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An Evaluation of the Effects of Inhalation of Gasoline Vapour on the Lungs, Liver and Kidney of Wistar Albino Rats

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Abstract: *Exposure to gasoline vapour in a similar way as found at work place environment in wistar albino rats was shown to have untoward effects. The animals were exposed to gasoline vapour in an exposure chamber. The serum calcium and phosphate significantly increase ($p<0.05$) but potassium was significantly ($p>0.05$) decreased with sodium, chloride and bicarbonate showing slight decrease. The liver enzymes, alkaline phosphatase, ALT and AST all showed significant decrease ($p>0.05$) and so was the total proteins, albumin, total bilirubin and conjugated bilirubin significantly decreased ($p>0.05$), likewise total cholesterol and serum glucose ($p>0.05$). Lung histology showed oedema and exudates in the alveoli with infiltration of lymphoid cells around the terminal bronchioles. The kidney histology showed interstitial mononuclear cell infiltration, tubular ballooning and multi-focal hydrophobic changes within the tubular lumen and the liver showed focal mononuclear cell infiltration.*

Keywords: *gasoline, liver, kidneys, lungs, rats*

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I. Introduction

Air pollution due to volatile hydrocarbons found in gasoline and motor vehicle exhaust fumes, and many other compounds and chemicals are readily found in the environment especially hydrocarbons in gasoline when dispensing or due to accidental spillage (Boudoung, et al., 2001 and McCreanor, 2007, Kapil, et al., 2016). There are several occupations associated with respiratory diseases, e.g., those who work in saw mills, textile industries, flour mills, and gasoline filling stations (Farah et al., 2006, Mayank et al., 2007, Dhudmal et al, 2006). Studies have been carried out in different parts of the world to ascertain the association of respiratory diseases with different environmental conditions, use of biomass fuels in homes, exposures at the work place, (Ugheoke et al, 2006, Torre-Doque et al, 2008). Other means of exposure to gasoline vapour is by elimination of the volatile hydrocarbons following ingestion or dermal absorption, and aspiration of liquid gasoline or inhalation of contaminated vomitus. In adults accidental ingestion is often as a result of siphoning by mouth from gasoline tanks (Torre-Doque et al, 2008).

Inhaled gasoline vapour pass through the lungs and some of these aromatic hydrocarbons found in gasoline dissolve into the blood and the blood is filtered by the kidney to remove waste products. The liver as a major center of metabolic activity also process the blood in order to metabolize, detoxify and remove waste. With these in mind the study was conducted to investigate the effects of gasoline vapour inhalation in wistar albino rats on the lungs, kidneys and liver under a controlled laboratory simulated work place exposure.

II. Materials And Methods

A total of twelve adult wistar albino rats weighing 120-160gm divided into two exposure groups of six were used in this study. The animals were obtained from the Department of Pharmacology and Clinical Therapeutics, University of Maiduguri and kept in the laboratory to acclimatize with free access to rat chow and water. The handling and use of animals was cleared by the Departmental Animal Ethics Committee. The animals were exposed to gasoline vapour daily for eight hours, five days a week (to simulate the normal working hours) for six months. Exposure to gasoline vapour was in a chamber made of plywood with a tiled roof, measuring 240cm x 120cm x 90cm with a sliding glass door in the front measuring 85cm x 60cm, this is a modification of the methods of Uboh et al, 2005 and 2008; and Al-Saggaf et al, 2009. The glass door was

adequate to allow easy access and introduction of both animals and gasoline and also allows for visualization during the eight hour exposure periods. Gasoline was purchased from one of the authorized service stations (Oando filling station) and introduced into the chamber in a four liter container measuring 30cm x 25cm x 18cm with an opening measuring 13cm x 9cm on its two broad sides and 500ml of gasoline was put in the container. Fresh gasoline was introduced on each day of exposure. Animals were introduced into the chamber in four cages, the first two cages placed 6cm from the source of gasoline vapour while the other two cages were placed 150cm away from the gasoline vapour source. The walls of the exposure chamber were not "air tight" to allow for a minimal air circulation required. The concentration of gasoline vapour in parts per million (ppm) in the chamber was thus calculated:

III. Indentations And Equations

$$\text{Gasoline conc. (ppm)} = \frac{\text{Volume occupied by gasoline}}{\text{Volume of inhalation chamber}} \times 10^6$$

(Kinawy, 2009)

After the six months eight hour five days a week exposure period the animals were humanely sacrificed and blood collected for electrolytes, urea, creatinine, liver function studies. The lungs, kidneys and liver harvested for histological studies.

