Effect of Formaldehyde Inhalation and Alcohol Consumption on some Kidney Markers of Albino Rats

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ABSTRACT
Exposure to organic solvents has been known to be harmful to humans. However, the toxicity resulting from the additive effect of several organic solvents can exceed the toxicity of a single solvent. The effect of oral administration of 20% alcohol (10 ml/kg BW) and formaldehyde inhalation on kidney markers of albino rats were investigated. Twenty one apparently healthy albino rats were randomly subdivided into three groups. Group A was fed with normal rat chow while group B and C were exposed to formaldehyde inhalation chamber under dynamic airflow condition, 8hrs per day for four weeks. Group C were further given oral administration of 20mg/kg BW of alcohol. They were sacrificed after 4 weeks and blood samples collected for analyses. Results of the analysis showed a statistically significant difference in some electrolytes (Na, K and Cl) when compared with the control (P<0.05). Also, there are statistically significant changes in HCO3−, urea and creatinine levels of the experimental group when compared with the control at P<0.05. When the two experimental groups (B and C) were compared, there is statistically significant difference in the biochemical parameters analyzed. These findings indicated that alcohol consumption in addition to formaldehyde inhalation could have some deleterious effect on the renal biochemical parameters of albino rats.

INTRODUCTION
A large percentage of the human populace is directly or indirectly exposed to pollutants in the course of their day-to-day activities. It is generally reported that those who are occupationally exposed constitute the population at greatest risk of frequent exposure (Carballo et al., 1994; Rabble and Wong, 1996). Formaldehyde is one of the most volatile organic solvents use as a disinfectant in many human medicines and cosmetics, as antiseptics and embalming fluids. Millions of workers are exposed to organic solvents that are used in such products as paints, varnishes, lacquers, adhesives, glues, degreasing/cleaning agents, and in the production of dyes, polymers, plastic, textiles, printing inks, agricultural products, and pharmaceuticals (Nuyts et al., 1995; Radican et al., 2006). In epidemiological and experimental animal studies, formaldehyde induce a variety of toxic effects, especially on the liver and kidney tissues after inhalation. These effects included dose related focal hepatic enlargement, decreased weight and hepatocellular fatty degeneration. Prolonged exposure of formaldehyde may cause degeneration in the proximal tubules and necrosis in the kidney (Mensing et al., 2002). Morticians are consistently exposed to formaldehyde during embalmment and most of these workers may indulge in alcohol consumption due to the nature of their jobs.

Chronic alcohol consumption has been reported to have detrimental effect on behavior and cognitive processes such as learning and memory (Beracochea et al., 1987). Chronic alcohol consumption has also been reported to produce cell loss in specific cerebral structures and reduced regional metabolic activity (Belzunegui et al., 1995). The effects of a single solvent on kidney have been reported in rats (Harman, 1971; Mensing et al., 2002). In real life people are exposed to multiple chemicals or organic solvents simultaneously rather than a single agent, because most chemicals or organic solvents are the mixtures of several different kinds. Some solvents potentiate the metabolism of others, while others inhibit metabolism and thereby increase solvents levels in the blood and reduce elimination time (Inoue et al, 1988; Skowroń et al., 2001).
Many authors have reported biochemical changes in renal function of experimental animals with exposure to different hydrocarbons (Ravnskov, 2005; Kum et al., 2007) the renal injury of some mixtures of solvents has not been well documented in animal models. Therefore, this study aims at evaluating the effect of ethanol ingestion and formaldehyde inhalation in renal function using rat models.

MATERIALS AND METHOD

Acquisition and Acclimatization of Animals

Twenty one adult male albino rats (wistar strain) eight to ten weeks old, weighing between 140-160g obtained from the Animal Breeding Unit of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka, were used for the study. The animals were kept in clean metal cages under a 12/12hours light/dark cycle and housed in the animal house of department of Physiology Anambra State University, Uli. The rats were allowed to acclimatize to the laboratory environment for a period of two weeks before commencement of the experiment. Standard feed and water were provided ad-libitum. All experimental animals were handled in accordance with the US National Institutes of Health Guidelines for the care and use of laboratory animals. Rats were housed under standard conditions including pathogen-free environment and free access to food and water. They were divided into three groups (seven rats per group). Group A were fed with normal rat chow and housed in a closed chamber, (60 X 50 X 40 cm). Group B and Group C were housed in a separate chambers of the same dimensions and were exposed to formaldehyde inhalation chamber under dynamic air flow condition, and its concentration was adjusted to 150 PPM 8 hrs per day for four weeks. Group C were further given oral administration of 20 mg/kg BW of alcohol daily simultaneously. After four weeks, the rats were anaesthetized with chloroform and bled by cardiac puncture. The blood was transferred to serum separator tubes, allowed to clot, thereafter, centrifuged for 10 minutes at 2500 rpm. The sera was carefully removed and placed into clean and appropriately labelled sample containers and stored frozen until the time of analysis. Electrolytes were analysed using ion selective electrode, while urea and creatinine was done using auto analysers.

