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Hepatoprotective Effects of Ethanol Extract of *Platycerum bifurcatum* in Lead Acetate Induced Oxidative Damage in Albino Rats

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ABSTRACT

This study evaluated the hepatoprotective effects of ethanol extract of *Platycerum bifurcatum* in lead acetate induced oxidative damage. Thirty male albino rats of mean weight 120 g were divided into 5 groups of six rats each. Groups 1 - 3 served as normal control, lead acetate control (100 mg/kg body weight), extract group only (400 mg/kg body weight), and while groups 4 and 5 were lead acetate induced groups treated with 200 and 400 mg/kg body weight of ethanol extract of *Platycerum bifurcatum* respectively. Treatment lasted for 28 days, after which the animals were sacrificed under mild ether anaesthesia. Blood samples were collected for biochemical analysis. The result from the study showed that there was statistically significant ($p< 0.05$) decrease in the concentration of ALT, AST, ALP, total bilirubin and albumin in the treated groups, when compared with the lead acetate untreated group. Also, there was statistically significant ($p< 0.05$) increase in the concentration of total protein in the treated groups, when compared with the lead acetate untreated group. These findings indicate that ethanol extract of Platycerum bifurcatum possesses hepatoprotective effects in lead acetate induced oxidative damage in albino rats, and thus could be utilized pharmacologically in the management and treatment of oxidative damage and organ toxicity.

Keywords: Hepatoprotective, *Platycerum bifurcatum*, Lead acetate, Oxidative damage, Alanine aminotransferase, Aspartate transaminase.

1. Introduction

Lead (Pb), a toxic heavy metal, poses a significant threat to human health on a global scale[1]. This insidious substance exists in various forms and sources, including food and air pollution[2]. It exacts a toll on multiple vital organs, ranging from the brain and kidneys to hematopoietic tissues[3]. As lead-contaminated food

and water are absorbed through the duodenum, more than 95% of lead binds to erythrocyte proteins and is stored in internal organs, particularly the liver[4]. One of the key mechanisms implicated in lead-induced toxicity is oxidative stress, an imbalance between oxidant and antioxidant systems due to the excess production of reactive oxygen species (ROS). This unchecked generation of ROS by lead exposure leads to mitochondrial impairment and cell damage[5]. In response to lead toxicity, various heavy metal chelating agents have been employed as therapeutic drugs, but they come with side effects[6].

In this context, the study explores the potential of *Platycerium bifurcatum*, commonly known as the "staghorn fern," to mitigate liver function impairment caused by lead toxicity. This unique plant, naturally found in the canopies of tropical and subtropical forests, has gained recognition for its medicinal properties and antioxidant potential[7,8]. It is traditionally employed in Nigeria for various therapeutic purposes, such as addressing ulcers and preventing miscarriages[9,10]. The antibacterial properties of this fern have been well-documented, with activity against clinical strains of *Escherichia coli*, *Staphylococcus aureus*, and *Klebsiella spp*. Furthermore, *Platycerium bifurcatum's* antioxidative potential, linked to its rich phenolic content, makes it a promising candidate for addressing lead-induced oxidative stress[11]. Notably, the chloroform fraction of this plant has demonstrated antioxidant properties comparable to ascorbate[12].

This study embarks on an exploration of the potential of *Platycerium bifurcatum* in alleviating liver function impairment induced by lead toxicity in Wistar albino rats. By examining the potential of this plant to safeguard the liver in concomitant administration of lead, this research aspires to deepen our comprehension of lead-induced health challenges and to unravel the promising avenues offered by natural remedies, with a particular emphasis on *Platycerium bifurcatum*.

2. Materials and methods

2.1. Collection and identification of specimen

Fresh frond (leave) and stalk of *Platycerium bifurcatum* were collected in the mangrove vicinity of university of Lagos and was identified and authenticated by a Taxonomist, Dr. Akinnibosun Henry Adewale in the department of Plant Biology and Biotechnology, University of Benin, and given a voucher number UBH-A650.