IV. Results

The results were expressed as Mean ± SEM. Serum calcium and phosphate showed a significant increase ($p<0.05$) compared to the control whereas there was a significant decrease ($p>0.05$) in serum sodium, potassium, chloride and bicarbonate. Urea and creatinine was slightly elevated. On the other hand serum glucose was significantly increased ($p>0.05$), Table 1.

Table 1. Effect of Gasoline Vapour Inhalation on Serum Electrolytes, Urea, Creatinine and Glucose

	Groups	Groups (n = 10)	
Parameter	Control	Exposure I	Exposure II
Calcium mmol/L	2.51 ± 0.05	2.56 ± 0.04*	2.42a ± 0.03
Phosphate mmol/L	1.30 ± 0.06	1.32 ± 0.08*	1.35b ± 0.06*
Sodium mmol/L	141.10 ± 2.25	135.30 ± 1.25	145.60 ± 3.40
Potassium mmol/L	7.92 ± 0.29	7.33 ± 0.22**	6.54 ± 0.15
Chloride mmol/L	101.50 ± 2.46	100.90 ± 1.99	98.10 ± 1.93
Bicarbonate mmol/L	23.40 ± 0.45	22.90 ± 0.43	22.80 ± 1.06
Urea mmol/L	5.81 ± 0.57	5.78 ± 0.31	5.82 ± 0.35
Creatinine µm/L	110.60 ± 9.42	111.70 ± 7.18	111.70 ± 6.18
Glucose mmol/L	5.73 ± 0.14	6.19 ± 0.29*	6.40 ± 0.32*

Mean ± SEM,*---significant increase compared to control, $p<0.05$;**---significant decrease compared to control, $p>0.05$*

All the liver enzymes were significantly increased ($p<0.05$) and the liver proteins significantly decreased ($p>0.05$) as shown in Table 2 below.

Table 2. Effect of Gasoline Vapour Inhalation on Liver Function in the Albino Rats

		Groups (n = 10)	
Parameter	Control	Exposure I	Exposure II
Alkaline phosphatase iu/L	171.50 ± 8.03	234.80 ± 11.34*	239.20 ± 6.04*
AST iu/L	111.10 ± 3.98	115.80 ± 2.45*	94.10 ± 1.59*
ALT iu/L	38.50 ± 3.40	48.30 ± 1.56*	44.60 ± 2.12*
Total protein g/L	79.10 ± 1.40	72.60 ± 1.93**	74.50 ± 1.56**
Albumin g/L	43.00 ± 0.88	39.50 ± 1.08**	41.70 ± 0.98
Total bilirubin µm/L	7.10 ± 0.35	5.60 ± 0.37**	4.90 ± 0.28
Conjugated bilirubin µm/L	4.40 ± 0.34	3.10 ± 0.23**	3.10 ± 0.23
Total cholesterol mmol/L	3.68 ± 0.28	3.84 ± 0.23**	4.34 ± 0.10

Mean ± SEM,*---significant increase compared to control, $p<0.05$;** ---significant decrease compared to control, $p>0.05$
AST-Aspartate Aminotransferase, ALT-Alanine Aminotransferase.

Histological studies also showed changes in the tissues of the control as compared to the exposure groups. Figures 1 and 2(a, b) showed the changes in the normal (control) versus the exposure group in the lungs, and figures 3(a, b) and 4, that of the liver in the normal (control) as compared to the exposure group whereas the last two figures 5 (a, b) and 6 (a, b) showed the changes in the kidneys of the control as compared to the exposure group respectively.

