Histological Changes In The Liver Of The Adult Wistar Rat Following Exposure To Cement Dust

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ABSTRACT

Background: The Liver regulates many important metabolic functions, and any injury causes distortion of these metabolic functions.

Aim: This study investigated the histological changes in the liver of Wistar rats following exposure to cement dust.

Methodology: 24 Wistar rats weighing between 250g and 280g were divided into 4 groups of 6 rats per group. **Group A** rats were placed in a cement dust free environment while Group B-D rats were exposed to various concentration of cement dust dispersed from 5g, 10g and 20g of cement respectively. The weights of the rats were taken weekly and the difference between them and previous weights were noted. At the end of the 30th day exposure, the animals were euthanized under chloroform anaesthesia and the liver was harvested and processed for histological examination. The obtained data analyzed using the paired t-test, with level of significance set at <0.05.

Results: The histological sections of the liver of rats in **Group A** showed normal histoarchitecture of hepatocytes radiating from the central vein. There were observable histological variations in the liver histoarchitecture of the exposed rats **(Group B-D)** which include lymphocytic infiltration around the portal vein and in patches within the hepatic tissue and congestion of the sinusoids and portal vessels around the central veins.

Conclusion: It was concluded that cement dust has histomorphologic effects on the liver tissue which are capable of compromising the health of the research animals.

KEYWORDS: Cement dust; liver; histoarchitecture; hepatic disease

Introduction

The Liver is the largest solid organ in the body.[1] It regulates many important metabolic functions, and any injury causes distortion of these metabolic functions. As per an estimate, about 20,000 deaths occur every year in United States due to liver disorders.[2] Prolonged inhalation of cement dust is susceptible to liver damage and if not corrected can lead to liver failure.[3] Besides cement dust, some other conditions can increase susceptibility to the development of liver disease e.g., obesity, heavy alcohol use, type 2 diabetes, tattoos, unprotected sex, injecting drugs using shared needles and undiagnosed hepatitis infection.[4] Therefore, a logical long term strategy to avoid or deal with liver disease and its complications is to aim at the causes, prevention and treatment of liver disorders.

Cement dust is a serious atmospheric pollutant. It is emitted during manufacturing and processing of cement, transportation, bag dumping, storage, usage, concrete cutting and when workers empty bags of cement.[5] The basic components of cement dust include: Calcium, Silicon, Aluminium, Manganese, Iron and Zinc.[6,7] Many of the chemical elements of cement dust have been found to be toxic or mutagenic to both animals and humans [8,9] Despite the health risks and hazards of cement dust there is no way use of cement can be avoided in building industries and this is attributable to its superiority to other building materials e.g., metakaolin, ashcrete, flyash and ground granulated blast-furnace slag.[10] Cement mill workers are the high risk exposed group to cement dust.[11] Construction laborers, cement transporting workers. Masons and everyone with cement dust related occupation are also exposed to cement dust during the course of their work.

Prolonged exposure to cement dust has been implicated in a variety of maladies. Previous studies have shown that prolonged inhalation of cement dust can damage the liver, lungs, respiratory tract, stomach, liver, kidneys and blood/blood-forming organs.[12] Signs and symptoms of cement dust related liver disorders include chronic fatigue, abdominal pain, nausea and vomiting, general malaise and pruritus.[12,3] Hence, the objective of this paper was to evaluate the effects of cement dust on the liver of adult Wistar rats.

Materials and method

Experimental Animals:

Twenty-four (24) adult Wistar rats weighing between 250g and 280g were purchased from the animal house, Department of Anatomy, University of Benin and were utilized for this experimental research. The rats were given a period of two (2) weeks to adapt to their new environment before commencement of the experiment. During this period, the animals were allowed free access to standard animal feed (Vital grower's feed, Manufactured by Bendel Flour Mill, Ewu) and clean water *ad Libitum.* The weight of the animal in each group was taken and recorded weekly so as to get the cumulative weight required for experimental use.