All the laboratory analysis was performed at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State.

Statistical analysis

The mean ± SD of each parameter was taken for each group. The statistical package for the social science (SPSS) software version 16.01 was used for the data analysis. Analysis of variance (ANOVA) was used to test whether or not significant differences existed between groups. Pair-wise comparisons were made using the Post hoc test. Test probability value of P< 0.05 was considered significant.

RESULTS

Table 1 showed the effect of alcohol consumption and formaldehyde inhalation on some kidney markers of albino rats for 28 days. Inhalation of formaldehyde in rats caused a significant increase in electrolytes (Na, K, CI) and a significant reduction in Bicarbonate (P<0.05) when compared with control. Also there is a significant increase in urea and creatinine (P<0.05). Inhalation of formaldehyde with administration of 10ml/kg BW of alcohol caused significant (p<0.05) increase in the electrolytes.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control group (A)</th>
<th>Experimental group (B)</th>
<th>Experimental group (C)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (mmol/l)</td>
<td>137.60±4.51</td>
<td>138.20±1.15</td>
<td>150 ± 4.01</td>
<td>0.032</td>
</tr>
<tr>
<td>Potassium (mmol/l)</td>
<td>5.68±0.80</td>
<td>5.50±0.62</td>
<td>7.0 ± 0.21</td>
<td>0.020</td>
</tr>
<tr>
<td>Chloride (mmol/l)</td>
<td>93.20±5.40</td>
<td>96.00±4.00</td>
<td>134 ± 3.24</td>
<td>0.030</td>
</tr>
<tr>
<td>Bicarbonate (mmol/l)</td>
<td>29.40±1.82</td>
<td>21.40±2.97</td>
<td>12.20 ± 1.60</td>
<td>0.002</td>
</tr>
<tr>
<td>Urea (mmol/l)</td>
<td>6.98±1.07</td>
<td>9.26±0.80</td>
<td>18.10 ± 0.96</td>
<td>0.005</td>
</tr>
<tr>
<td>Creatinine (µmol/l)</td>
<td>51.80±10.90</td>
<td>141.00±17.22</td>
<td>201.21± 18.50</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Results were presented as mean ± SD of triplicate determination; P <0.05 was considered statistically significant.

DISCUSSION

Many researchers have examined the role of organic solvent exposure in a population of individual with glomerulonephritis (Porro et al., 1992; Stengel et al., 1995). Also earlier studies have used single chemicals, including benzene, toluene, xylene, formaldehyde and dichloromethane to induce renal injury in rats, and observed some derangements in kidneys of rats with exposure of 4 to 6 weeks (Harman; 1971; Mensing et al., 2002; González-Yebra et al., 2006). It is known that the effects of the organic substances contained in a solvent mixture are additive (Stacey, 1989; McDermott et al., 2008). Even at a low level of exposure to a mixture, the toxicity resulting from the additive effect of several solvents can exceed the toxicity of a single solvent (Stacey, 1989).

Some workers are mainly exposed to mixtures composed of many kinds of organic solvents, it is more meaningful to use a mixture of several different kinds of organic solvents for animal model studies. Formaldehyde is often used as embalming fluids in developing countries and morticians who are occupationally exposed may also indulge in alcoholism. The results of our studies have shown that formaldehyde alone is able to induce severe renal injuries in...
rats, and may be worse if combined with alcohol as evidenced by the biochemical alterations in renal functions.

Some mechanisms behind organic solvent-induced glomerulonephritis have been proposed (Nanez et al., 2000; Commandeur and Vermeulen, 1990). Chemical damage to either the pulmonary capillary alveolar basement membrane or the glomerular basement membrane (GBM) could induce an antigen-antibody response (Kleinkecht et al., 1980). By combining with renal proteins, organic solvents may act as hapitens and induce autoimmune against kidney cells. Increase in serum electrolytes, urea and creatinine are one of the primary features seen in renal impairment as these serve as markers of renal functions. This results is consistent with other findings that mixtures of organic solvent exceed toxicity of a single solvent.

**CONCLUSION**

Results obtained from the studies revealed that a mixture of organic solvents such as formaldehyde and alcohol could cause more deleterious effect in kidney than a single solvent as shown by alterations in biochemical parameters of kidney.

**REFERENCES**


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