2.2. Preparation of sample and extraction

Fresh frond (leaves) of *Platycerium bifurcatum* were rinsed in running tap water to remove debris and then air dried under shade for two weeks. The leaves were pulverized using a mechanical blender to coarse powder. Three hundred (300) g of pulverized sample was macerated in 2100 ml of ethanol and shaken severally. After 72 hours, total extract obtained were filtered using a muslin cloth and subsequently with Whattman filter paper No. 1 (125 mm). Filtrate was obtained after concentration using a rotary evaporator at 45°C to obtain the crude extract.

2.3. Experimental design

Thirty (30) wistar albino rats of mean weight 120 g were purchased from the animal facility Centre of the Faculty of Pharmaceutical Science, University of Nigeria Nsukka. The animals were allowed to acclimatize for two weeks prior to start of experiment, at the animal facility Centre of the Department of Biochemistry, Michael Okpara University of Agriculture, Umudike, with access to standard rodent feed and water ad libitum.

The animals were fasted overnight and randomly distributed into five groups of six rats each. Among the five (5) groups of animals, Group I received only food and water serving as normal control, while group 2 received lead acetate only (100 mg/kg body weight), group 3 received extract only (400 mg/kg body weight), Group 4 received lead acetate and extract (200 mg/kg), and Group 5 received lead acetate and extract (400 mg/kg body weight). Treatment lasted for 28 days after the animals were sacrificed under mild ether anaesthesia, blood samples were collected for biochemical analysis.

3. Evaluation of In Vitro Antioxidant Activity

2,2-diphenyl-1-picrylhydrazine (DPPH) scavenging activity was carried out as described by[13]. FRAP assay was carried out following the method described by[14,15].

3.1. Evaluation of in vivo antioxidant activity

The activity of catalase was assayed by the method of [16]. Superoxide dismutase activity was assayed by the method of[17] as contained in Randox kit. Estimation of glutathione peroxidase was done according to the method of[18]. Estimation of reduced glutathione was determined by the method of[19]. Estimation of malondialdehyde (MDA) concentration was estimated by measuring spectrophotometrically the level of the lipid peroxidation product, malondialdehyde (MDA) as described by[20].

4. Statistical Analysis

All data were treated statistically using Statistical Package for Social Science (SPSS) (Version 20). The data are expressed as mean ± standard deviation using bar charts. Comparisons were made between the control and test groups using the one-way analysis of variance (ANOVA) and multiple comparisons (Tukey) at $p \leq 0.05$ level of significance.

5. Results

5.1. Result of liver function assay

There was a significant ($P<0.05$) decrease in ALT for all extract treated groups when compared to the lead acetate control group **(Figure 1)**.

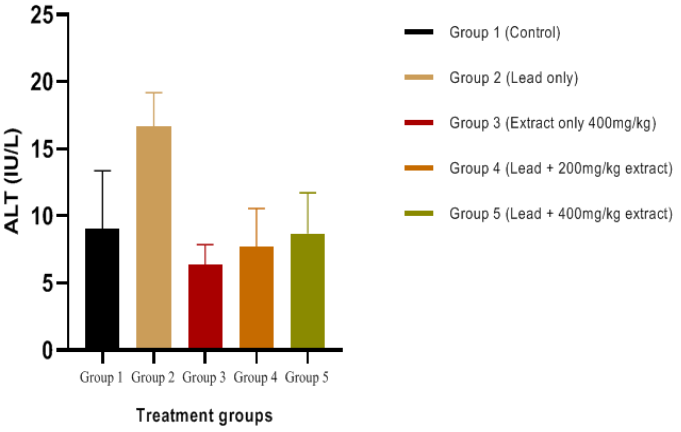

Figure 1: Effect of administration of crude extract of *Platycerium bifurcatum* on ALT activity.

There was a significant (P<0.05) decrease in AST for all extract treated groups when compared to the lead acetate control group **(Figure 2)**.

