International Research Journal of Environment Sciences ISSN 2319–1414
Vol. **4(11),** 12-18, November **(2015)** *Int. Res. J. Environment Sci.*

Effect of Exposure of Male Albino Rats to Kerosene, Diesel and Petrol on Kidney Function

Uhegbu Friday O.[1], Imo Chinedu[1]* and Ifeanacho Nkeiruka Glory[2]
[1]Department of Biochemistry, Abia State University, Uturu, Abia State, NIGERIA
[2]Department of Animal Production and Management, Michael Okpara University of Agriculture, Umudike, Abia State, NIGERIA

Available online at: www.isca.in, www.isca.me
Received 20th August 2015, revised 23rd September 2015, accepted 5th November 2015

Abstract

The effect of exposure of male albino rats to inhalation of Kerosene, Diesel, Petrol and a mixture of kerosene, diesel and petrol on kidney function was examined in this research. Creatinine, serum urea and serum electrolytes (sodium, potassium and chloride) increased in all groups exposed to the petroleum products compared with the control. Creatinine and serum urea increased significantly ($p<0.05$) in all groups exposed to the petroleum products. Creatinine increased highest in the rats exposed to kerosene (from 0.73 ± 0.11 to 1.50 ± 0.19 mg/dl), while serum urea increased highest in the group exposed to petrol (from 27.20 ± 2.05 to 52.80 ± 3.49 mg/dl). Sodium increased significantly ($p<0.05$) only in the group exposed to kerosene (from 124.80 ± 11.88 to 165.20 ± 14.17 mEq/L), but increased non-significantly ($p<0.05$) in all other groups exposed to the petroleum products compared with the control. Potassium increased significantly ($p<0.05$) in all the groups exposed to the petroleum products. Potassium increased highest in the rats exposed to petrol (from 3.70 ± 0.03 to 6.15 ± 0.34 mEq/L). Chloride increased significantly ($p<0.05$) in the rats exposed to kerosene and petrol, but increased non-significantly in the rats exposed to diesel and mixture of kerosene, diesel and petrol. Chloride increased highest in the rats exposed to kerosene (from 36.63 ± 3.68 to 44.13 ± 1.66 mEq/L). Histological analysis of kidney section from rat in group one (control) show essentially normal histoarchitecture of the kidney tissue, but exposure of the animals to inhalation of kerosene, diesel and petrol show necrosis, distorted glomeruli and Bowman's capsule of the kidney tissue when compared with the control. The results of this study show that exposure of the male albino rats to inhalation of kerosene, diesel and petrol can cause alterations in kidney function parameters and distortion in normal histoarchitecture of the kidney tissue. This means that exposure to inhalation of kerosene, diesel and petrol can cause kidney damage.

Keywords: Kerosene, diesel, petrol, inhalation, kidney, histology.

Introduction

Kerosene, diesel and petrol are used for different purposes by human beings at various places such as homes, in petrochemical and manufacturing industries. The uses include fuels for vehicles, lighting and cooking fuels and as chemical for therapeutic reasons. Daily use of kerosene, diesel and petrol may expose the users to inhalation of these products.

Crude petroleum is composed of various metals and hydrocarbons[1]. Crude oil is refined into fractions of petrol, diesel, kerosene, heavy gas and lubricating oils, among others. Petrol, diesel and kerosene are the frequently used fractionated products of crude petroleum. Petrol is reported to contain aromatic and aliphatic hydrocarbons, as well as different other branched unsaturated and saturated hydrocarbons at variable concentrations[2-3].

The chemical pollutants from petrol vapour, like other known xenobiotic, may be metabolically transformed into different metabolites in the body[4]. Some of these metabolites may be very reactive in various ways, thereby interacting in different ways with the excreting and metabolizing tissues (mainly the liver and kidneys) to elicit toxic effects[5]. Cellular injury may be caused by the interaction of these metabolites with the tissues, thereby, causing damage to the tissues. Some composition of petroleum products such as volatile nitrates, benzene and lead have been reported to produce harmful effects on lymph nodes, bone marrow and spleen[6]. Exposure to different fractionated products of crude petroleum has been reported to cause impairment of renal function as a result of derangement of serum electrolytes[7-8]. During the course of usage of these products, individuals are usually exposed to pollutants from petroleum products in their environments.

