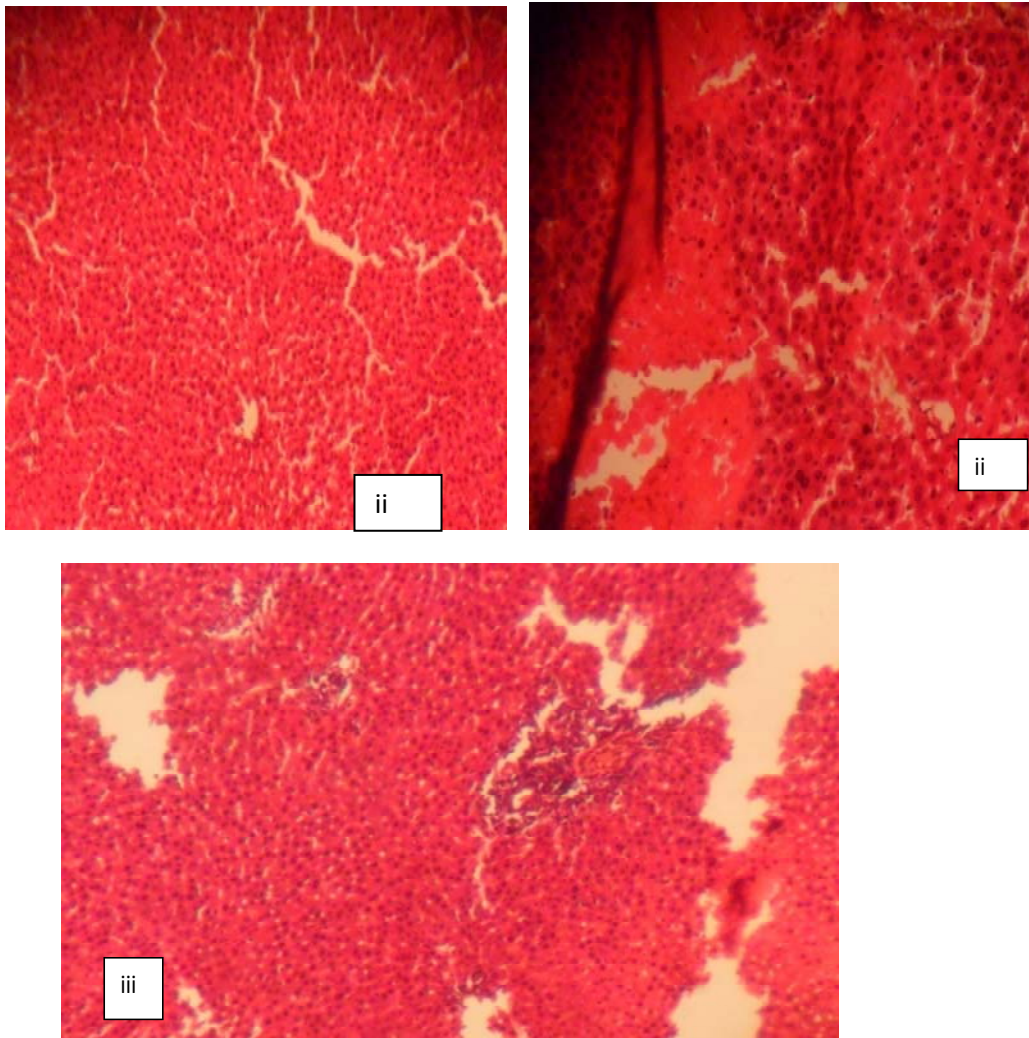
Photomicrographs of kidney of wistar albino rats of groups i,ii and iii.

Figure 1: (i) a section of control rat kidney showing normal architecture. (ii) a section of rat kidney exposed to effluent showing lobulated glomerulus with congested capillaries and patchy generation of the convoluted tubules. (iii) a section of kidney exposed to PAH showing degenerating changes

biomarkers (Urea and Creatinine). This indicates renal   toxicity and damage to the kidney.

DISCUSSION

The physicochemical, biological, hydrocarbon and metal content analysis of effluent from Port Harcourt refinery and borehole water sample reveals the presence of PAH, THC, TPH, heavy metals and some toxicity parameters.

Previous studies (Kuehn *et al.*,1995, Onwumere *et al.,*1990) revealed that polycyclic aromatic hydrocarbon causes poor health – (carcinogenic, teratogenicity genotoxicity, imununotoxicity), diseases such as typhoid fever, dysentery, cholera and other intestinal diseases. The values of PAH, TPH and THC in the effluent sample are seen to be high indicating a high level of hydrocarbons in the effluent, hence toxicity of the effluent sample. The high level of hydrocarbon could be attributed to the crude and chemicals used in the refining process. The BOD value of the effluent is higher than the WHO limit, thus the toxicity of the effluent sample to the environment and health. This value could be attributed to the organic materials which use up oxygen resources as they are chemically oxidized, oil and grease that inhibit the transfer of oxygen from the atmosphere and surfactants that affect oxygen transfer into water (Eneh,1994). COD value varied significant for the samples. The result showed a high value of COD in the effluent sample (113mg/l) and 5mg/l in the control-borehole water sample, which indicates a high degree of organic pollution from the refining process. Phosphate was detected at low concentration in the effluent, below the WHO limit for portable water. The effluent sample is seen to have phenol value of 2.17mg/l against <0.1mg/l in borehole water sample, indicating pollution. This could be attributed to the use of organic chemicals, phenolic resins, etc in the refining process. Inorganic ions like sulphate can result from breakdown of sulphur-containing organic compound and it is one of the least toxic anions, WHO does not recommend any guideline value for it but suggest that health authorities should be notified when concentration of sulphate exceeds 500mg/l (APHA *et al.,*1992). The values of sulphate in effluent and borehole sample shows values of <0.05 which is much below the WHO limit. (IPCS,1998) Reported that nitrate determination helps the assessment of the character and degree of oxidation in surface water and in biological processes. The value of nitrate in effluent (2.7mg/l) falls within the range of the WHO limit. Chloride values as seen in Table 2 also show variation between the effluent sample and water sample and were within the WHO limit for pollutants. From the table, the value of iron in the effluent, although not above the WHO limit were varied significantly, with that of the effluent in abundance (0.21 and 0.09mg/l) respectively. Symptoms observed in the animals were shivering, bulging of eyes, lacrimation which agrees with the study reported by (McCain *et al.,*1978). Renal function parameter (biomarkers) monitored during the toxicity study of effluent and PAH in rats is the activity level of creatinine and urea. These markers of renal function from the result of table 3 shows decrease in the activity of creatinine and urea following the administration of PAH and effluent water sample from Port Harcourt Refinery. The result shows a progressive increase in the values (level of the biomarkers in the serum) with significant difference ($p < 0.05$). These values indicates damage to the renal function of the experimental animal with the most damage in group 1 (PAH). The histopathological examination of tissue slides to ascertain the integrity of the cells was carried out on the renal. The slides revealed renal damage with characteristics such as proximal tubular degeneration, hemorrhage.

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