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Effect of Garlic (*Allium Sativum*) Oil on Liver Functions in Lead Acetate Exposed Female Wistar Rats

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Abstract

Introduction: Lead is one of the most toxic heavy metals that humans are often exposed to, making it a metal of public health concern, its exposure has been reported to be toxic to many organs especially the liver which is involved in its detoxification. This study aims to determine the effect of garlic (*Allium sativum*) oil on liver functions in Lead exposed rats.

Methods: A randomized block design was adapted for this study, with 20 Adult Female wistar rats randomly placed into 5 groups of 4 rats each. With group 1 being control treated with 1ml N/S only and group 2 treated with 50mg/kg lead acetate (LA) without garlic oil (GO). While groups (3, 4 and 5) in addition to 50mg/kg (LA) each was treated with 15mg/kg, 30mg/kg and 60mg/kg (low, medium and high dose (LA) respectively. A comparative hepatoprotective effect of (GO) at the various regimen of concentration was observed against the (LA) induced liver damage. Effects were observed as changes in levels of hepatocellular enzymes (AST, ALT, and ALP) as well as histological changes in the liver cells and variations in weights of the wister rats. ANOVA and Turkey was used to test significant difference at 95% confidence level using SPSS version 26.0.

Results: Results showed that treatment with lead in Group 2 reduced the percentage weight gain relative to control, while GO treatment ameliorated with the weight loss. Histology slides revealed severe portal hepatocellular degeneration, necrosis and inflammation in rats treated with Lead acetate, while treatment with GO reduced the severity of liver damage. Biochemical assay showed that treatment with lead acetate significantly increased serum levels of AST, ALT and ALP and treatment with GO reduced the level of these liver enzymes in a dose dependent manner.

Conclusion: This finding suggests that garlic oil exhibited hepatoprotective properties by ameliorating the liver structural damage and reducing serum AST, ALT and ALP. GO also mitigated lead induced body weight loss. Populations at risk of exposure to lead should be advised to take garlic oil.

Keywords: Hepatocellular enzymes; Garlic oil; Lead; Wister rats

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1. Introduction

Hepata is the Greek word for liver. Terms referring to the liver frequently begin with hepato or hepatic. Because the body relies on the liver to regulate, synthesise, store, and secrete many essential proteins, nutrients, and chemicals as well as to purify and clear toxins or unnecessary substances from the body, the liver plays an important role in mechanism, secretion, and storage. (Arige *et al*., 2017). The liver is one of the largest and most important organs of the human body; it is the main organ for the detoxification and metabolism of drugs. Other functions of the liver include nutritional homeostasis, cholesterol, and glucose metabolism, and synthesis of clotting factors (Bischoff *et al*., 2018; Al-Megrin *et al*., 2019). These functions have exposed it to the toxic effect of drugs and chemicals as a result of ingestion or other means of exposure to the chemicals. These toxic agents can be deleterious to the role of the liver as a detoxifying organ (Alhusaini *et al*., 2019). This chemical works by attacking functional macromolecules such as lipid, protein, and nucleic acids, either through the generation of free radicals, depletion of antioxidant molecules, inflammation, and apoptosis (Hsu *et al*., 2002; Sabath *et al*., 2012; Abdelhamid *et al*., 2020). Some distortion in liver tissue includes damage to the membrane of the hepatocyte and organelles leading to swelling, damage, and necrosis. Health challenges and death from liver disorders are on the rise globally (Al-Dbass *et al*., 2012). Some of the common liver diseases include biliary disease, hepatitis B and C, and alcoholic liver disease. A total loss of liver function could leads to death within minutes, demonstrating the liver‘s great importance (Ozougwu *et al*., 2014).

