

Histopathological Effects of Dichlorvos Exposure on Cardiac Tissues of Male Wistar Rats

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Abstract

Original Research Article

Background to the study: Dichlorvos (DDVP), commonly regarded as Sniper, is a regular pesticide used in Nigerian homes towards the eradication of pests. However, it is capable of causing adverse effects on the cardiovascular system on exposure to these pesticides while in use. This study was done to investigate the histopathological effects of short-term inhalation exposure to dichlorvos (DDVP) concentration on the cardiac tissues of adult male wistar rats.

Methods: Twenty (20) male wistar rats weighing 140g – 180g were recruited for this research and were randomly placed into four (4) groups of five (5) rats per group. Group 1 was control group, while groups 2 – 4 were given 10ml DDVP/90 ml distilled water – v/v, 20ml DDVP/80 ml distilled water – v/v and 40ml DDVP/60 ml distilled water – v/v, respectively. At completion of exposure, rats were anaesthetized with chloroform, sacrificed and their hearts were harvested for routine histopathology procedure. The stained sections were morphologically evaluated and the pictures of the slides compared. Photomicrographs were obtained with the aid of Amscope camera fitted on an Amscope microscope. **Results:** There were significant histopathological changes in the cardiac tissue architecture in the rat groups exposed to higher concentrations such as loss of cross-striations, degeneration of myocardial fibers, as well as mild signs of congestion of blood vessels. **Conclusion:** It can be concluded that short-term inhalation exposure to high concentrations of dichlorvos (DDVP) could contribute to toxicological effects of the heart.

Keywords: Dichlorvos, heart, cardiac, myocardial fibers, cross striations, toxicological.

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INTRODUCTION

The application of pesticides in the eradication of pests such as insects in most low-income countries has been promoted because these chemicals are relatively cheap and easy to handle [1]. These chemicals are relevant towards the prevention and control of diseases that are easily transmitted by their corresponding pests, as well as reducing their harmful effects on plant and animal growth as well as food production in industries [2, 3]. In countries like Nigeria, there are a limited number of rules and regulations that enable the safe usage of these chemicals domestically [4].

Dichlorvos also known as DDVP (2,2-dichlorovinyl dimethyl phosphate), is an organophosphate locally sold in parts of Nigeria as Sniper or *ota-piapia*, is a predominant pesticide used in domestic control of insects in low-income and middle-income countries [5]. Like other organophosphate insecticides, it is neurotoxic in action, and acts on the

nervous system by inhibiting the enzyme acetyl cholinesterase (AChE) [6, 7]. The action between an organophosphate insecticide and the active site in the AChE protein results in the formation of a transient inter-mediate complex that partially hydrolyses, leaving a stable phosphorylated and largely non-reactive inhibited enzyme that, under normal circumstances, can be reactivated only at a very low rate [8].

Ogunsola *et al.*, [9] reported on the findings from their experimental study of histopathological effect of long-term inhalation exposure to DDVP that the rat heart tissues showed signs of degeneration and necrosis of cardiocytes, as well as congestion of blood vessels depicting levels of haemorrhage. Limited experimental studies have been done to show the effect of short-term inhalation exposure to DDVP on the histological architecture of the cardiac tissues, hence the purpose of this study.

METHODS

Research Design

The research design was experimental which intended to investigate the dichlorvos-induced toxicity on the hearts of male albino wistar rats. An ethical clearance was applied for and obtained (UPH/CEREMAD/REC/MM78/049) from the Research Ethics Committee of the University of Port Harcourt.

Twenty (20) rats were recruited for this research and were randomly placed into four (4) groups of five (5) rats per group. A box-like cage measuring 40cm x 40cm x 15cm (3 in number) that was made of Perplex glass, was used as inhalation chambers (that were poorly ventilated) for the experimental rats for groups 2 – 4. The table below shows the pattern of administration of dichlorvos (DDVP).

Table 1: Rat groups and their administration of concentration levels

GROUP	CONCENTRATION LEVELS
Group 1 (control)	100% distilled water
Group 2	10ml DDVP/90 ml distilled water – v/v
Group 3	20 ml DDVP/80 ml distilled water – v/v
Group 4	40ml DDVP/60ml distilled water – v/v

DDVP = Dichlorvos

According to Maheshwari and Shaikh [10], experimental animals are exposed to the test substance for a minimum of four (4) hours and are monitored for a short-term period of 14 days. Animals that die during the study will be autopsied. At the end of the study, animals are sacrificed and observed for pathological changes.