Creatinine, Urea and body electrolytes concentrations are usually used for assessing renal function. In renal disease, serum creatinine values do not increase significantly until renal function has been considerably impaired. Determination of creatinine clearance ratios, however, may more sensitively indicate renal impairment. Causes of an increase in blood urea nitrogen include: high protein diet, congestive heart failure, fever, decrease in blood volume and in Glomerular Filtration Rate (suggestive of renal failure), gastrointestinal hemorrhage and increased catabolism. The main causes of a decrease in blood urea nitrogen are anabolic state, severe liver disease and

syndrome of inappropriate antidiuretic hormone. Measurement of serum electrolytes (sodium, potassium, chloride) can be used to assess symptoms of heart disease. It can also be used to ascertain the effectiveness of treatments for heart failure, high blood pressure, as well as kidney and liver disease since it is an indicative of how well the heart and kidneys are functioning.

Methodology

Petroleum Products: Petrol, kerosene and diesel were purchased from a Petrol station in Uturu, Abia State, Nigeria.

Experimental Animals: Twenty five healthy male albino rats aged 7 weeks (between 130g-160g body weight) were used in this study. The rats were bought and kept in the animal house, Department of Biochemistry, Faculty of Biological and Physical Science, Abia State University, Uturu. The animals were allowed to acclimatize for 7 days under standard laboratory conditions with free access to commercial rat feed and water.

Experimental Design: The twenty five healthy animals were randomly placed into five (5) groups with five (5) rats in each group. Group 1 served as the control group (it was not exposed to any Petroleum product). Group 2 was exposed to inhalation of Kerosene. Group 3 was exposed to inhalation of Diesel. Group 4 was exposed to inhalation of Petrol. Group 5 was exposed to inhalation of a mixture (equal volumes) of Kerosene, Diesel and Petrol. The five different groups were kept far from the location of one another.

Groups 2, 3, 4 and 5 were exposed to the products (as stated above) five hours daily for twenty one (21) consecutive days. During the five hour daily exposure, the products were placed in plates (without cover) and stationed very close to the cages of the animals constantly and also occasionally sprayed around the environment where the animals were stationed. All animals were allowed free access to feed and water *ad libitum*. Standard laboratory protocols for animal studies were maintained.

The essence of exposing the animals to the petroleum products for five hours daily is to accommodate the fact that most workers in standard or well-established petrol stations work for about four (4) to five (5) hours daily, though some also work up to eight hours daily. The reason for the occasional spray around the environment where the rats were stationed is to accommodate the fact that occasionally at the petrol stations, some of the products may unknowingly be sprayed within the station as a result of force out of a container under pressure or over-filling of the tanks, cans, etc.

Blood Collection: Twenty four hours after exposing the animals to inhalation of kerosene, diesel and petrol, the animals were starved overnight, anaesthetized with chloroform and sacrificed. Blood was collected by cardiac puncture and blood samples from each animal collected into dry test tubes. The blood sample was allowed to stand for about 15 minutes to clot and further spun in a centrifuge. Serum was separated from the clot with Pasteur pipette into sterile sample tubes for the measurement of selected kidney function parameters.

Biochemical Analysis: Serum Creatinine was assayed by the method of Bowers and Wong[9]. Serum Urea was assayed by the method of Tietz[10], while Sodium, Potassium and Chloride were determined using the method described by Tietz[11].

Histological Analysis: After sacrificing the animals, histological analysis was carried out on the kidney of representatives of each of the five groups.

Statistical Analysis: The results were statistically analyzed using Analysis of Variance (ANOVA) and standard student-T-distribution-test: using Statistical package for Social Sciences (SPSS) version 20. Group means were compared for significance at $p \leq 0.05$. Data were represented as mean ± standard deviation.