Lead is one of the most toxic heavy metals that humans are often exposed to, making it a metal of public health concern. Lead exposure has been reported to be toxic to most organs, such as the liver, kidney, heart, brain, testes, and hematopoietic tissues (Abdel *et al*., 2012; Basgen *et al*., 2014, Mujaibel., 2015; Assi *et al*., 2016) Exposure to lead can be through various routes-orally through ingesting food and water contaminated with lead, inhalation of polluted air, from dust, burning fuel, and fossil. Due to the colorless and odorless nature of lead, it persists for a longer time in the environment. It can only be detected at a very high concentration, a stage where it becomes harmful to the environment and living organisms including humans. Sources of lead poison include contaminated food and water, lead-containing paint and gasoline, industrial emission (Wu X *et al*., 2016; Al-Megrin *et al*., 2019). Mudipalli *et al*., (2007) reported that the liver is the main storage organ of lead accumulation. More than 33% of accumulated lead in the human body is found in the liver, followed by the kidney. The animal experiment involving lead hepatotoxicity has shown that lead exposure altered enzymes and molecules involved in the metabolism of xenobiotics, metabolism of cholesterol, and liver hyperplasia. The toxicity of lead has been reported to cause liver injury, osteoporosis, neurological disorders, and cardiovascular diseases (Alhusaini *et al*., 2019). The accepted mechanism of lead toxicity is oxidative stress (Al-Megrin *et al*., 2019; Alhusaini *et al*., 2019; Chen *et al*., 2019; Abdelhamid *et al*., 2020; Adli *et al*., 2020). This is often achieved by generating free radicals and depleting the antioxidant systems. Lead has been reported to replace the cations in enzymes and proteins resulting in loss of activities and functions respectively (Flora *et al*., 2006). Some of the macromolecules oxidized by lead include lipids (measured as malonedialdehyde (MDA), reduced glutathione (GSH), and antioxidants such as superoxide dismutase (SOD) and catalase (SOD).

The role of natural products in combatting the toxic effects of heavy metals and other poisonous chemicals is on the rise. Since the major mechanism of lead toxicity is oxidative stress, natural products rich in antioxidants can be a good antidote against lead poison and can be used along with common lead chelators. Several compounds from natural products with confirmed antioxidant activities have been used as a hepatoprotective agent against lead poison (Al-Dbass *et al*., 2012; Alhusaini *et al*., 2019; Chen *et al*., 2019 Adli *et al*., 2020).

Garlic (*Allium sativum L*) is a bulb belonging to the Liliaceae family, which belongs to the Allium genus (Ramírez-Concepción *et al*., 2016). Garlic has been used since ancient times not only to flavor foods, but as a medicinal plant (Morales-González *et al*., 2019). The consumption of garlic has been linked to improved cardiovascular health. It can help lower blood pressure and reduce the risk of heart disease by preventing the formation of blood clots (Smith, 2020).To reap the benefits of garlic, it can be incorporated into one's diet by adding it to salads, sauces, and marinades. Garlic supplements are also available for those who prefer an alternative to fresh cloves (Rahman *et al*., 2019). Most of its health benefits are due to the presence of allicin molecules (Touloupakis and Ghanotakis, 2010; Varga-Visi *et al*., 2019). Therefore, the spread of information related to the preventive and curative properties of garlic along with its benefits to help fight various diseases and its benefits to human health, have greatly increased the consumption of this species (Fratianni *et al*., 2016). Garlic is consumed through-out the world. Thanks to its antioxidant properties and biological activities, it can be assigned such as one of nature’s wonderful plants with potential preventing and curing different diseases (Singh et.al., 2014). Indeed, *Allium Sativum* is well-known and widely spread for various biological activities (Gebreyohannes *et al*., 2013), especially the enhanced detoxification of foreign compounds, as well as the hepatoprotection, antimicrobial and antioxidant effects (Santhosha *et al*., 2013). Besides, it causes the prevention of liver damage in mice (Ali *et al.*, 2016). Studies of garlic reported the presence of two major classes of antioxidant components, such as flavonoids (Zaidi *et al*., 2015) and sulfur-containing compounds (diallyl sulphide, trisulphide and

allyle- cysteine) (Suleria et.al., 2015). The importance of garlic is largely based on organosulphurs, primarily responsible for the characteristic flavour and contributing to the beneficial health effects and antioxidant action (Mumtaz *et al*., 2020). Garlic comprises a remarkable source of novel chemical compounds characterized by medicinal properties, many of which have been used for the prevention of a large number of diseases along with oxidative damage by scavenging free radicals. One of the most important protective functions of garlic is to decrease the oxidative damage in liver. Chen *et al*., (2016) and Sayed *et al*., (2019) suggest that garlic offers protection against oxidative stress and prevents fatty liver and liver cirrhosis. Currently, despite the development of methods and techniques of physicochemical and biological analyzes, it remains interesting to know the composition of food plants compounds and their nutritional effects. The search for plant extracts rich in molecules, endowed with powerful antioxidant and measuring antioxidant activity in various media, still represents a considerable field of phytomedicine Amorati and Valgimigli study (Amorati et.al., 2018). Thus, the purpose of this study is to investigate the possible effect of garlic oil on the liver functions in lead acetate exposed wistar rats.