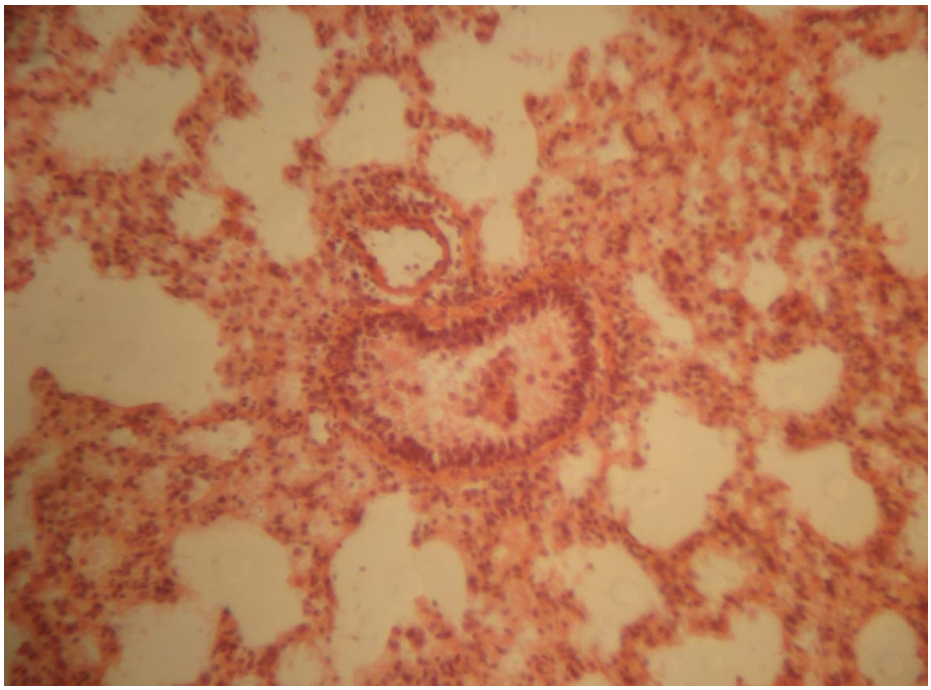

Figure.1: Photomicrograph of rat lungs (control) showing normal alveoli, terminal bronchiole (TC) and blood vessel (BV) H&E ×100.

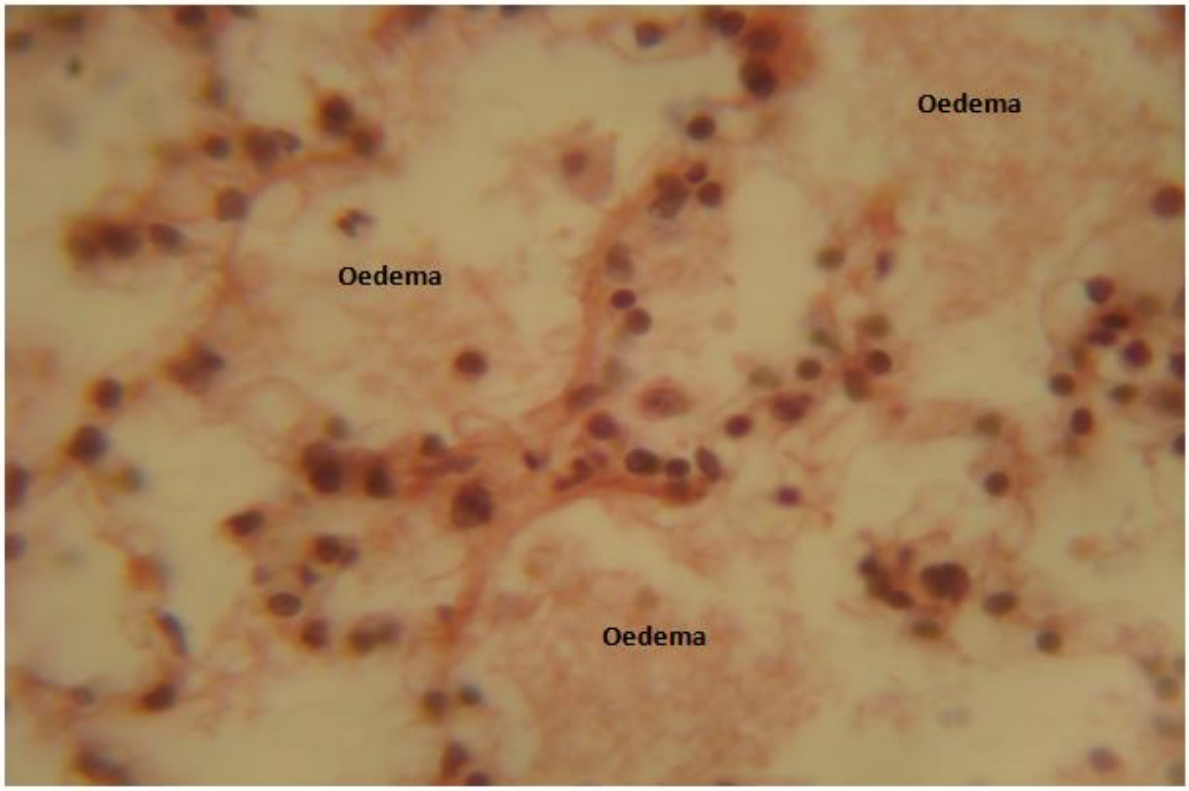

Figure 2a: Photomicrograph of rat lungs exposed to gasoline vapour by inhalation showing oedema in the alveoli (AL) H&E ×400