Sample Collection/Identification

Dichlorvos is the active ingredient of the insecticide, Sniper. Sniper was purchased from the Dooka Pharmacy located opposite University of Port Harcourt Teaching Hospital, Alakahia, Port Harcourt.

Acute Toxicity for Dichlorvos Inhalation

In line with a similar study done by Owoeye *et al.*, [11] the average lethal concentration for dichlorvos inhalation is 50 ml DDVP/50ml distilled water.

Animal Acclimatization & Handling

The animals that were used are twenty (20) male albino wistar rats weighing 140g – 180g and were bred in the Animal House of the department of Pharmacology, University of Port Harcourt. They were grouped into four (4) groups of five (5) animals each and left to adapt to the environment for fourteen (14) days. They were kept in standard cages and maintained in standard laboratory condition at an average room temperature of (25 ± 2°C) with relative humidity (55-64%) and light and dark conditions (12/12h). They were given standard diet and water *ad libitum*. Animal ethics and proper handling methods were closely abided. The bedding of the cages (sawdust) was changed daily and the cage also washed and disinfected weekly. The feed, Top Feeds Premier Feeds (Broiler finisher) manufactured by Premier Feed Mills Co. Ltd. (A subsidiary of Flour Mills Nig. Plc., Lagos State) were purchased at Choba, Port Harcourt. They were stabilized for one week during which they were allowed access to commercial rat feed and portable clean water *ad libitum*.

Histopathological Analysis

At completion of exposure, rats were anaesthetized with chloroform, sacrificed and their hearts were harvested for routine histopathology procedure. The harvested organs from all groups were fixed in 10% formaldehyde, and then hydrated with grades of ethanol (75%, 90%, 95% and 100%). Dehydration was then followed by clearing the samples in two changes of xylene. Samples were then impregnated in molten paraffin wax, then embedded and blocked out. Paraffin sections of 5µm thick were cut using a sledge microtome and mounted on glass slides and stained with haematoxylin and eosin (H&E) staining method. The stained sections were morphologically evaluated and the pictures of the slides compared. Photomicrographs were obtained with the aid of Amscope camera fitted on an Amscope microscope.

RESULTS

Results from this study show the histopathology of the heart of experimental groups 1 – 4. After 14 days of inhalation exposure to DDVP, the cardiac tissue of control group (Figure 1) showed a normal histological architecture characterized by a normal distribution of myocardial fibers as well as no signs of congestion of blood vessels. In comparing the control group results to the other groups, there were significant degenerative changes in the histological architecture of cardiac tissues of rat group 4 (Figure 4). These observations included loss of cross-striations and degeneration of myocardial fibers, as well as mild signs of congestion of blood vessels. The rat groups 2 and 3 did not show significant degenerative histological changes in the cardiac tissues (Figure 2 and 3).

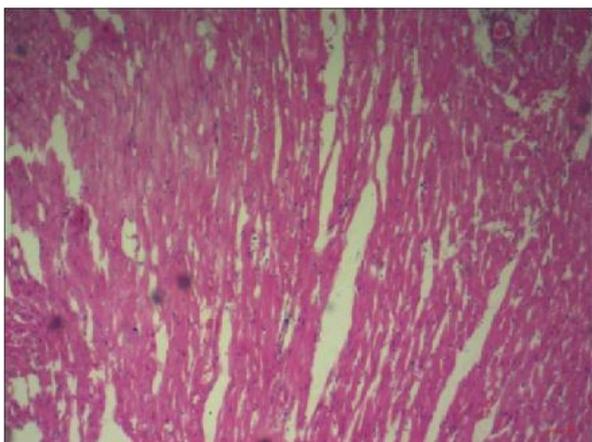


Figure 1: Photomicrograph of the rat control group (magnification x400)

