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Effect of Periodic Exposure to Formaldehyde in the Anatomy Laboratory on Some Liver Function Indices in Male Wistar Rats

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ABSTRACT: The effect of periodic exposure to formaldehyde in the Anatomy laboratory on some liver function indices in fifteen male wistar rats divided into three groups of A,B and C with 5 animals in each group were investigated. Group A served as control with nil exposure while groups B and C were the test groups with 5 months exposure on non-dissection days and dissection days respectively. Formaldehyde air level was measured both at experimental and control sites. Some liver function indices measured include Alanine aminotransferase (ALT), Aspartate aminotransferase (AST) and alkaline phosphatase (ALP). Statistical analysis was done using Graph Pad Prism version 5.0. Results were presented as Mean ± SEM. Analysis of Variance was used to compare the means of test and control values while post hoc test was done using Student Newman Keul's test and a P-value of less than 0.05 was considered as statistically significant. Results revealed significant increase in formaldehyde air level in the dissection hall. There was observable increase in ALT, AST and ALP but they were not significant. It was therefore concluded that periodic exposure to formaldehyde may not have any harmful effect on liver function in wistar rats.

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Formaldehyde is a chemical fixative that is used for preserving dead bodies (cadavers) in order to prevent them from decomposition and decay (Farooqui, 1983). This unique property of formaldehyde makes it useful in the mortuaries and Anatomy laboratories where dead bodies are embalmed and kept for the purposes of burial or for study among medical students in the course of their training (Bjorkman *et al.*, 1986; McKone, 1994). Apart from the mortuaries and Anatomy laboratories, formaldehyde is also very useful in other areas (Gerberich and Seaman, 2004; IARC, 2006). Atmospheric levels of formaldehyde has been reported to be higher in the Anatomy laboratory when compared to other laboratories in a tertiary institution where medical students are trained (Ebojele and Iyawe, 2021) and this pose a risk to the health of medical students as formaldehyde has been reported to have adverse effects on the respiratory health (Mathur and Rastogi, 2007; Patil *et al.*, 2012; Neginhal *et al.*, 2013). In some studies carried out in rats formaldehyde was reported to produce oxidative stress in the liver (Petushok, 2000; Sogut *et al.*, 2004). The authors also reported evidence of lipid peroxidation among rats exposed to as high as 8ppm (*part per million*) of formaldehyde. Some researchers have tried to look at possible effects of formaldehyde on the central nervous system (Usanmaz *et al.*, 2002; Aslan *et al.*, 2006; Sarsilmaz *et al.*, 2007) as well as the reproductive system (Ozen *et al.*, 2005; Zhou *et al.*, 2006). Medical Students of a tertiary institution where this present study was carried out are usually exposed to the Anatomy laboratory where they carry out

dissection for eight hours every week that is, twice a week for a duration of four hours each. This periodic exposure to the Anatomy laboratory was mimicked in wistar rats and they were exposed for five months to see if there will be any adverse effect of formaldehyde on some liver function indices and this formed the basis of this present study. Hence, the objective of this study is to evaluate the effect of periodic exposure to formaldehyde in the Anatomy laboratory on some liver function indices in fifteen male wistar rats.

MATERIALS AND METHODS

Experimental animals: Fifteen male wistar rats of comparable age weighing between 180-220g were procured from the animal house of the Department of Anatomy, University of Benin. The animals were kept in plastic cages with wire mesh floor and allowed to acclimatize for a period of two weeks on normal feeds and water before the commencement of the experiments. Animal management and experimental protocols were carried out in accordance with the recommendations of the 1996 Guide for the Care and Use of Laboratory Animals (Clark *et al.,* 1997).

