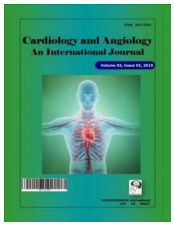

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Histomorphological Study of Effects of Oral Administration of Cadmium Nitrate on Heart of Adult Wistar Rats

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Authors' contributions

This work was carried out in collaboration between all authors. Authors ODO, SAA, NOA, UPI and OOO designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors SAA, ODO, NOA, UPI and OOO managed the literature searches and analyses of the study performed the spectroscopy analysis. Authors SAA, ODO and OOO managed the experimental process. Authors SAA and ODO identified the species of plant. All authors read and approved the final manuscript.

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ABSTRACT

Cadmium nitrate occurs as a colorless solid. It is soluble in dilute acids and ethanol, acetone, water, diethyl ether, and ethyl acetate. This study examined the effects of Oral Administration of cadmium nitrate on histomorphology of the heart of adult wistar rats. Twenty (n=20) adult wistar rats of both sexes randomly divided into four groups (A-D) of five (n=5) rats each; Rats in group A which served as control were given 10 ml/kg/day of distilled water for 21 days. Rats in group B, C, and D (cadmium nitrate CdN group) were given 150 mg/kg/bw of CdN, 225 mg/kg/bw of CdN and 300 mg/kg/bw of CdN administered orally through an orogastric cannula into the stomach via the esophagus, once a day, for twenty one consecutive days. The heart of each rat was harvested and weighed before fixed in 10% formal saline for histological procedures. Results revealed normal

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histological architecture in control while the experimental rats showed inflammations, distortions, congestions, and degenerative changes in myocardium tissue. The heart weight significantly increased in treated group while compared with the control group. Observed effects may therefore cause cardiovascular disorder.

Keywords: Heart; cadmium; rat; orogastric; histomorphology; ethanol.

1. INTRODUCTION

Heavy metals are individual metals and metal compounds that can impair human health [1]. Among the heavy metals cadmium is a very genotoxic metal. Numerous studies have shown that genotoxicity of Cd is directly related to its effect on structure and function of DNA, which may be determined using a number of laboratory methods [2-4]. In plants, cadmium is known to inhibit seed germination and root growth [5,6] and induces chromosomal aberrations and micronucleus formation [7]. Cadmium (Cd) is a highly toxic element and is naturally present in all parts of the environment, which includes; food, water, and soil [8] and by World Health Organization is major concern for public health [9]. It is a non-essential element and has a half-life which is extremely persistent in the environment [10,11]. Human are at risk to cadmium exposure through the food chain because cadmium is not degraded in the environment [12]. Cadmium accumulates in organ it enters, affecting the cell physiology and growth [13,14], induces disorders in the hormonal and cellular immune responses [15-17].

Cadmium is the cause of various diseases including cancer, respiratory disease and cerebrovascular diseases, especially the rates of popular mortality due to these diseases are higher in cadmium contaminated areas than those areas which are not cadmium contaminated. Breast cancer and endometrial cancer are also associated with chronic exposure to cadmium [18,19].

Cadmium nitrate occurs as a colorless solid. It is very soluble in dilute acids and soluble in ethanol, acetone, water, diethyl ether, and ethyl acetate [20]. Cadmium nitrate is available in technical and reagent grades with a purity of 99% or higher [21].

The heart is a muscular organ that circulates the blood through the vessels to different parts of the body [22]. The apex is directed anteroinferiorly toward the left. Its wall consists largely of cardiac muscle (myocardium), lined and surrounded by membranes-endocardium and pericardium. It is divided by a septum into right and left halves. The endocardium is a thin internal layer (endothelium and sub endothelial connective tissue) or living membrane that cover its values. The myocardium is a thick middle layer that is composed of cardiac muscle while the epicardium is a thin external layer formed by the visceral layer of serous pericardium [23].