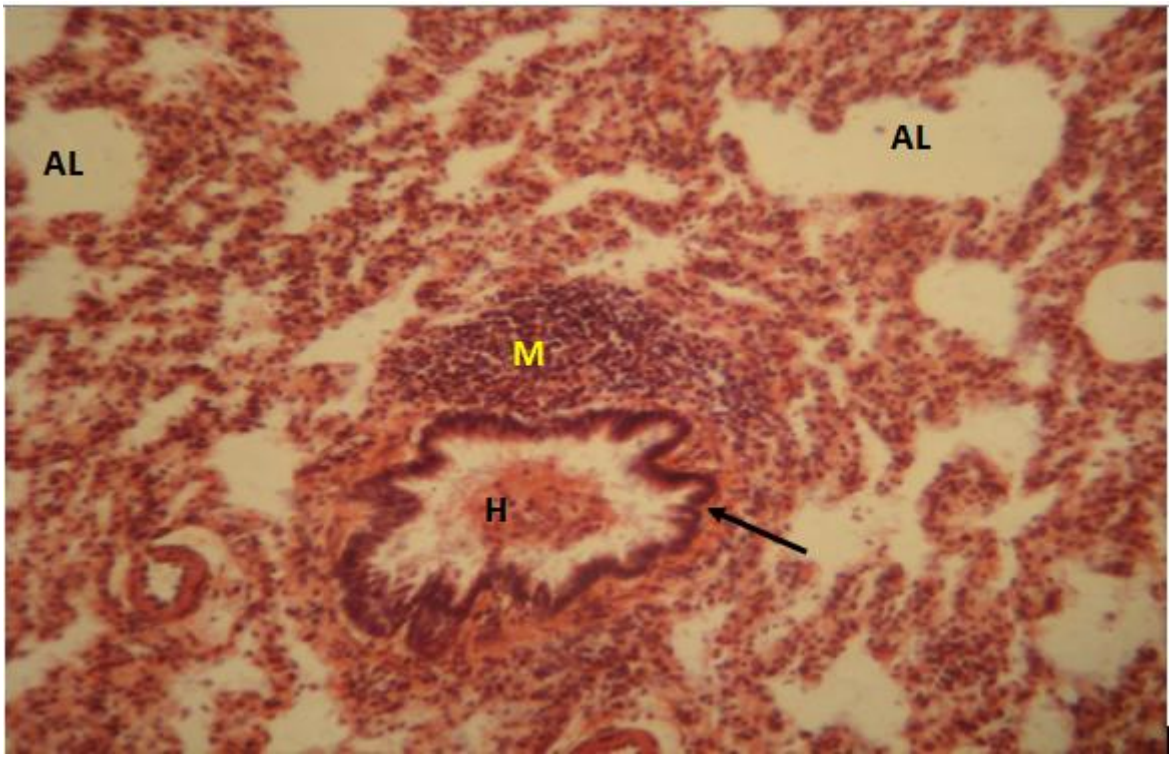

Figure2b. Photomicrograph of rat lungs exposed to gasoline vapour by inhalation showing lymphoid cells (M) around the terminal bronchiole (arrow) with exudates in the lumen (H) and alveoli (AL) H&E x200