Results and Discussion

The results are as presented in the table and figures below:

Table-1
Kidney Function Parameter Concentrations

Parameters	Group 1	Group 2	Group 3	Group 4	Group 5
CREATININE (mg/dl)	0.73 ± 0.11^{a}	1.50 ± 0.19^{b}	0.98 ± 0.09^{c}	1.04 ± 0.17^{d}	1.06 ± 0.22^{e}
SERUM UREA (mg/dl)	27.20 ± 2.05^{a}	42.40 ± 1.52^{b}	51.20 ± 2.49^{c}	52.80 ± 3.49^{d}	52.60 ± 4.83^{e}
SODIUM (mEq/L)	124.80 ± 11.88^{a}	165.20 ± 14.17^{b}	134.20 ± 7.26^{a}	138.80 ± 12.64^{a}	132.00 ± 8.12^{a}
POTASSIUM (mEq/L)	3.70 ± 0.03^{a}	4.08 ± 0.26^{b}	3.91 ± 0.14^{c}	6.15 ± 0.34^{d}	4.18 ± 0.26^{e}
CHLORIDE (mEq/L)	36.63 ± 3.68^{a}	44.13 ± 1.66^{b}	40.53 ± 0.47^{a}	42.32 ± 4.57^{c}	40.73 ± 6.27^{a}

Results represent mean ± standard deviation of group serum results obtained (n=5). Mean in the same row, having different letters of the alphabet are statistically significant ($p \leq 0.05$) compared with the control (group one).

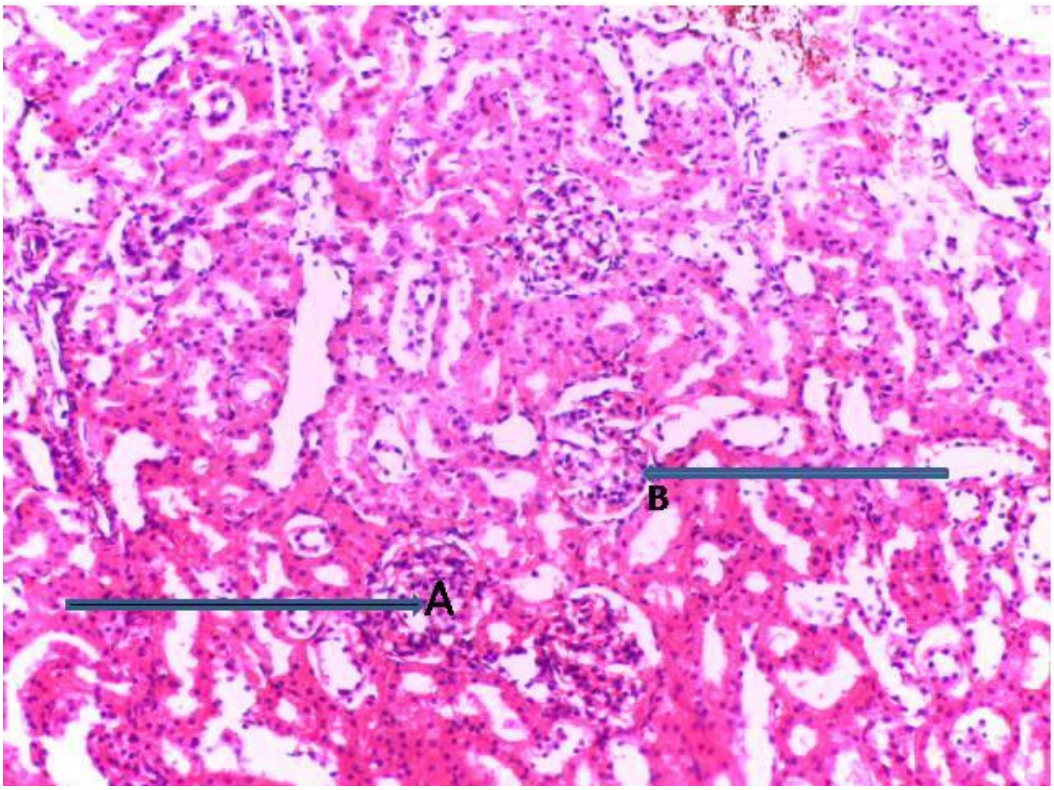

Figure-1
Kidney section photomicrograph from rat in control group (group 1)