The present study was therefore designed to carry out histo-morphological Study of Effects of Oral Administration of Cadmium Nitrate on Heart of Adult Wistar Rats

2. MATERIALS AND METHODS

2.1 Cadmium Nitrate

2.1.1 Procedure

The cadmium nitrate in this research was purchase from pharmaceutical shop in Yaba Lagos, Lagos State, Nigeria in January 6, 2015 and it was taken to Anatomy Laboratory of Department of Anatomy, College of Medicine, University Of Lagos, Idi-Araba, Lagos, Lagos State, Nigeria and were authenticated by a staff in the Department of Chemistry University of Lagos, Lagos state Nigeria.

2.1.2 Animals and diet

Twenty (n=20) adult wistar rats of both sexes were obtained from a breeding stock maintained in the animal house, the animal had free access to rat chow and tap water and they were randomly divided into four (4) groups (A-D) of five (n=5) rats each in a separate room at a constant temperature (22.0±1.0^{o}c) under a 12 h light/dark cycle. Rats in group A which served as control were given 10 ml/kg/day of distilled water for 21 days. Rats in group B, C, and D (Cadmium Nitrate group) were given 150 mg/kg/bw cadmium nitrate, 225 mg/kg/bw of cadmium nitrate and 300 mg/kg/bw of cadmium nitrate administered orally through an orogastric cannula into the stomach via the esophagus,

once a day respectively, for Twenty one (21) consecutive days. The average daily oral intake of cadmium by non-smokers living in unpolluted areas was estimated to 10–25 µg [24] while in Laboratory animals oral LD50 values for mice and rats range from 60 to over 5000 mg/kg of body weight [25]. All experimental investigations were done in compliance with humane animal as stated in the "Guide to the care and use of Laboratory Animals Resources". National Research Council, DHHS, Pub.No NIH 86-23 [26] and in accordance with the guideline and approval of Nigeria Medical Ethical Association for Accreditation of Laboratory Animal Care.

2.2 Animal Sacrificed and Sample Extraction

Twelve hours(12 hours) after the administration of the last cadmium nitrate, the rats were at the time of sacrifice first weighed and then cervical dislocation was carried out following ethical humane animal euthanasia which was adopted with expertised cervical dislocation. The abdominal cavity of each rat was opened up through a midline thoracic incision to expose the heart. The heart was excised and weighed; the heart was weighed with an electronic analytical and precision balance. The heart of each animal was fixed in 10% formol-saline for histological examination. [BA 210S, d=0.0001- Sartoriusen GA, Goettingen, Germany].

2.3 Histological Procedures and Analysis

This was done as described by Ogunlade et al. [27]. Briefly, the organs were cut on slabs about 0.5 cm thick and fixed in 10% formol saline for a day after which they were transferred to 70% alcohol for dehydration. The tissues were passed through 90% alcohol and chloroform for different durations before they were transferred into two changes of molten paraffin wax for 20 min each in an oven at 570 C. Serial sections of 5 µm thick were obtained from a solid block of tissue and were stained with haematoxylin and eosin stains, after which they were passed through a mixture of equal concentration of xylene and alcohol. Following clearance in xylene, the tissues were oven- dried. Photomicrographs were taken with a JVC colour video digital camera (JVC, China) mounted on an Olympus light microscope [Olympus UK Ltd, Essex, UK] to demonstrate the liver damage.

2.4 Statistical Analysis

Data are expressed as mean ± S.D. Statistical analyses were perfumed with SPSS software. $P < 0.05$ was considered statistically significant. Overall Differences between groups were determined by one-way ANOVA.

3. RESULTS

3.1 Mean Body Weights, Heart Weights in Experimental and Control Rats

As showed in Table 1: It indicates the average body weights of the rats before and after the experiment. The control rats gained weights significantly ($p<0.05$) from the beginning of the experiment to the end of the experiment. Body weights of experimentatyl rats decreased as compared to the control group. The mean heart weight of the rats significantly increased as compared to the control (Table 2).

Table 1. This table shows mean body weight and standard deviation of the experimental and control rats

Groups	Day 7 (Mean±S.D)	Day 14 (Mean±S.D)	Day 21 (Mean±S.D)
A (control)	118±8.19	182±9.11	202±8.94
B	160±62.60	150±7.38*	156±3.57
C	138±5.39	162±3.34	178±5.90*
D	174±67.00	136±4.32	146±5.21*

*Value are expressed as n=5 mean±SEM *p<0.05*

Table 2. This table shows heart weight in experiment and control rats

Parameter	Group A (control)	Group B	Group C	Group D
Liver weight	0.43±0.03	0.49±0.03*	0.54±0.04*	0.58±0. 05*

*Value are expressed as n=5 Mean±SEM *p<0.05*

3.2 Heart Histology

Fig. 1 shows the photomicrograph of the heart from control (group A) rats. Heart histology of the control rats revealed a normal appearance showing normal nucleus, connective tissue also appeared normal and the cardiac muscle fibers are well arranged.