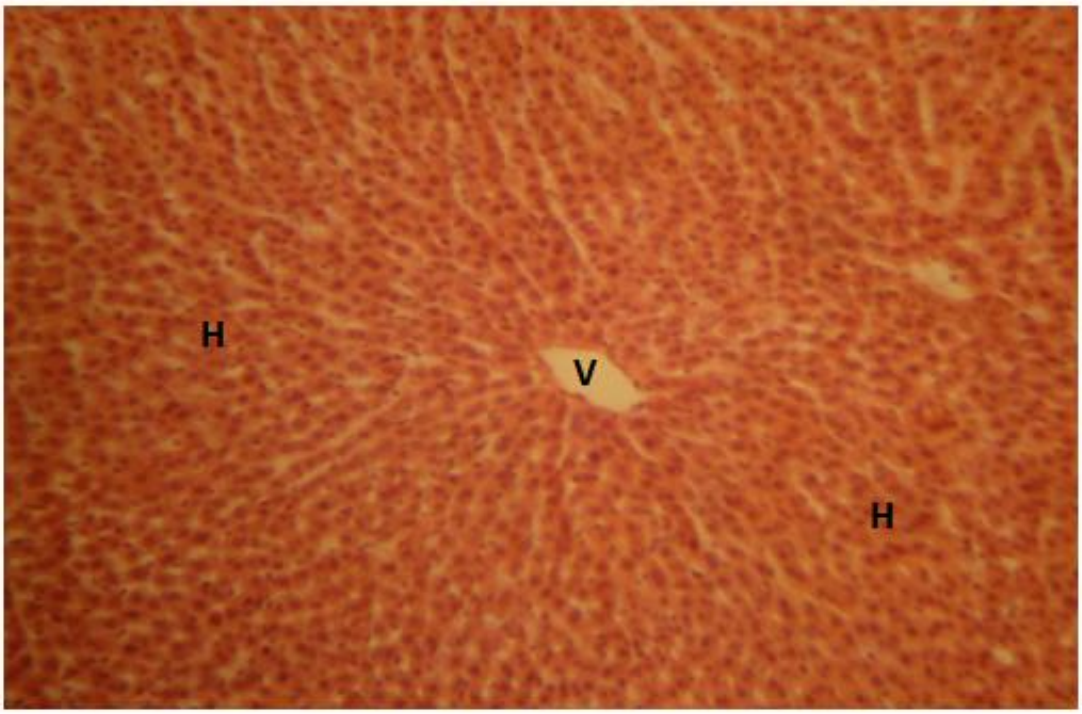

Figure3a. Photomicrograph of rat liver (control) showing normal central vein (V) and hepatocytes (H) H&E x100

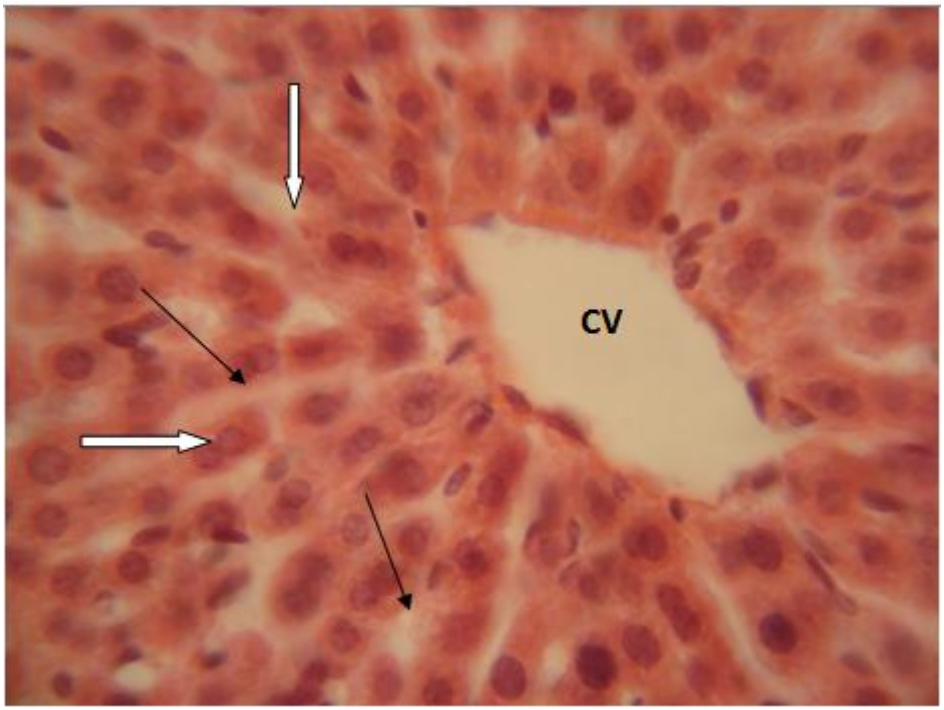

Figure3b: Photomicrograph of rat liver (control) showing normal hepatocytes (black arrows) radiating away from the central vein (CV) and clear sinusoids (white arrows) H&E ×400.