Animal grouping: The rats were divided into three groups (A, B and C) with five animals in each group. Group A served as the control with nil exposure while groups B and C served as the test group. Group B animals were exposed to formaldehyde in the dissection room on non-dissection days for eight hours per week for a duration of five months while Group C animals were exposed to formaldehyde in the dissection room on dissection days for eight hours per week which was also equivalent to the period medical students spent in the anatomy laboratory during dissection and this was also carried out for a duration of five months.

Measurements of formaldehyde air level: Formaldehyde air level was measured using Formaldehyde Gas Meter (EXTECH FM200). The meter is automated, calibrated and has an external probe that detects the atmospheric levels of formaldehyde. Five measurements were taken on five different occasions at the control site and in the dissection hall on dissection days and non-dissection days and the average was calculated and taken as the air exposure level. Within the dissection hall, the measurements were taken around the dissection table to get an idea of the personal exposure, and three meters away from the dissection table to get an idea of the area exposure. Measurements were also taken at the different corners of the laboratory. The formaldehyde air levels were measured in *part per million* (ppm). The meter also gave measurement of the room temperature and the relative humidity.

Sample collection and analysis: Blood samples from the animals were collected through cardiac puncture as described by D'Armour *et al.* (1965). The blood samples were transferred into plain containers and centrifuged at 2500rpm for five minutes to obtain the serum for biochemical analysis of alanine amino transferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP). Serum ALT and AST activities for cellular liver integrity were estimated with the Randox reagent kit using 2,4-dinitrophenylhydrazine substrate as described by Reitman and Frankel (1957). ALP activity for biliary tract integrity was determined with the Randox reagent kit using the p-nitrophenylphosphate substrate as described by Bassey *et al.,* (1946).

Statistical analysis: Statistical analysis was done using Graph pad prism version 5.0. Results was presented as Mean ± SEM. Analysis of Variance was used to compare the means of test and control values while post hoc test was done using Student Newman Keul's test and a p-value of less than 0.05 was considered as statistically significant.

RESULTS AND DISCUSSION

Formaldehyde air level of control site and dissection room is shown in Table 1. There was a significant increase ($p<0.05$) in formaldehyde air level in the dissection room both on the dissection days and non-dissection days when compared to control. Figure 1 shows an observable increase in Alanine aminotransferase in groups B and C when compared to control, however, it was not significant. This same trend was also reflected in Figures 2 and 3 for Aspartate aminotransferase and alkaline phosphatase respectively.

Table 1: Formaldehyde air level, room temperature and relative humidity of control site and dissection room

Parameters	Control site	Dissection room on non-dissection days	Dissection room on dissection days	P-value
Formaldehyde air level (ppm)	0.06±0.00	0.47±0.02*	1.95±0.02*	0.0001
Room temperature (℃)	30.32±0.08	29.42±0.10*	30.06±0.23	0.0039
Relative humidity (%)	73.40±0.71	76.36±0.12	76.14±1.27	0.0518

Significant values are Mean ± SEM compared to control (= P<0.05)*

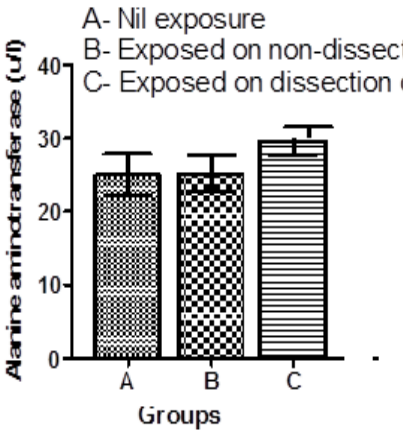

Fig 1: Mean serum alanine aminotransferase (ALT) concentration (u/l) in Wistar rats following periodic exposure to formaldehyde