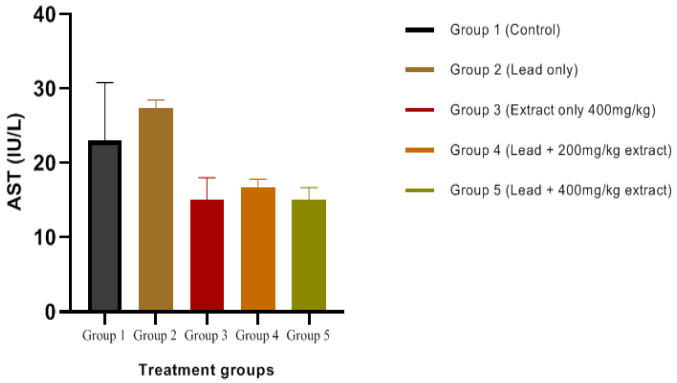

Figure 2: Effect of administration of crude extract of *Platycerium bifurcatum* on AST activity.

There was a significant (P<0.05) decrease in ALP for all extract treated groups when compared to the lead acetate control group.

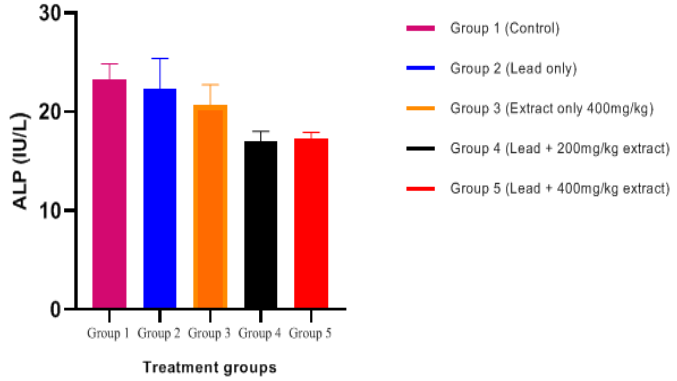

Figure 3: Effect of administration of crude extract of *Platycerium bifurcatum* on ALP activity.

There was a significant (P<0.05) decrease in total bilirubin (TB) for all extract treated groups when compared to the lead acetate control group **(Figures 4-6)**.

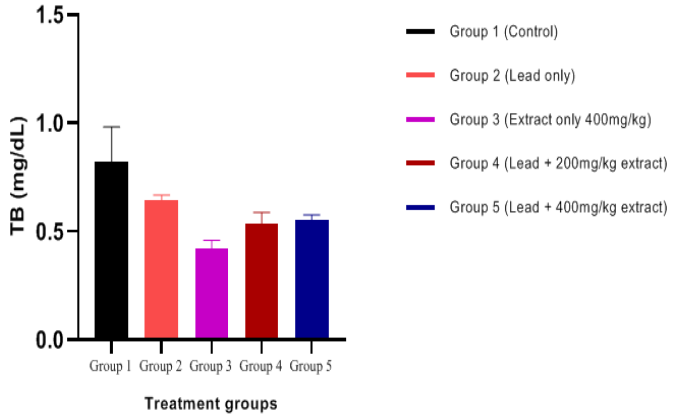

Figure 4: Effect of administration of crude extract of *Platycerium bifurcatum* on Total bilirubin concentration.

5.2. Histopathological examination of the liver

The histopathological examination of the liver showed variable necrosis for all groups except group 5 which showed the normal liver histomorphology. The lead only treated group **(Figure 8)** showed multifocal hepatocellular necrosis. There is also mild infiltration of anti-inflammatory leukocytes in group 1, 2, 3 and 5 **(Figures 7-9, 11)**.

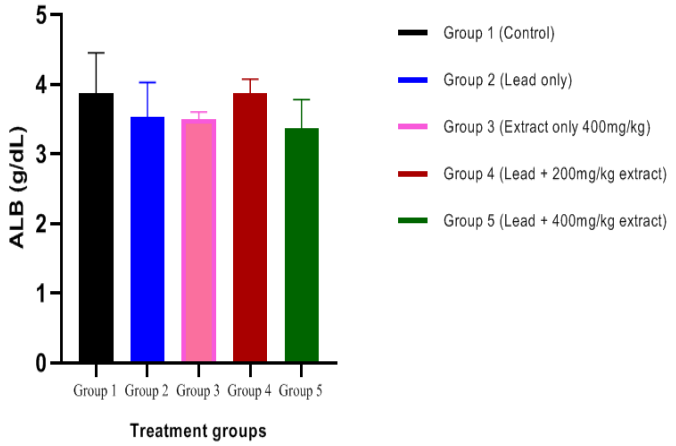

Figure 5: Effect of administration of crude extract of *Platycerium bifurcatum* on Albumin concentration.