2. Material and methods

2.1. Procurement of experimental animals

A total of twenty (20) healthy female Wistar rats were purchased and housed in the Animal House of the College of Health Sciences, Benue State University, Makurdi for this research. The animals were handled according to the international guide for the care and use of animals (National Academy of Animal Science, 2011). They were divided into Five (5) groups of four rats each, and fed with rats feed (Vital feed, manufactured by Grand Cereal Limited) and water *ad libitum*. The rats were weighed at the beginning and end of the experiment using Kern PNS Balance (Model PNS 12000-1).

2.2. Animal cages

A total of 5 plastic cages of 30cm×20cm in size were obtained from the Animal House Facility in the College of Health Science, Benue State University, in which the experimental animals were housed, acclimatized and fed throughout the duration of the experiment.

2.3. Chemicals

Lead acetate. Manufactured by Kem Light Laboratories, Maharashtra, India. It was purchased from Noble Chemical store, Makurdi, Benue state, Nigeria

Garlic oil (garlic capsule 3mg) manufactured by SIRIO PHARMA CO., LTD, Taishan Road (West), Shantou, China. It was purchased from Rovi pharmacy, High level, Makurdi, Benue state, Nigeria.

2.4. Animal feed

The animal feed (Vital feed, manufactured by Grand Cereal Limited) and was purchased from feed store in Wurukum area of Makurdi, and stored at room temperature in the animal house.

2.5. Other Materials

Other materials include: hand gloves, sterile bottles, syringes and needles, dissecting board and kit, homogenizer (MXBAOHANG High Speed Homogenizer model: FSH-2A), distilled water, feeding plates and water bottles.

2.6. Experimental Design

Female Wistar rats were randomly divided into 5 groups of 4 rats each. The experiment lasted for fourteen (14) days.

2.7. Animal Grouping and Administration

- GROUP 1: The control group, rats in this group were treated with standard feed and distilled water only for 14 days.
- GROUP 2: This group was treated with 50mg/Kg/day of lead acetate dissolved in water, administered via gavage for two weeks daily.
- GROUP 3: This group was treated with 50mg/Kg/day of lead acetate. In addition, they were also treated with low dosage of garlic oil (15mg/kg) administered via gavage, four times a week for two weeks.

- GROUP 4: This group was treated with 50mg/Kg/day of lead acetate. In addition, they were also treated with medium dosage of garlic oil (30mg/kg) administered via gavage, four times a week for two weeks. GROUP 5: This group was treated with 50mg/kg/day of lead acetate. In addition, they were also treated with high dose garlic oil (60mg/kg) administered via gavage, four times a week for two weeks.

2.8. Measurement of Weight

The weight of all rats in each group were measured using an accurate Metler electronic balance (MT-2000) before and after the experiment.

2.9. Animals Sacrifice

At the end of the 14 days period, all the 20 rats were sacrificed under chloroform anaesthesia in accordance to the animal rights act. The organ of interest (the liver) was harvested and preserved with buffered formaldehyde (10%) in organ bottles for further analysis, and blood samples were drown by cardiac puncture and centrifuged at 3000 rpm for 15 minutes to harvest the serum with which the liver functions assessment were analyzed.

2.10. Histological Analysis

Tissue samples were fixed in 10% buffered formaldehyde and subsequently dehydrated through a series of ethanol solutions. The samples were then cleaned with xylene, embedded in paraffin, and sectioned to a thickness of 3 μm using a microtome. The sections were mounted on gelatinized slides and stained with hematoxylin and eosin (H&E) for examination under a light microscope (Optika B-350). Additionally, toluidine blue staining was performed for further analysis. Microscopic images were captured using a digital camera (Optikam B5) following the guidelines provided by Aeffner et al. (2018).

2.11. Serum Analysis for Liver Enzymes

Blood samples were drown via cardiac puncture and centrifuged at 3000 rpm for 15 minutes to harvest the serum with which the liver functions assessment were analyzed. The activities of Alanine aminotransferase(ALT), aspartate aminotransferase (AST) were determined in serum according to the methods described by Reitman and Frankel (1957). Serum alkaline phosphatase (ALP) activity was determined according to Kind *et al*., (1980).

2.12. Statistical Analysis

Differences in groups was determined using One-Way ANOVA with Tukey post hoc test. All test were carried out at 95% confidence level. Data were analyzed using SPSS version 20.0 software (International Business Machines Corporation). Results were presented using tables and charts. Values were mean ± SEM.