Fig. 2 shows the photomicrograph of the heart from (group B) rats. Heart histology of the rats revealed elongations of the nucleus and slight inflammations of myocardium.

Fig. 3 shows the photomicrograph of the heart from (group C) rats. Heart histology of the rats shows shrinkages and elongated of the nucleus and there are slight inflammations in the myocardium connective tissue.

Fig. 4 shows the photomicrograph of the heart from (group D) rats. Heart histology of the rats shows distortions and deformation of the nucleus and there are inflammations and congestions of the myocardium connective tissue.

3.3 Photomicrograpy Demostrations

3.3.1 Group A (control)

Photomicrographs of the heart of experimental animal administered 10 ml/kg/day of distilled water as control.

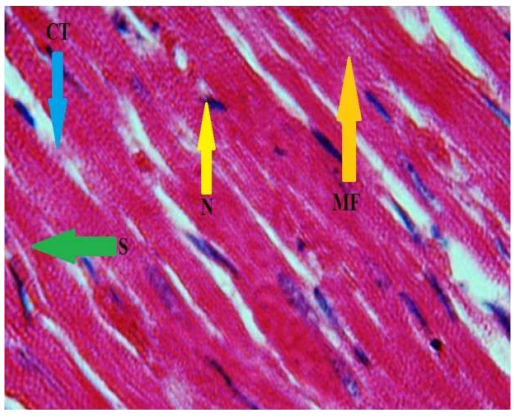

Fig. 1. Histological demonstration of the photomicrograph of longitudinal section of the heart at light microscope level using H & E staining techniques [X400] showing, normal Nucleus (N, yellow arrow), normal space striation (S, green arrow), normal connective tissue (CT, blue arrow), normal muscular fibre (MF, orange arrow) were well arranged

3.3.2 Group B

Photomicrographs of the heart of experimental animal administered 150 mg/kg/bw cadmium nitrate for twenty one days.

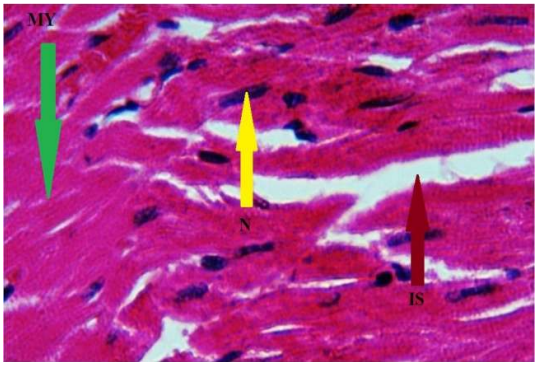

Fig. 2. Histological demonstration of the photomicrograph of longitudinal section of the heart at light microscope level using H & E staining techniques [X400] showing, elongated nucleus (N, yellow arrow), interstitial stroma (IS, brown arrow), myocardium(MY, green arrow). The nucleus is elongated and there are slight inflammations in the myocardium

3.3.3 Group C (225)

Photomicrographs of the heart of experimental animal administered 225 mg/kg/bw cadmium nitrate for twenty one days

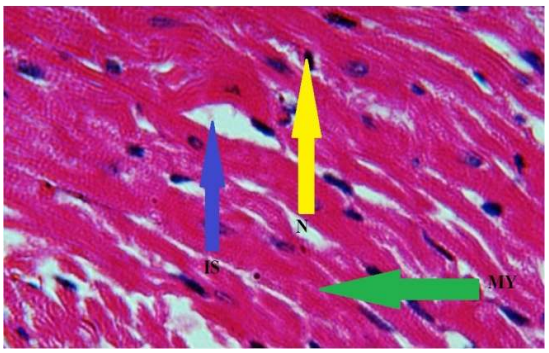

Fig. 3. Histological demonstration of the photomicrograph of longitudinal section of the heart at light microscope level using H & E staining techniques [X400] showing, nucleus (N, yellow arrow), interstitial stroma (IS, blue arrow), myocardium(MY, green arrow). There are shrinkages and elongated of the nucleus and there are slight inflammations in the myocardium

3.3.4 Group D

Photomicrographs of the heart of experimental animal administered 300 mg/kg/bw cadmium nitrate for twenty one days.