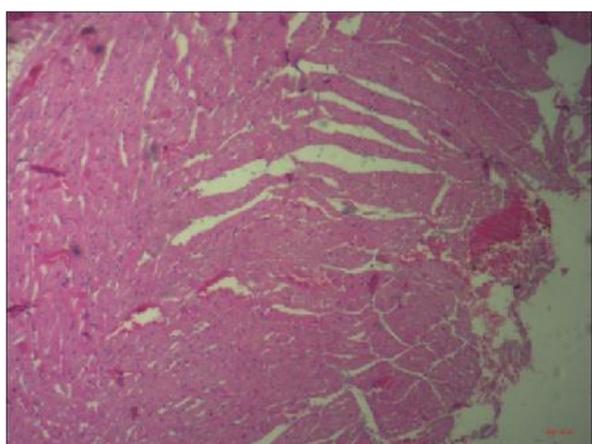


Figure 2: Photomicrograph of the rat experimental group given 10ml DDVP/90 ml distilled water – v/v (magnification x400)

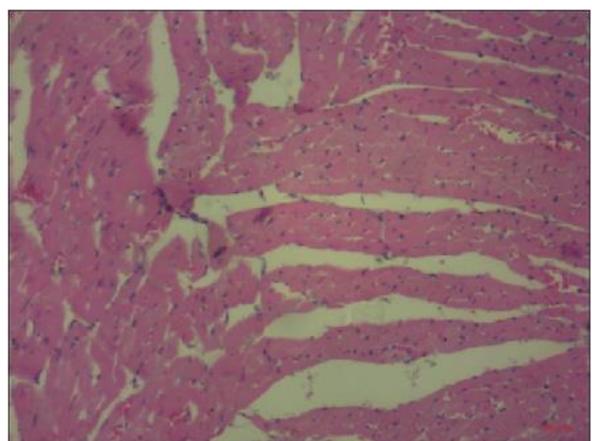


Figure 3: Photomicrograph of the rat experimental group given 20ml DDVP/80 ml distilled water – v/v (magnification x400)

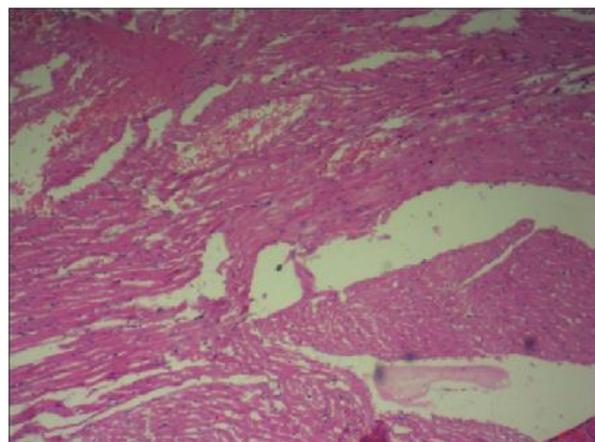


Figure 4: Photomicrograph of the rat experimental group given 40ml DDVP/60 ml distilled water – v/v (magnification x400)

DISCUSSIONS

This study was done to investigate the histopathological effects of short-term inhalation exposure to dichlorvos (DDVP) concentration on the cardiac tissues of adult male wistar rats. Extensive studies have been done to show its toxicological effects on various body organs such as the kidney, liver and lungs [9, 11, 12]. To the best of the researchers' knowledge, limited studies have been done to achieve this particular aim.

Analytically, DDVP toxicity has been reported to be oxidative stress through excessive production of reactive oxygen species can lead to lipid peroxidation [13, 14]. This could explain the reasons behind the histopathological results obtained from experimental group 4 in this current study. These results included significant loss of cross-striations as well as degeneration of myocardial fibers and mild signs of congestion of blood vessels. These observations are in line with the results obtained from studies reported by Al-Attar [13] and Ogunsola *et al.*, [9].

CONCLUSION

It can be concluded that short-term inhalation exposure to high concentrations of dichlorvos (DDVP) could contribute to moderate toxicological effects of the heart. Therefore, the role of awareness on the usage of these organophosphate pesticides is important towards ensuring proper health and functioning of the cardiovascular system.

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Competing Interests: There is no conflict of interest.

AUTHORS' CONTRIBUTIONS

The first author designed the study, wrote the study protocol and the first draft of the manuscript. The second author managed the literature search. Both authors collectively did the study analysis, read and approved the final manuscript.

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