Ethical Considerations

Each animal procedure was carried out in accordance with approved protocols and in compliance with the recommendations for the proper management and utilization of laboratory animals used for research.[13]

Experimental Design:

Twenty-four adult Wistar rats of either sex were randomly assigned into four study groups of six rats per group. Dust Distributor Glass-Chamber of dimensions 32.5cm^3 in length, 32.5cm^3 in width and 16.5cm^3 in height was used in this experimental research for uniform dispersion of cement dust. This exposure modality simulated a general construction site in which cement dust saturated the ambient air to which people with cement dust related occupation actually encountered daily for hours during the course of their work. **Group A** rats which served as control was placed in a cement dust free environment while **Group B** rats were exposed to cement dust dispersed from 5g of cement 1 hour daily for 30 consecutive days (Low concentration exposure). **Group C** rats were exposed to cement dust dispersed from 10g of cement 1 hour daily for 30 consecutive days (Moderate concentration exposure) while **Group D** rats were exposed to cement dust dispersed from 20g of cement 1 hour daily for 30 consecutive days (high concentration exposure).

Method of Sacrifice and Sample Collection

At the end of 30th day exposure, the animals were weighed and euthanized under chloroform anaesthesia; a midline incision was made through the ventral wall of the abdomen of the rats to access the liver. The liver was harvested and immediately fixed in 10% formal saline for24 hours before the histological analysis.

The tissues were trimmed to about 3-5mm thick sections and processed according to method of Drury and Wallington (1980).[14] And then histologically assessed using the following methods: fixation, embedding and tissue staining for microscopy. Histological sections were examined under Leica DM750 research microscope with a digital camera (Leica ICC50) attached. Photomicrographs of the tissue sections were taken at various magnifications i.e. x40 and x400.

Statistical Analysis:

Results were presented as Mean (X) and Standard error of mean (SEM). The data were subjected to statistical analysis of paired t-test, with level of significance set at $P \leq 0.05$.

RESULTS

Table 1: Changes in Body Weights of the Rats in All the Experimental Groups

Period Of Exposure	Group A	Group B	Group C	Group D	P Values
Ist week	5.60 ± 0.68	0.60 ± 0.19*	0.42 ± 0.16*	0.38 ±0.16 *	0.000
2nd week	6.70 ± 0.93	0.30 ± 0.05*	0.30 ± 0.09*	0.20± 0.14*	0.000
3rdweek	7.40 ± 1.24	0.06 ± 0.17*	0.20 ± 0.05*	0.16± 0.07*	0.000
4thweeks	7.74 + 0.60	0.18 ± 0.09*	0.36 ± 0.10*	0.04± 0.08*	0.000