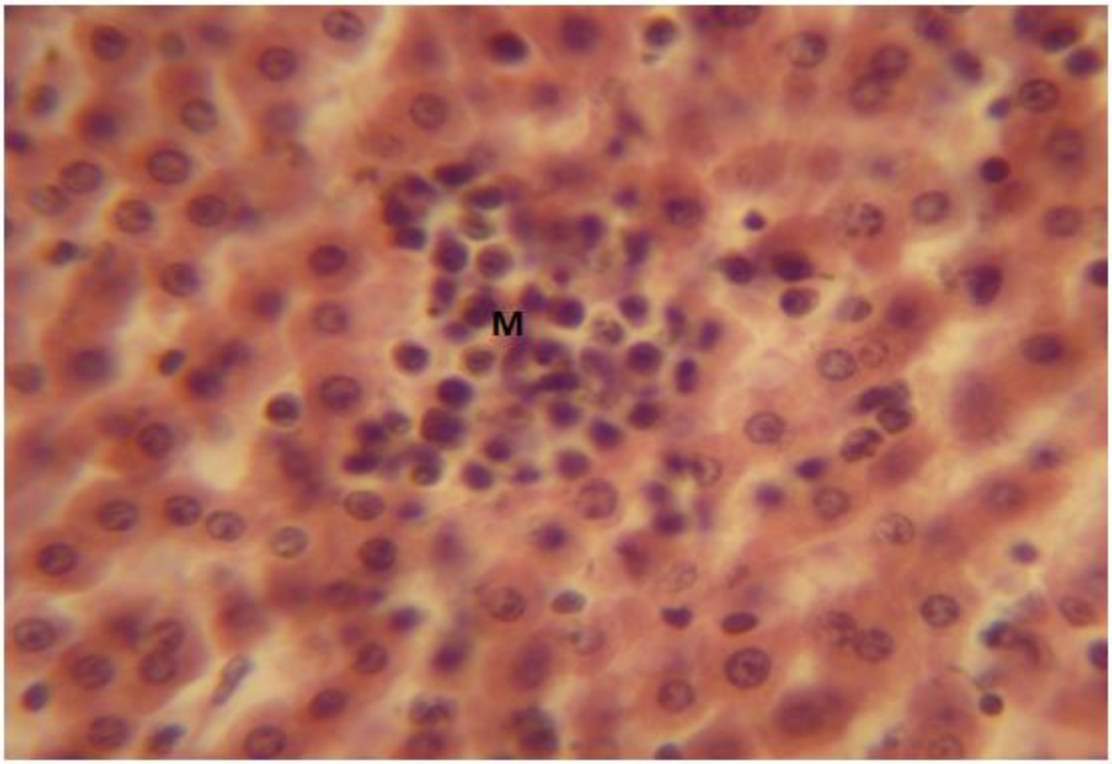

Figure 4: Photomicrograph of rat liver exposed to gasoline vapour by inhalation showing focal mononuclear cell infiltration (MN) H&E ×400

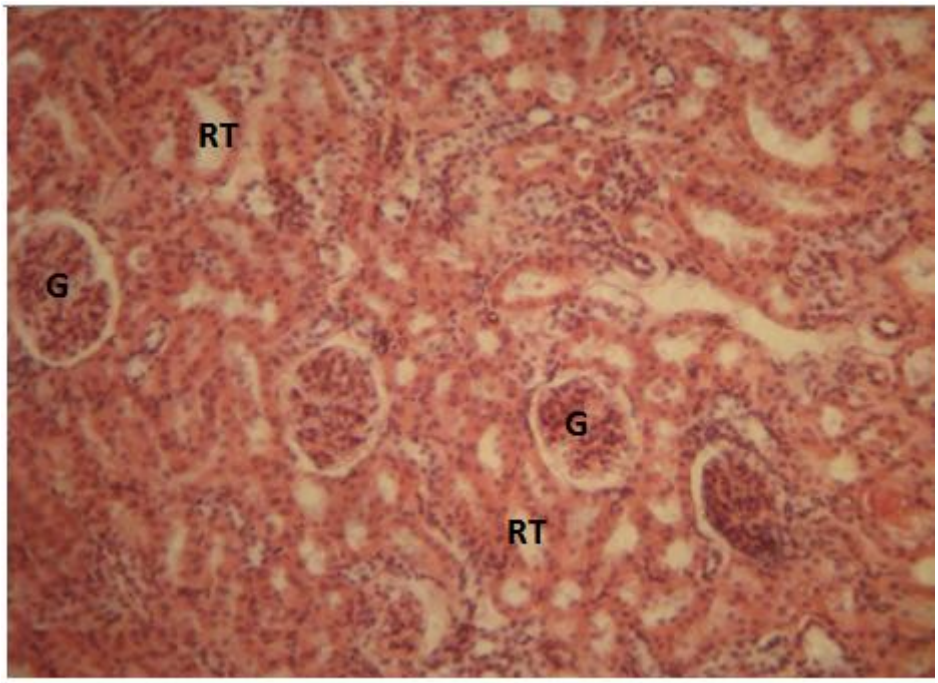

Figure 5a: Photomicrograph of rat kidney (control) showing normal glomeruli (G), renal tubules (RT) H&E ×200.