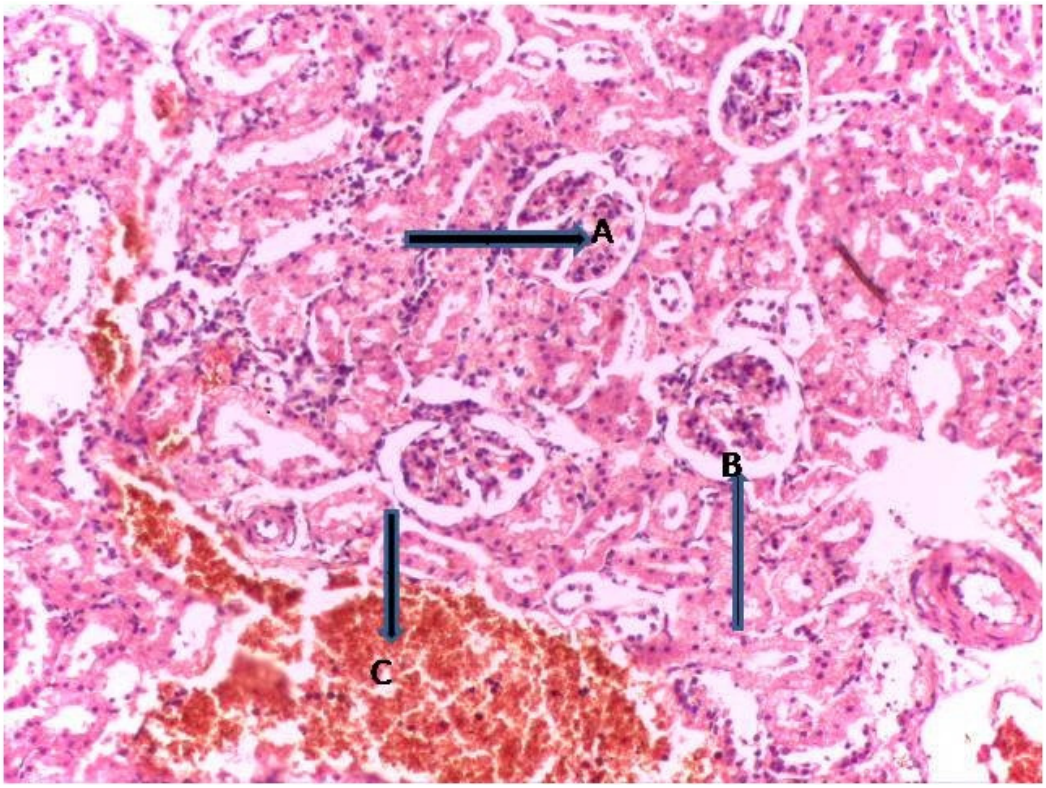

Figure-2
Kidney section photomicrograph from rat exposed to Kerosene (group 2)