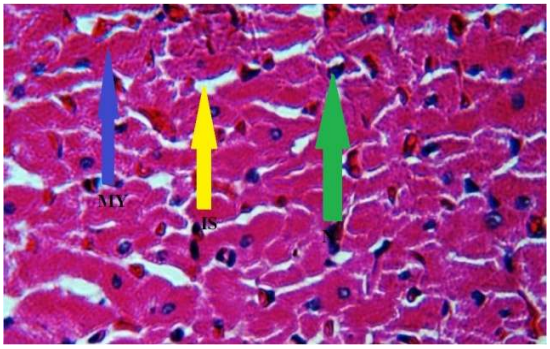

Fig. 4. Histological demonstration of the photomicrograph of longitudinal section of the heart at light microscope level using H & E staining techniques [X400] showing, nucleus (N, green arrow), interstitial stroma (IS, yellow arrow), myocardium (MY, blue arrow). There are shrinkages and deformation of the nucleus and there are inflammations and congestions of the myocardium

4. DISCUSSION

Heavy metals are individual metals and metal compounds that can impact human health [1]. Health problems have been widely reported due to long-term ingestion of contaminated drinking water with heavy metals. Pollution of water bodies with heavy metals from variety of sources is becoming a matter of global concern [28]. Though effects of chemical contamination of drinking water are not felt on short-term basis (except nitrate), their accumulation over a long period in the body has significant health effects [29]. Present study examined the effects of Oral Administration of cadmium nitrate on heart histomorphology of adult wistar rats. Present study revealed changes in histomorphology of the heart sections of adult wistar rats in dose dependent following the oral administration of cadmium Nitrate treated rats compared with the control rats. These observations are supported by earlier findings of Ogbonnia et al. [30] which reported that degenerative changes were observed in the heart tissue of mice following subchronic administration of high doses of chromolaena odorata administration. Administration of aflatoxin-B1 (AFB1) to rats resulted in cardiac damage [31].

Fig. 1 shows the photomicrograph of the heart from control (group A) rats. Heart histology of the control rats revealed a normal appearance showing normal nucleus, connective tissue also appeared normal the cardiac muscle fibers are well arranged.

Fig. 2 shows the photomicrograph of the heart from (group B) rats. Heart histology of the rats revealed elongations of the nucleus and slight inflammations of myocardium.

Fig. 3 shows the photomicrograph of the heart from (group C) rats. Heart histology of the rats shows shrinkages and elongated of the nucleus and there are slight inflammations in the myocardium connective tissue.

Fig. 4 shows the photomicrograph of the heart from (group D) rats. Heart histology of the rats shows distortions and deformation of the nucleus and there are inflammations and congestions of the myocardium connective tissue.

This is in accordance as reported by Ajibade et al. [32] Some Morphological Findings on the heart of adult wistar rats following experimental artesunate administration caused distortions, disaggregation, vacuolations of the heart muscles tissue. The heart weight significantly increased in treated group while compared with the control group. The observed increased in the heart weights of the treated rats is in agreement with the findings of Izunya et al. [33] and Ajibade et al. [32] that recorded significant increased in hearts weights of the wistar rats following chloroquine and artesunate administration. Inflammations, distortions, congestions, and degenerative changes in myocardial tissue are due to the toxic effects observed following the oral administration of cadmium Nitrate.

5. CONCLUSION

We therefore concluded that Inflammations, distortions, congestions, and degenerative changes in myocardial tissue and increased in heart weight may lead to cardiovascular dyfunctions.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All the authors hereby declare that all the experiments have been examined and approved

by the appropriate ethics committee and have therefore been performed in line with the ethical procedure laid down in 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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