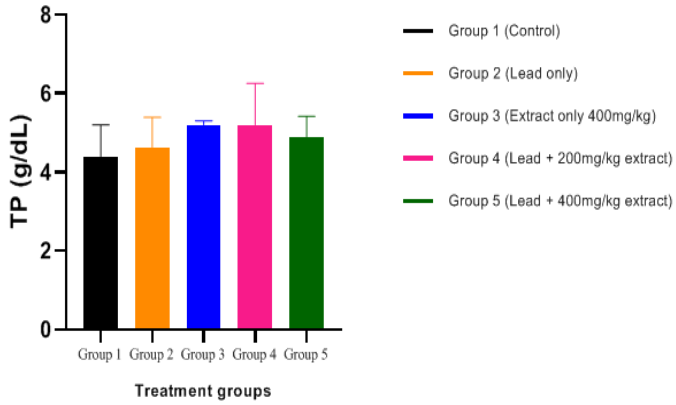

Figure 6: Effect of administration of crude extract of *Platycerium bifurcatum* on Total protein concentration.

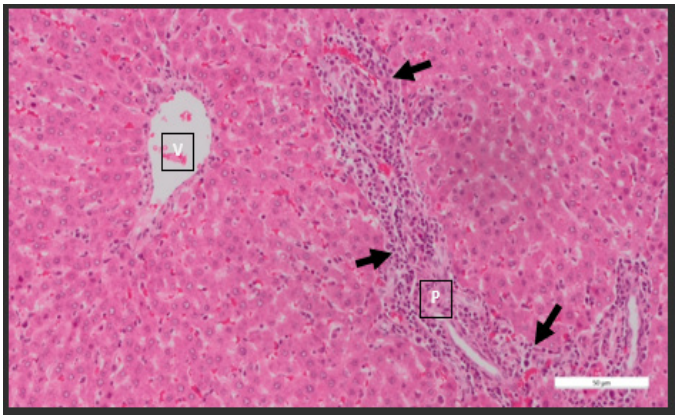

Figure 7: Histopathology of liver for group 1.

The sections of the liver presented in group 1 showed piecemeal necrosis with moderate periportal infiltration of inflammatory leukocytes (arrow). Central vein (V), Portal triad (P).

The sections of the liver presented in group 2 showed multifocal areas of hepatocellular necrosis with mild to moderate infiltration of inflammatory leukocytes (arrow). Portal triad (P).

The sections of the liver presented in group 3 showed mild, random, areas of hepatocellular necrosis (red arrow). Also, periportal piecemeal necrosis with mild infiltration of inflammatory leukocytes were observed (black arrow). Central vein (V), Portal triad (P).

The sections of the liver presented in group 4 showed the normal hepatic histomorphology. Central vein (V), portal triad (P).

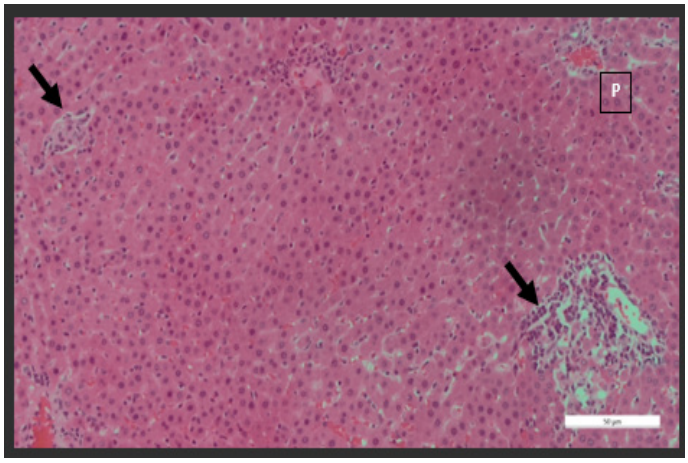

Figure 8: Histopathology of liver for group 2.