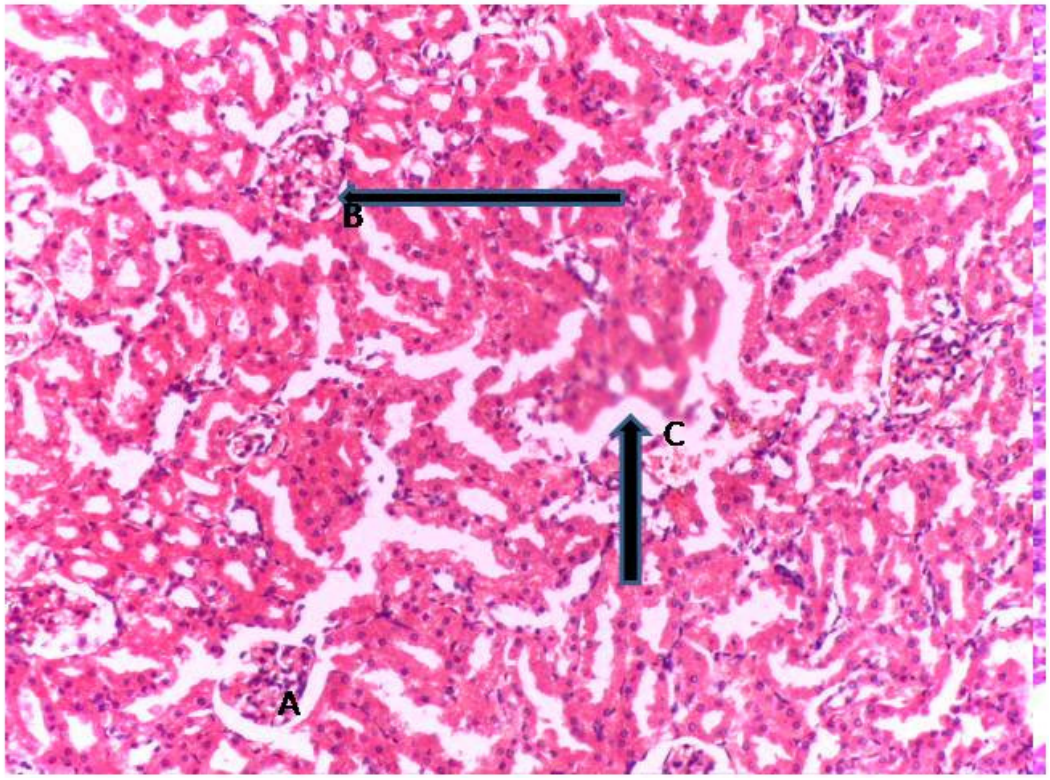

Figure-3
Kidney section photomicrograph from rat exposed to Diesel (group 3)

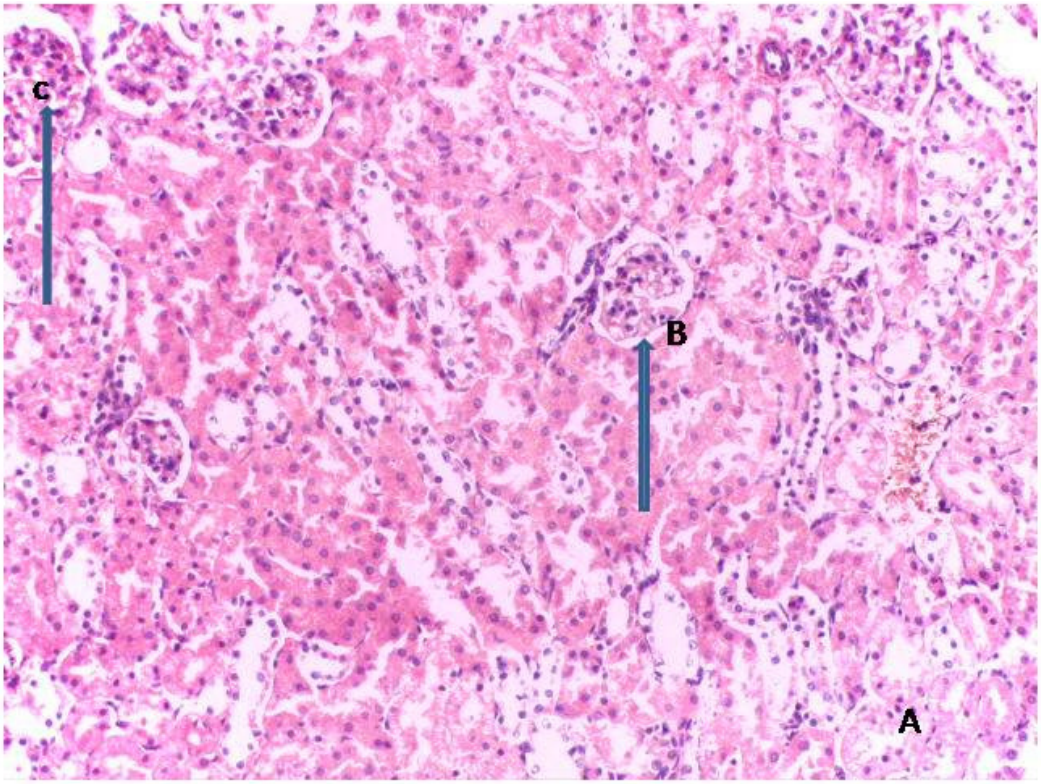

Figure-4
Kidney section photomicrograph from rat exposed to Petrol (group 4)