n=6; Values are Mean ± S.E.M

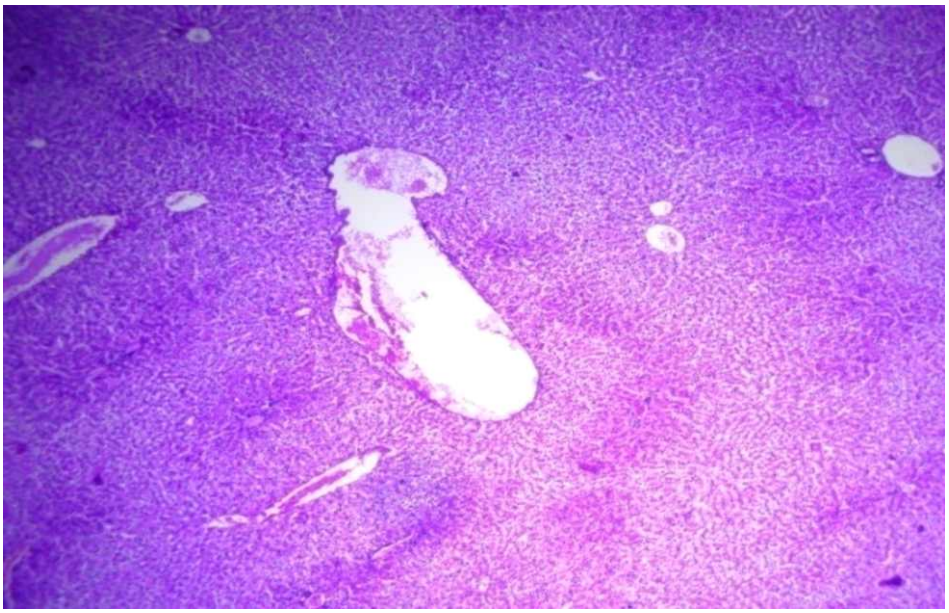

Figure 1: Photomicrograph of liver of rats in Control (**Group A**) showing A, sheets of hepatocytres, B, Portal tract and C, Central veins with areas of congestion (**H&E x 40**)

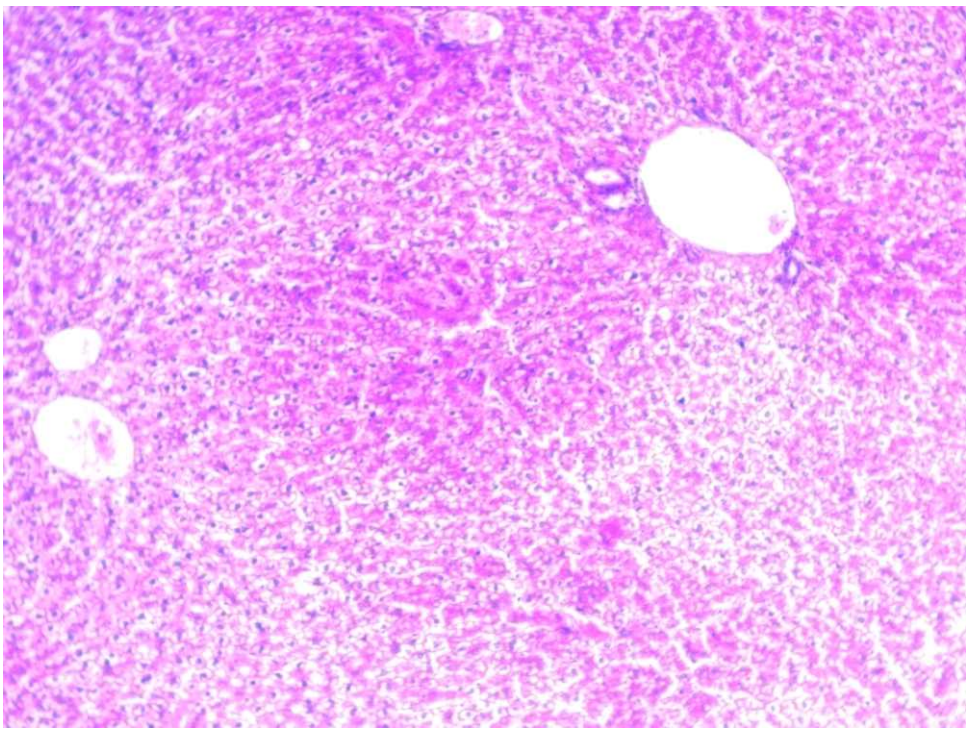

Figure 2. Photomicrograph of liver of Rats in Control (Group A) showing A, sheets of hepatocytes, B, portal tract and C, central veins with areas of vascular congestion.. (H&E x 100)