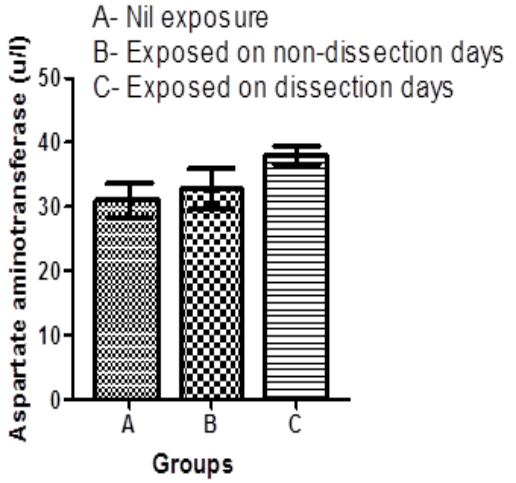

Fig 2: Mean serum aspartate aminotransferase (AST) concentration (u/l) in Wistar rats following periodic exposure to formaldehyde

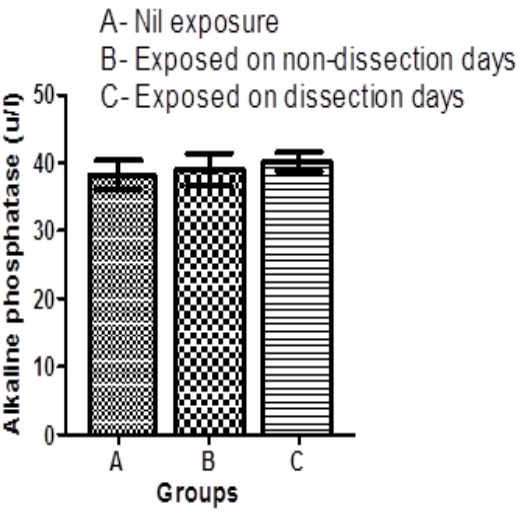

Fig 3: Mean serum alkaline phosphatas (ALP) concentration (u/l) in Wistar rats following periodic exposure to formaldehyde

Among the initial steps in detecting damage to the liver is to determine the level of some of the enzymes in blood which are usually used as biomarkers of liver function. The enzymes that are more often used to assess hepatocellular damage are Alanine aminotransferase, Aspartate aminotransferase and Alkaline phosphatase (Dial, 1995). Normally, these enzymes reside within the cells of the liver. However, when there is injury to the liver, the enzymes are spilled into the blood stream, raising the enzyme levels in the blood, thus signaling liver damage (Dial, 1995; Crook, 2006). Damage to the liver tissues result in increase in the activities of these enzymes in plasma and such increase in serum hepatic enzyme activity is known to be proportional to the extent of tissue damage (Crook, 2006). The result from this present study as shown in Figures I, II and III revealed an increase in Alanine aminotransferase, Aspartate aminotransferase and Alkaline phosphatase both in groups B and C when compared to control but it was not significant. This therefore suggests that periodic exposure to formaldehyde in the Anatomy laboratory may not have adverse effect on the liver in wistar rats. In some studies carried out in rats formaldehyde was reported to produce oxidative stress in the liver (Petushok, 2000; Sogut *et al.*, 2004). The authors also reported evidence of lipid peroxidation among rats exposed to as high as 8ppm (*part per million*) of formaldehyde. In this present study, air exposure level to formaldehyde for group B rats exposed on non-dissection days was 0.47ppm while that of group C rats exposed on dissection days was 1.95ppm (Table 1). The exposure level to formaldehyde in present study is not up to the level (8ppm) that produced oxidative stress and lipid peroxidation in the study on rats earlier cited. Recall that this study carried out on wistar rats actually mimicked medical student's attendance at the Anatomy laboratory for the purpose of dissection during the course of their training. Since the liver function in wistar rats was not affected, is it possible that liver function may not also be affected among medical students who are exposed to the Anatomy laboratory? Further studies among medical students with regard to liver function following exposure to formaldehyde is required in order to substantiate these observations in wistar rats.

*Conclusion***:** We therefore conclude that periodic exposure to formaldehyde in the Anatomy laboratory may not have any adverse effect on liver function in wistar rats.

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