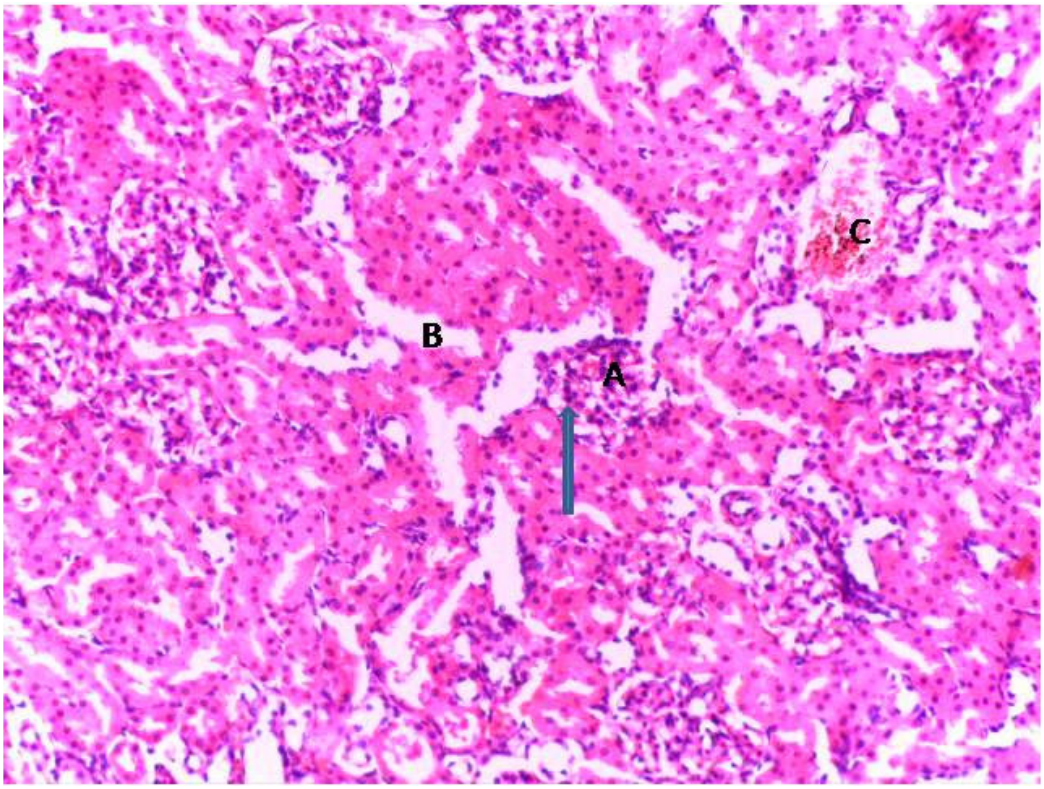

Figure-5
Kidney section photomicrograph from rat exposed to mixture of Kerosene, Diesel and Petrol (group 5)

Discussion: The kidney functions in maintaining homeostasis in the body by the reabsorption of important materials and excretion of waste products. Creatinine, serum urea, sodium, potassium and chloride were used in this study as parameters for kidney function.

Creatinine retention in the blood is a significance of kidney impairment[12]. In this study, exposure of the albino rats to the different petroleum products show significant ($p<0.05$) increase in serum creatinine level in all groups compared with the control. This shows that creatinine was actually retained as a result of the petroleum products inhaled by the animals, thereby signifying indication of kidney impairment. Impairment of the kidney function may be caused by exposure to nephrotoxic substances such as petroleum products.