3. Results

3.1. Effect of Garlic Oil on Animal Body Weight

Results revealed that rats treated with lead acetate alone (Group 2) had a percentage weight change that was relatively lower to the control (group 1). Treatment with garlic oil increased the weight gain in rats in a dose dependent manner, but the differences were not significant ($P > 0.05$) as shown in Table 1

Table 1 Effect of Garlic Oil on Animal Body Weight

Groups	Weight before Experiment (g)	Weight after Experiment (g)	% Weight Change
Groups 1	102.10 ± 6.55	123.62 ± 6.19	21.59 ± 4.31
Groups 2	108.73 ± 8.40	126.28 ± 5.72	17.24 ± 5.17
Groups 3	104.92 ± 8.91	125.98 ± 10.91	20.23 ± 3.43
Groups 4	99.58 ± 6.96	120.18 ± 6.76	21.13 ± 2.77
Groups 5	99.63 ± 7.09	122.30 ± 7.99	23.20 ± 4.53

N= 4, values presented as mean ± SEM

3.2. Effect of Garlic oil on Liver Enzymes in Lead Treated Rats

3.2.1. AST

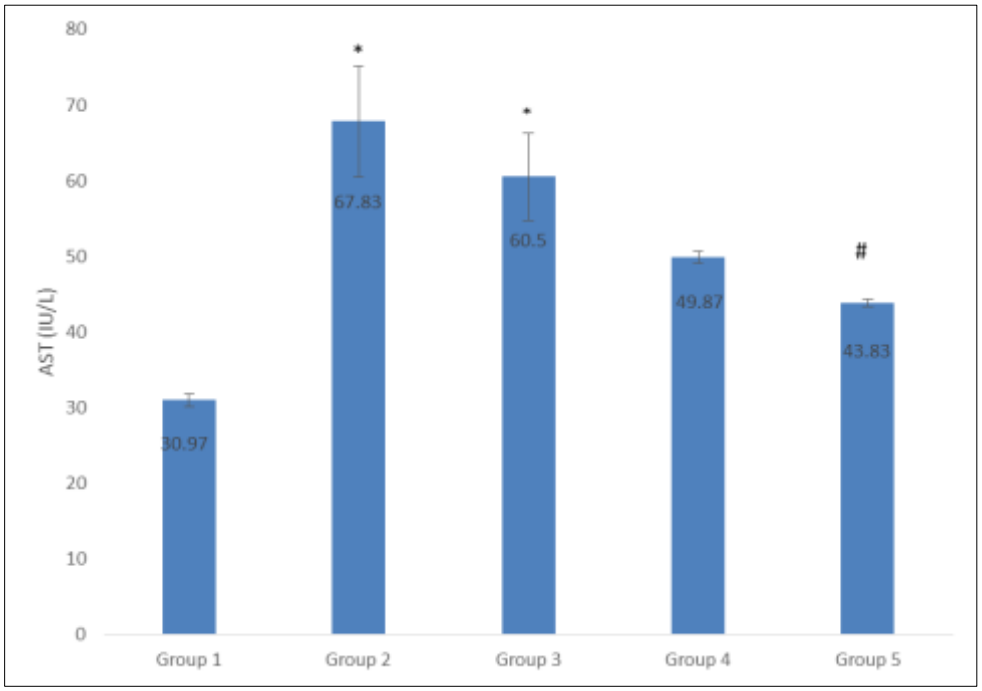
Results revealed that treatment with lead acetate alone (Group 2) significantly ($P < 0.05$) increased AST level relative to Control (Group 1). Treatment of the rats with garlic oil reduced the level of AST in a dose dependent manner and this was significant ($P < 0.05$) in rats treated with high dose garlic oil compared to Group 2 as shown in Figure 1.

3.2.2. ALT

Results revealed that treatments with lead acetate alone (group 2) significantly ($p<0.05$) increased the levels of ALT relative to the control (group 1). Treatment of the rats with garlic oil reduced the level of ALT in a dose dependent manner, however the reduction were not significantly ($P < 0.05$) when compared with rats in group 2 as shown in Figure 2.