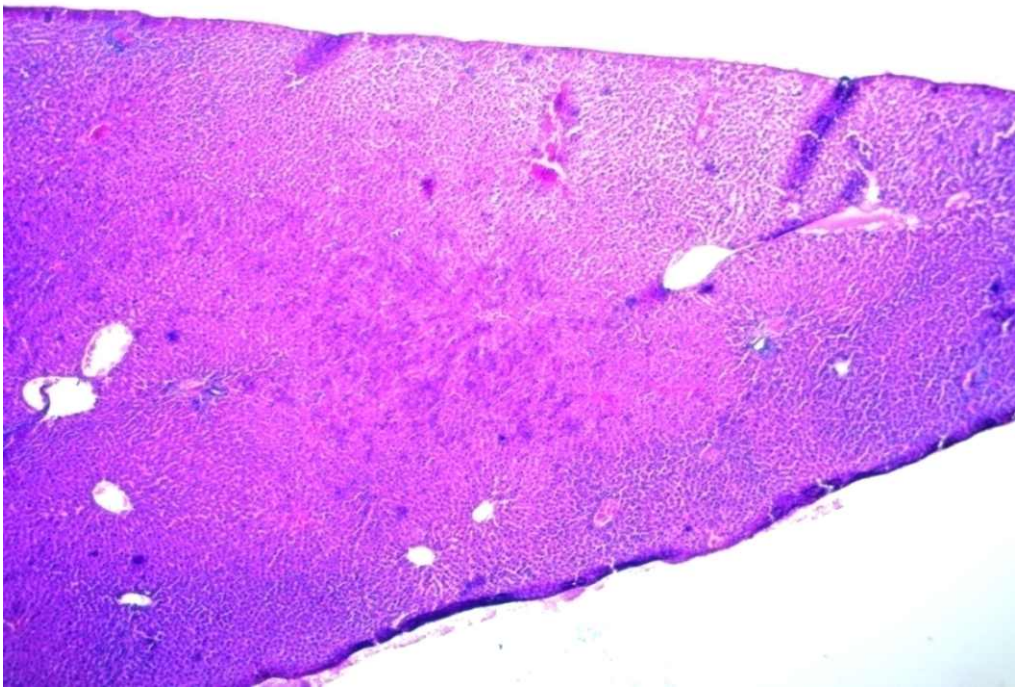

Figure 3. Photomicrograph of liver of Rats exposed to 5g cement dust (Group B) showing: A, sheets of hepatocytes, B, portal tracts and C, central veins with areas of vascular congestion (H&E x 40)

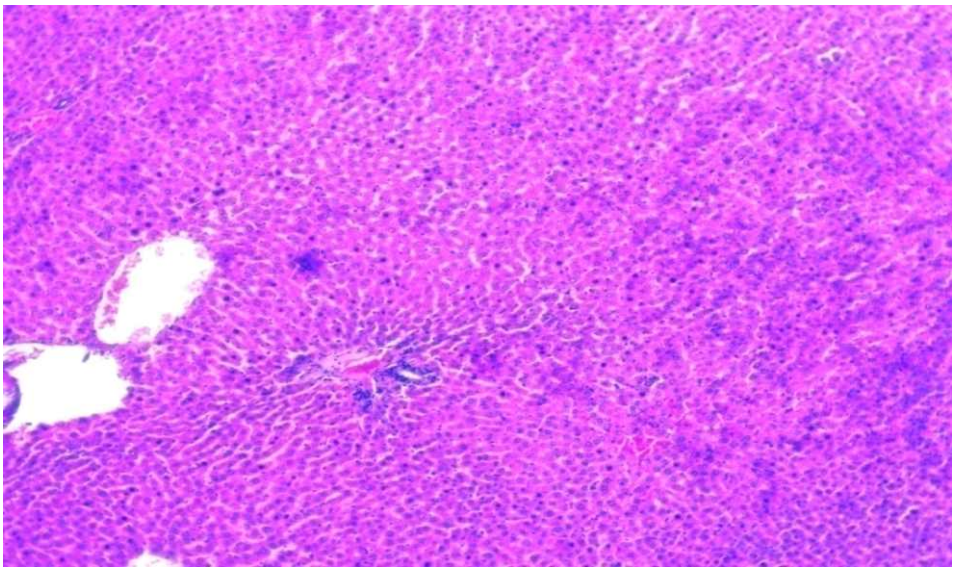

Figure 4. Photomicrograoh of liver of Rats exposed to 5g cement dust (Group B) showing A, sheets of hepatocytes, B, portal tracts and areas of vascular and C, sinusoidal congestion. There are area s of D, lymphocytic infiltration around the portal vein and in patches within the hepatic tissue.(H&E x 100)