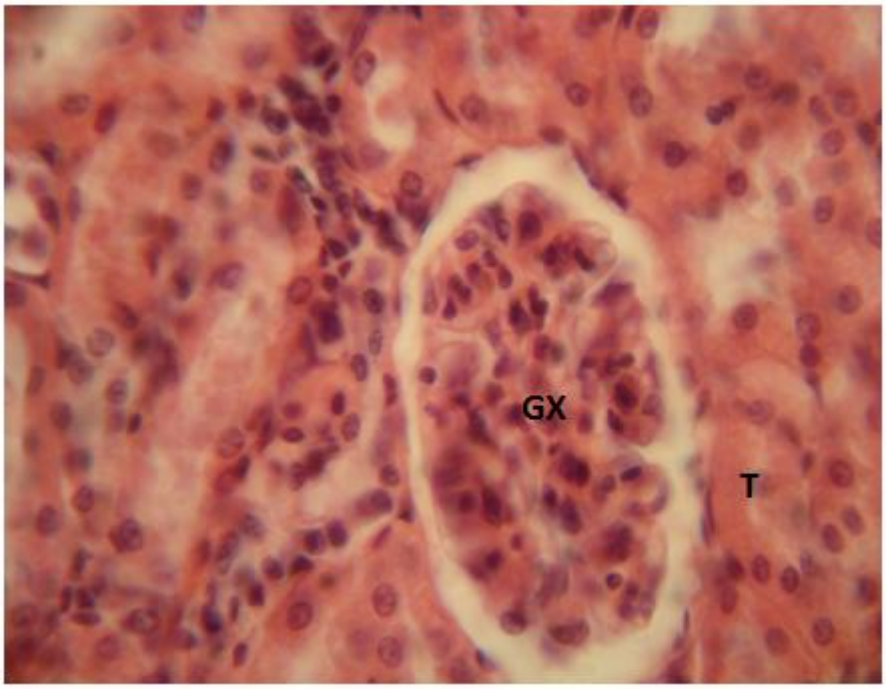

Figure 5b: Photomicrograph of rat kidney (control) showing normal glomerulus (GX) and tubules (T) in renal cortex H&E ×400

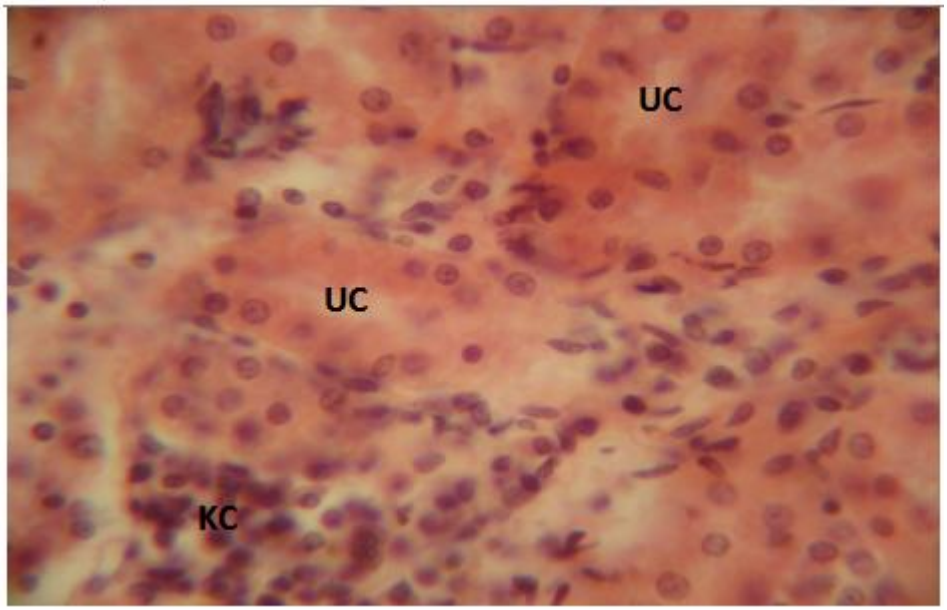

Figure 6a: Photomicrograph of rat kidney exposed to gasoline vapour by inhalation showing interstitial mononuclear cell infiltration (UC) and tubular ballooning (KC) H&E 400