Diseases of the kidney which diminish the glomerular filtration lead to the retention of urea. Urea was retained in all the animals exposed to the petroleum products as indicated by the significant ($p<0.05$) increase in serum urea concentration in the groups exposed to kerosene, diesel and petrol. This increase may be as a result of decrease in Glomerular Filtration Rate (GFR) which is suggestive of kidney failure. Exposure of the animals to inhalation of the petroleum products causes nephrotoxicity as indicated by significant ($P<0.05$) elevation in serum level of urea and creatinine (table-1). This elevation in urea and creatinine levels may be attributed to the damage of nephron structural integrity[13]. Increase in blood urea is due to the inability of damaged kidney to filter urea up to normal levels[14]. Heavy metals are highly concentrated in polluted environment[15] and in some toxic chemical substances (such as petroleum products) which could cause damage to the kidney.

The balance of these electrolytes (sodium, potassium and chloride) in the blood is an indicative of how well the heart and kidneys are functioning. Abnormal concentration of some electrolytes in the plasma or serum is an indication of kidney function impairment[16]. Sodium, potassium and chloride concentrations were altered in all the groups exposed to the petroleum products.

Sodium is associated with blood pressure. A reduction in the concentration of sodium intake lowers the blood pressure. Sodium increased significantly ($p<0.05$) in the animals exposed to kerosene, but increased non-significantly in other groups compared to the control. Potassium, which is an electrolyte in the intra-cellular fluid, is reported to be one of the protective electrolytes against hypertension[17]. Potassium increased significantly ($p<0.05$) in all groups exposed to the petroleum products. Very high concentrations of Potassium may be as a result of kidney disease or substances that can decrease potassium excretion from the body. Hyperkalemia (elevated potassium levels) are usually associated with kidney failure, adrenal insufficiency or dehydration shock. The increase in the

serum K^+ concentrations in the animals exposed to the petroleum products when compared with the control is an indication that membrane channels may be possibly affected by exposure to the chemical substances. Chloride is an important electrolyte in the maintenance of the anion/cation balance between the extra-cellular and intra-cellular fluids. Chloride is essential to the control of osmotic pressure, proper hydration and acid/base equilibrium. Elevated serum chloride concentrations may be seen in conditions of urinary obstruction, dehydration and congestive heart valve[11]. Chloride increased significantly ($p<0.05$) in the rats exposed to kerosene and petrol, but increased non-significantly in the rats exposed to diesel and the mixture of kerosene, diesel and petrol. Significant alteration in the concentrations of these serum electrolytes is indicative of poor renal functions or renal impairment.

The result of the kidney function parameters show that creatinine, sodium and chloride concentrations were altered more by exposure to kerosene, while serum urea and potassium were altered more by exposure to petrol.

Photomicrographs of section of Liver from rat in group one (normal control) show essentially normal histoarchitecture of the kidney tissue. Histological section of rat exposed to kerosene show kidney tissue with extensive areas of necrosis (C), the glomeruli appear slightly shrunken with the bowman's capsular space increased (B). Also observed are few cystically dilated spaces within the stroma. Histological section of rat exposed to diesel show kidney tissue with glomeruli closely adherent to the Bowman's capsule (B) and within the stroma are seen vascularization and some slightly enlarged tubules (C). Some of the glomeruli appear shrunken. Histological section of rat exposed to petrol show kidney tissue with normal glomeruli and Bowman's capsule (A, B). The stroma appears edematous and hyalinized, while the sections of the rat exposed to mixture of kerosene, diesel and petrol show a dense stroma with few cystically dilated spaces and compressed tubules (B). The glomeruli appear closely adherent to the bowman's capsular space and there is marked cellularity within the tuft (A). Also observed is a necrotic area (C).

Conclusion

The findings of this study demonstrate that exposure of male albino rats to the inhalation of kerosene; diesel and petrol could be dangerous to the kidney function of the rats and may possibly affect the kidney function of man. From the findings of this study, we therefore proclaim that adequate precautionary measures should be employed by those who use these petroleum products to avoid its inhalation. This will therefore aid in avoiding alterations to kidney function as a result of exposure to the petroleum products.