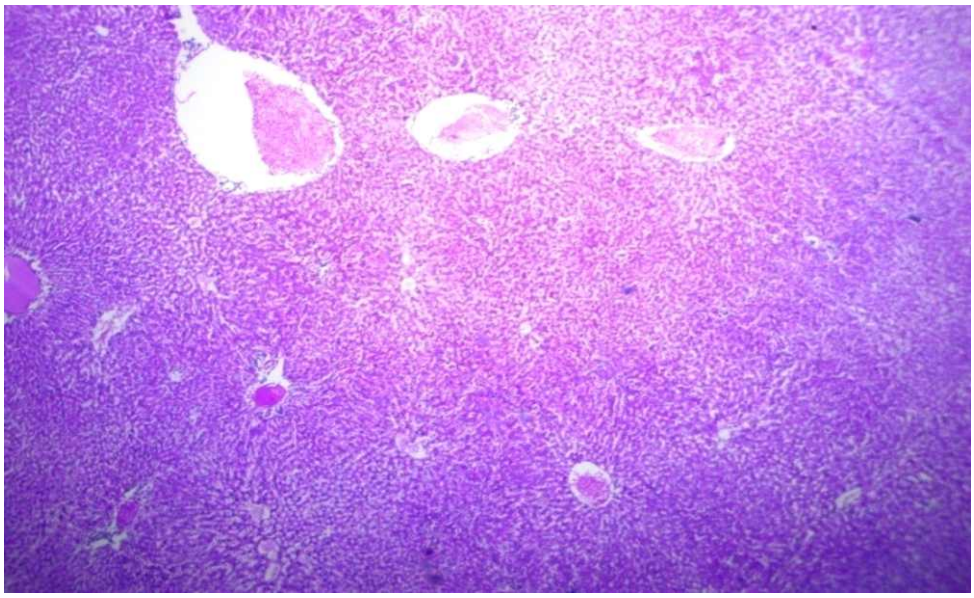

Figure 5. Photomicrograph of liver of Rats exposed to 10g cement dust (Group C) showing: A, sheets of hepatocytes, B, portal tracts and C, central veins with areas of vascular congestion (H&E x 40)

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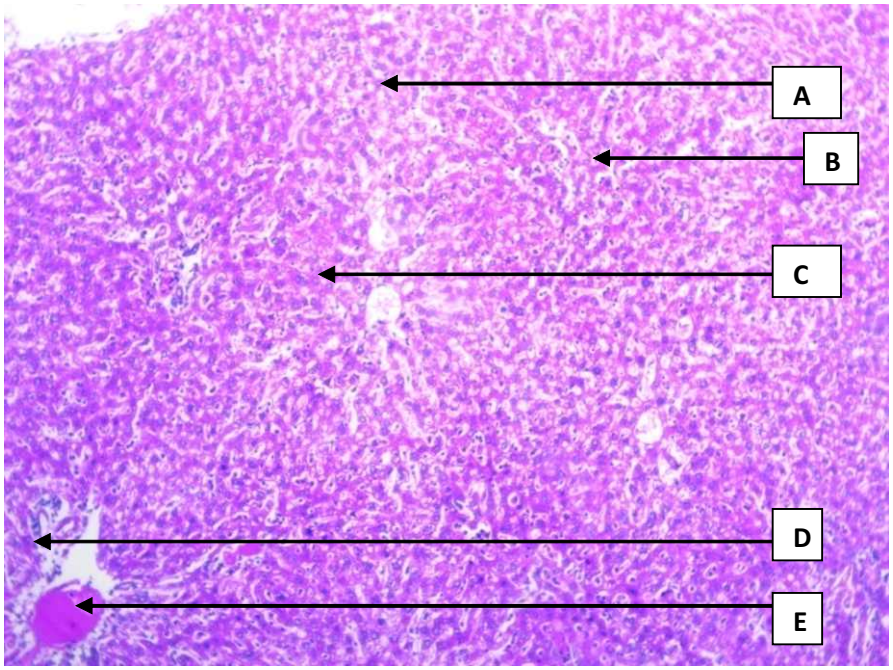