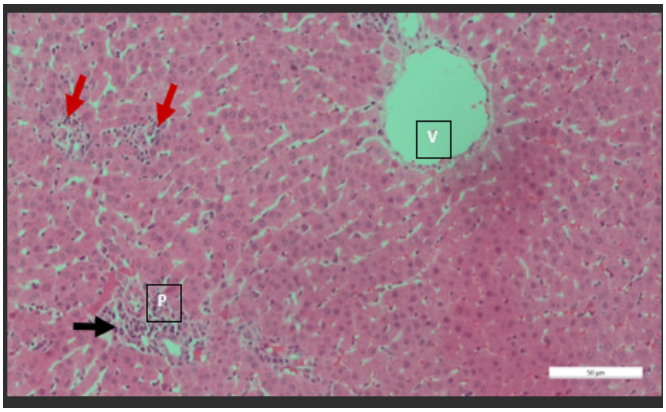

Figure 9: Histopathology of liver for group 3.

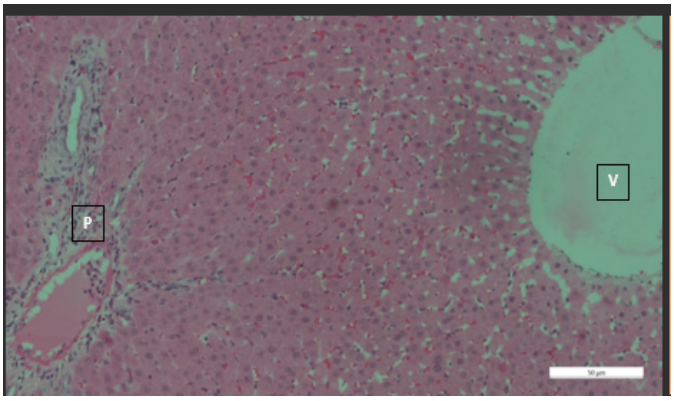

Figure 10: Histopathology of liver for group 4.

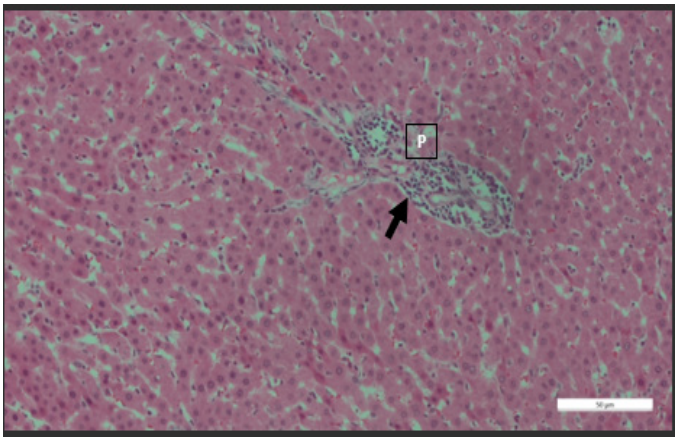

Figure 11: Histopathology of liver for group 5.

The sections of the liver presented in group 5 showed mild, periportal piecemeal necrosis with mild infiltration of inflammatory leukocytes were observed (black arrow). Portal triad (P).