References

1. Edwards C.W., Toxicology of oil field waste hazards to livestock associated with the petroleum industry, *Vet Clin North Am.*, **5**, 363-374 **(1989)**

2. Kato M., Rocha M. L., Carvallio A. B., Chaves M. B., Rana M. C. and Oliviera P. C., Occupation exposure to neurotoxicant; preliminary survey in five industries of camacari petrochemical complex, *Brazil Environ. Res.*, **61**, 133-139 **(1993)**

3. Anderson D., Yu T. W. and Schmeizer P., An investigation of the DNAdamaging ability of benzene and its metabolites in human lymphocytes using the comet Assay, *Environ. Mol. Mutation*, **26**, 305-314 **(1995)**

4. Hu Z. and Wells P G., Modulation of benzo (a) pyrene bioactivation by glucuronidation in lymphocytes and hepatic microsomes from rats with a hereditary deficiency in bilirubin UDP-glucuronosyl-transferase, *Toxicol. Appl. Pharmacol.*, **127**, 306-313 **(1994)**

5. Nygren J., Cedewal B., Erickson S., Dusinska M. and Kolman A., Induction of DNA strand breaks by ethylene oxide in human diploid fibroblasts, *Environ. Mol. Mutagen.*, **24**, 161-167 **(1994)**

6. Ovuru S.S. and Ekweozor I.K.E., Haematological changes associated with crude oil ingestion in experimental rabbits, *Afr. J. Biotechnol.*, **3**, 346-348 **(2004)**

7. Orisakwe E., Njan A.A., Afonne O.J, Akumka D.D., Orish V.N. and Udemezue O. O., Investigation into the nephrotoxicity of Nigerian bonny light crude oil in albino rats, *Int. J. Environ. Res. Public Health*, **1**, 106-110 **(2004)**

8. Uboh F.E., Akpanabiatu M.I., Ndem J.I., Alozie Y. and Ebong P.E., Comparative nephrotoxic effect associated with exposure to diesel and gasoline vapours in rats, *J. Toxicol Environ Health Sci.,* **1**, 68-74 **(2009)**

9. Bowers L.D. and Wong E.T., Kinetic serum creatinine assays II: A critical evaluation and review, *Clin.Chem.,* **26(5)**, 555-561 **(1980)**

10. Tietz N.W., Fundamentals of Clinical Chemistry, 3rd Edition, W. B. Saunders, Philadelphia, PA, 676 **(1987)**

11. Tietz N.W., Fundamentals of Clinical Chemistry, W. B. Saunders, Philadelphia, PA, 874-897 **(1976)**

12. Okpala J.C., Sani I., Abdullahi R., Ifedilichukwu H.N. and Igwe J.C., Effects of n-butanol fraction of *Gongronema latifolium* leave extract on some biochemical parameters in CCl4- induced oxidative damage in Wistar albino rats, *Afr. J. Biochem. Res.*, **8(2),** 52-64 **(2014)**

13. Chinedu Imo and Friday O. Uhegbu, Renal Protective Effect of Ethanolic Leaf Extract of Gongronema latifolium Benth in Acetaminopheninduced Renal Toxicity in Male Albino Rats, *American Chem. Sci. J.*,

8(3), 1-10 **(2015)**

14. Shaikh I.A. and Gautam R.K., Effect of Organophosphate Pesticide, Nuvan on Serum Biochemical Parameters of Fresh Water Catfish *Heteropneustes fossilis* (Bloch.), *Int. Res. J. Environ. Sci.*, **3(10)**, 1-6, **(2014)**

15. Zaware S.G., Environmental Impact Assessment on Soil Pollution Issue about Human Health, *Int. Res. J. Environ. Sci.*, **3(11),** 78-81 **(2014)**

16. Crook M.A., The kidneys. In: Clinical chemistry and metabolic medicine, 7th Edition, Bookpower, Britain, 36-57 **(2007)**

17. Nurminen M.L., Krpela R. and Vapattalo H., Dietary factors in the pathogenesis and treatment of hypertension, *Ann. Med.,* **30(2)**, 1433-1450 **(1998)**