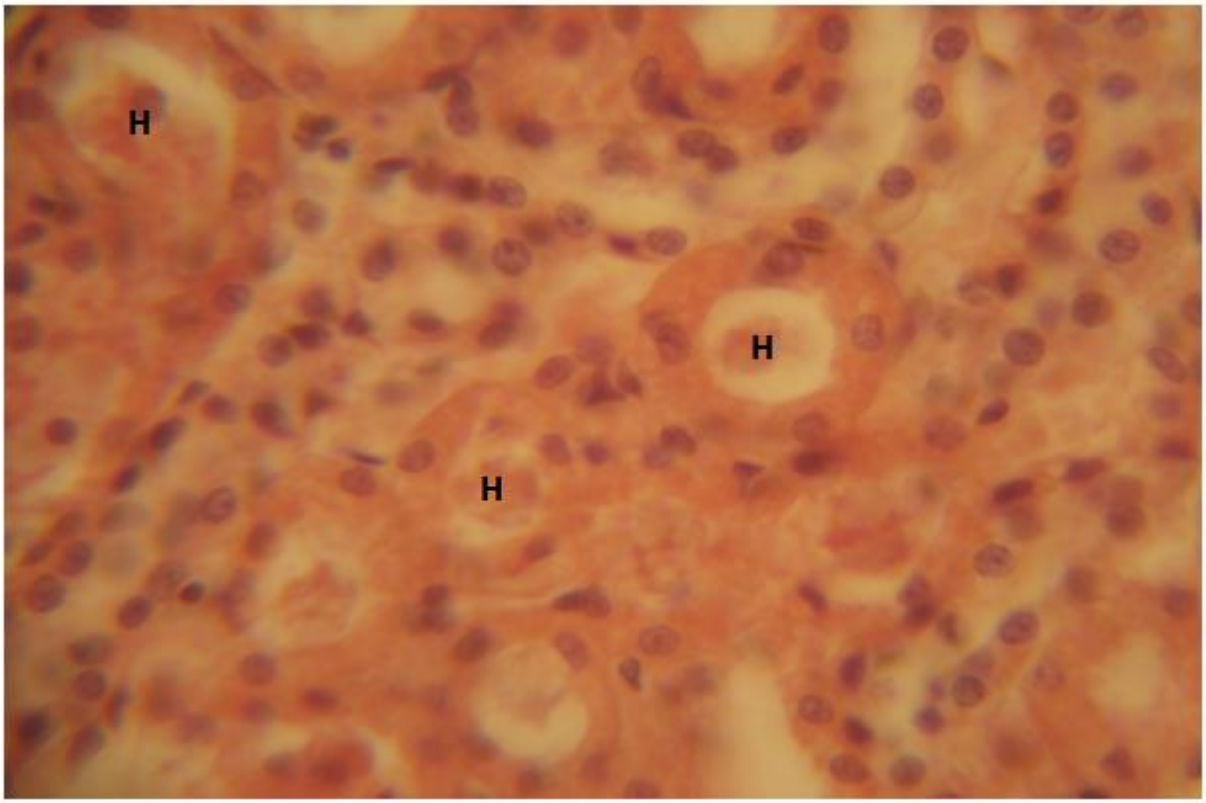

Figure 6b. Photomicrograph of rat kidney exposed to gasoline vapour by inhalation showing multi-focal hydrophobic changes within the tubular lumen (H) H&E x400

V. Discussion

There is a significant increase ($p<0.05$) in serum calcium and phosphate and significant decrease in ($p>0.05$) in serum potassium with serum sodium, chloride and bicarbonate showing slight decrease (Table 1) which indicates that gasoline vapour interferes with fluid and electrolyte regulation. This is further buttressed by the kidney histology that showed interstitial mononuclear cell infiltration, tubular ballooning (Figure 6a) and multi-focal hydrophobic changes within the tubular lumen (Figure 6b).

The liver enzymes, alkaline phosphatase, ALT and AST all showed significant decrease ($p>0.05$) as shown in Table 2. Also the liver proteins, total proteins, albumin, total bilirubin and conjugated bilirubin were significantly ($p>0.05$) decreased, likewise total cholesterol (Table 2). All these findings with the liver histology were indicative that gasoline vapour inhalation had deleterious effect on the normal function of the liver and affects the liver structure as shown in figures 3 and 4. The liver effects also causes imbalance in carbohydrate metabolism as evidenced by significant increase ($p<0.05$) in serum glucose concentration (Table 2). The gasoline vapour reached these organs via the lungs as some of the hydrocarbons found in gasoline dissolved into the blood are transported in like manner to the organs. The lung tissue also showed some histological changes as evidenced by oedema, exudates in the alveoli and infiltration of lymphoid cells around the terminal bronchioles (Figure 2a, b).

VI. Conclusion

The results of this study showed that the exposure to gasoline vapour has potential detrimental effects on the lungs, kidneys and the liver with consequent imbalance of fluid and electrolytes and carbohydrate metabolism.

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