6. Discussion

Lead is a ubiquitously found environmental and industrial pollutant that has been detected in nearly all phases of environment and biological system. Its persistence in human and animal tissues has quite often been associated with considerable health risks[21]. In the present study, the impact of lead in tissues of liver were significantly higher in lead acetate treated group than controls and groups administered with extracts. Also, multifocal necrosis of the hepatocytes was observed in lead treated group **(Figure 8)**. In addition to necrosis, inflammatory leukocytes infiltration was noticed in some other cases. Ingestion of lead is one of the primary causes of hepatotoxic effects. The necrosis observed in the control group may be due to other factors that may not have been easily identified or controlled. The molecular understanding of lead effects on hepatic drug metabolizing enzymes, cholesterol metabolism, oxidative stress, and hepatic hyperplasia suggest a potential role for lead in damaging extrahepatic systems, including the cardiovascular system. Groups treated with lead acetate and low dose of crude extract of *Platycerium bifurcatum* extract showed normal histopathology of the liver when compared to the control and lead acetate treated groups, representing a good sign of regeneration[22]. Also, similar results were reported by[23] who demonstrated that treatment with Quercetin, the major flavonoid component of *Platycerium bifurcatum*[24], by oral administration significantly protects the liver after alcohol induced liver injury, possibly through its antioxidant, anti-inflammation and anti-apoptosis effects by STAT3, Akt and NF-κB pathway.[25] found a significant higher levels of lead in liver of rats exposed to Pb for 4 weeks and a significant reduction of lead levels after treatment with chelating agent, EDTA, during 5th week[26-28] reported that Chlorogenic acid, a natural phenolic product and major constituent of *Platycerium bifurcatum* plays an increasingly positive role in removing the toxicity of heavy metals owing to its antioxidative activity and metal-chelating properties. We suggest one possibility that *Platycerium bifurcatum* complexes with lead ion decreasing its lipophilicity, and thus its gastrointestinal absorption. The chelating agents form an insoluble complex with Pb to remove it from Pb-burdened tissues[29]. This means that, the more lead is chelated from circulating freely in the biological system, the less impact it will have on organs[30] found sodium molybdate supplementation provide significant protection from Pb uptake by blood, liver and kidney. The liver enzyme assays indicated that lead acetate ingestion induced a significant elevation of plasma ALT, AST and ALP levels at four weeks of lead acetate treatment. Since aminotransferases (ALT and AST) are an important class of enzymes linking carbohydrate and amino acid metabolism, the relationship between the intermediates of the citric acid cycle is well established. These enzymes are regarded as markers of liver injury. The observed result showed that the administration of *Platycerium bifurcatum* extract doused the influence lead had on ALT and AST, however statistical evaluations of the result showed non-significance. This may be as a result of the dose of extract used, thus, there may be a more significant influence of *Platycerium bifurcatum* extract on ALT and AST levels altered by lead at higher doses.

In addition, ALP is membrane bound and its alteration is likely to affect the membrane permeability and produce derangement in the transport of metabolites. Moreover, elevated ALP activity, which was used as a marker of liver adaptation to

damaging factors, has been reported frequently in lead exposed animals[31,32]. The findings from this study showed a significant decrease in ALP levels indicating ameliorative effect of the extract on the impact of lead when administered. It is well known that lead binds to plasmatic proteins, where it causes alterations in a high number of enzymes. It can also perturb protein synthesis in hepatocytes[33]. It was observed that the administration of lead and co-administration of lead and extract did not show any significant alteration of the synthetic capacity of the liver. Again, this may be as a result of the doses administered for both the toxicant and treatment intervention. However, there was a significant reduction in bilirubin level **(Figure 4)**. Overall, the study showed that Platycerium bifurcatum offer mild protective ability to the liver in the case of lead toxicity.

7. Conclusion

This study indicates that *Platycerum bifurcatum* mitigates liver function impairment induced by lead toxicity in wistar albino rats. Lead being a heavy metal can accommodate in the biological system through exposure to environment and it has an impact on the liver which is a vital organ responsible for various metabolic processes. The result of this study indicates that the phytochemicals present in the plant could be a potential source of therapeutic agent in management of lead induced liver toxicity.

8. Ethical Approval

The authors hereby declare that "Principles of laboratory animal care" (NIH Publication No. 85- 23, revised 1985) were followed in this study, as well as specific national laws, where applicable. All experiments were examined and approved by the appropriate ethical committee.

9. Acknowledgement

We sincerely appreciate the Department of Biochemistry, College of Natural Sciences, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria for providing the facility for this study.

10. Conflicts of Interest

The authors declare that they have no conflict of interest.

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