Figure 6. Photomicrograph of liver of Rats exposed to 10g cement dust (**Group C**) showing: A, sheets of hepatocytes, B, congested sinusoids and C, central veins. There were D, lymphocytic infiltration around E, a portal vein and in patches within the hepatic tissue. (H&E x 100)

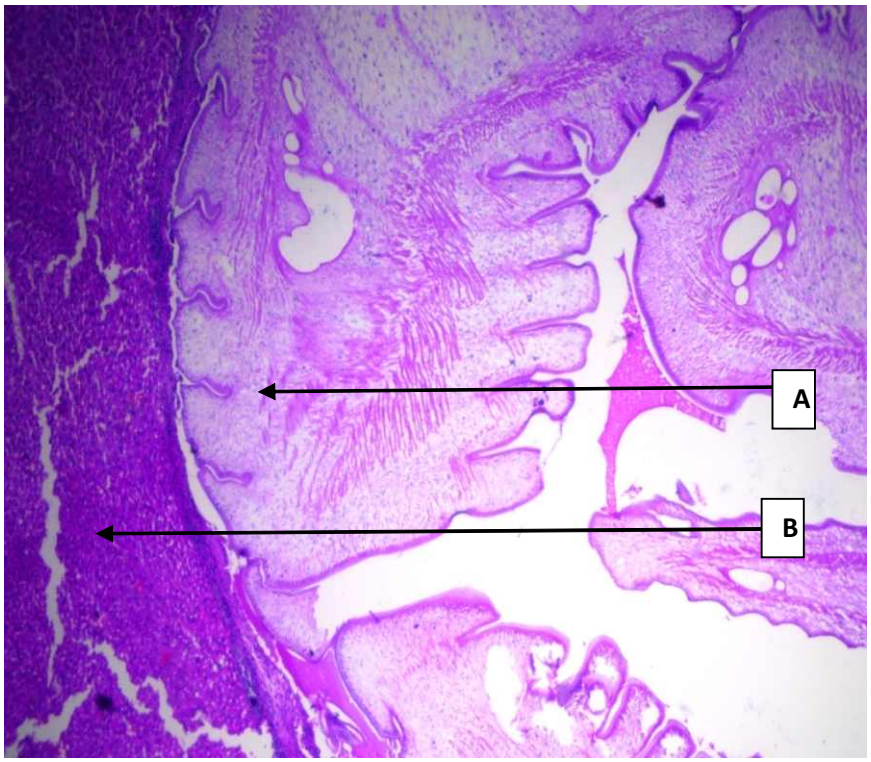

Figure 7 . Photomicrograph of liver of Rats exposed to 20g cement dust (G roup D) showing: a remarkable encysted larva and segments of tapeworm. A, the cyst wall and B, the encysted parasite are shown. (H&E x 40)

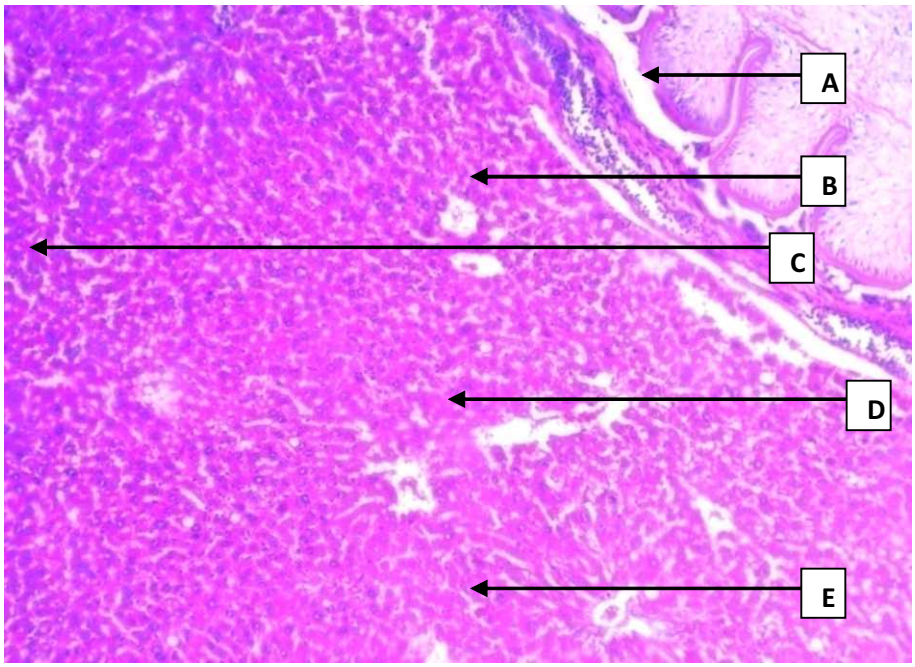

Figure 8. Photomicrograph of liver of Rats exposed to 20g cement dust (**Group D**) showing: A, a remarkable encysted larva and segments of tapeworm and B, lymphocytic infiltration around th e cyst wall and in patches within the hepatic tissue. There is also congestion of the C, central vein, D, sinusoids and E, the portal vessels. (H&E x 100)

Discussion

Results show there was significant increase in body weight of rats in the control group **(Group A).** Significant decrease was observed in body weight of the rats exposed to cement dust (**Group B, C and D)** which was what we actually expected because cement dust is toxic and so, it's expected to case decrease in body weight and this concurs with previous work.[12] The weight loss could be attributable to dysguesia,[15] anorexia[8] or toxicity of the basic constituent chemical elements of cement dust.[7]

The histological sections of the liver of the control group (**Group A**) shows normal histo-architecture of hepatocytes radiating from the central vein with intervening sinusoids **(Figure 1 and 2)**

There were observable histological variations in the liver histoarchitecture of the rats exposed to cement dust dispersed from 5g (**Group B**), 10g (**Group C**) and 20g (**Group D**) of cement respectively **(Figure 3, 4, 5, 6, 7, and 8).** The significant histopathological findings in the rats treated with cement dust include lymphocytic infiltratas around the portal vein and in patches within the hepatic tissue, encysted larva, segments of tapeworm (which might be due to coataminated feed/water) and congestion of the sinusoids and portal vessels around the central veins. It was therefore concluded that cement dust has histomorphologic effects on the liver tissue which are capable of compromising the health of the exposed animals. The histological findings from this research are inversely proportional to the doses administered and they agree with a similar work done by Poinen-Rughooputh *et al.,* (2006)[16] where they used silica dust to induce hepatic disease.

Apart from the use of liver-protective herbal drugs such as *Amaranthus tricolor* aqueous leaf extract[17] , how else can cement dust related-hepatic disease be prevented?

Over time, condition that damage the liver can lead to scarring (cirrhosis) which may result ultimately in liver failure, a life-threatening condition. But early treatment may give the liver time to heal. Cement dust-related liver disease and its associated complications can be prevented by adherence to proper safety precautions e.g., wearing of personal protective equipment (such as face masks, face shields, goggles, hand gloves, boots and coveralls) in order to minimize the degree of exposure to cement dust.; routine medical checkups, especially among cement factory workers and other people with cement dust related occupation should be encouraged so as to avert any occupational health risks and hazards of cement dust; sensitizing the general public regularly by providing them with current information regarding the health risks and hazards of cement dust; and management of cement factories in developing countries adopting the use of modern machines and technologies that can reduce the amount of cement dust released to the environment.

CONCLUSION

Cement dust caused decreased body weight in the treated rats and also caused distorted liver histoarchitecture which are capable of compromising the health of the research animals and may ultimately lead to death. The histomorphological findings are consistent with usual histological findings in hepatic disease.

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