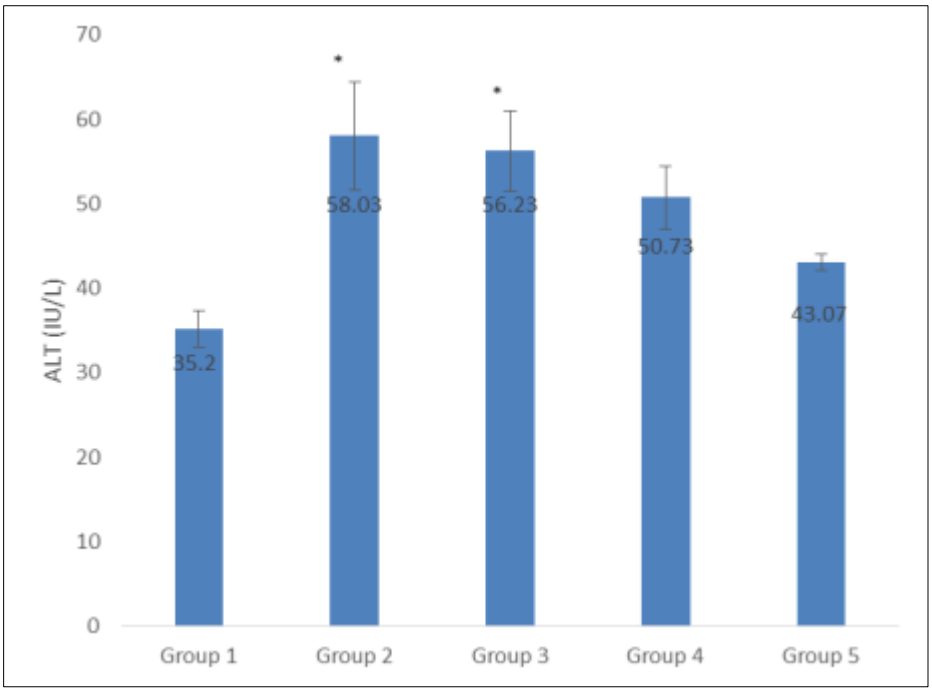
3.2.3. ALP

Result shows that treatment with lead acetate alone (group 2) significantly ($p<0.05$) increased ALP level relative to control group (group 1). Treatment of the rats with garlic oil reduced the level of ALP and this was significant ($p<0.05$) in rats treated with medium and high doses of garlic oil respectively relative to group 2 above shown in Figure 3.



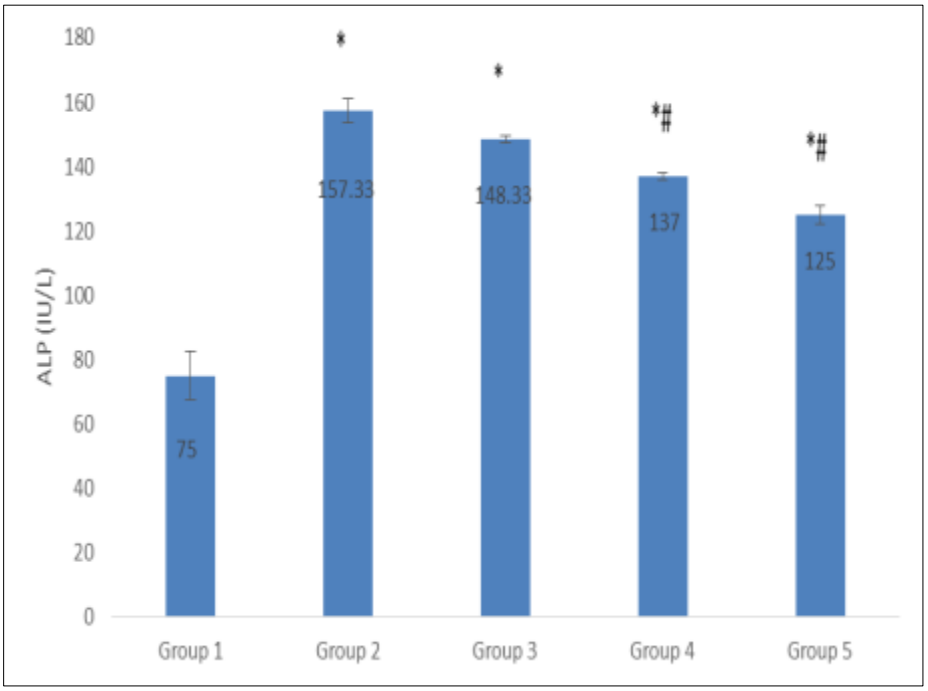
N = 3, values expressed as mean ± SEM, * = significant relative to Group 1 at $P < 0.05$, # = significant relative to Group 2 at $P < 0.05$.

Figure 1 Effects of garlic oil on plasma AST level in lead exposed rats



N = 3, values expressed as mean ± SEM, * = significant relative to Group 1 at P < 0.05.

Figure 2 Effects of garlic oil on plasma ALT level in lead exposed rats



N = 3, values expressed as mean ± SEM, * = significant relative to Group 1 at P < 0.05, # = significant relative to Group 2 at P < 0.05.

Figure 3 Effects of garlic oil on plasma ALP level in lead exposed rats

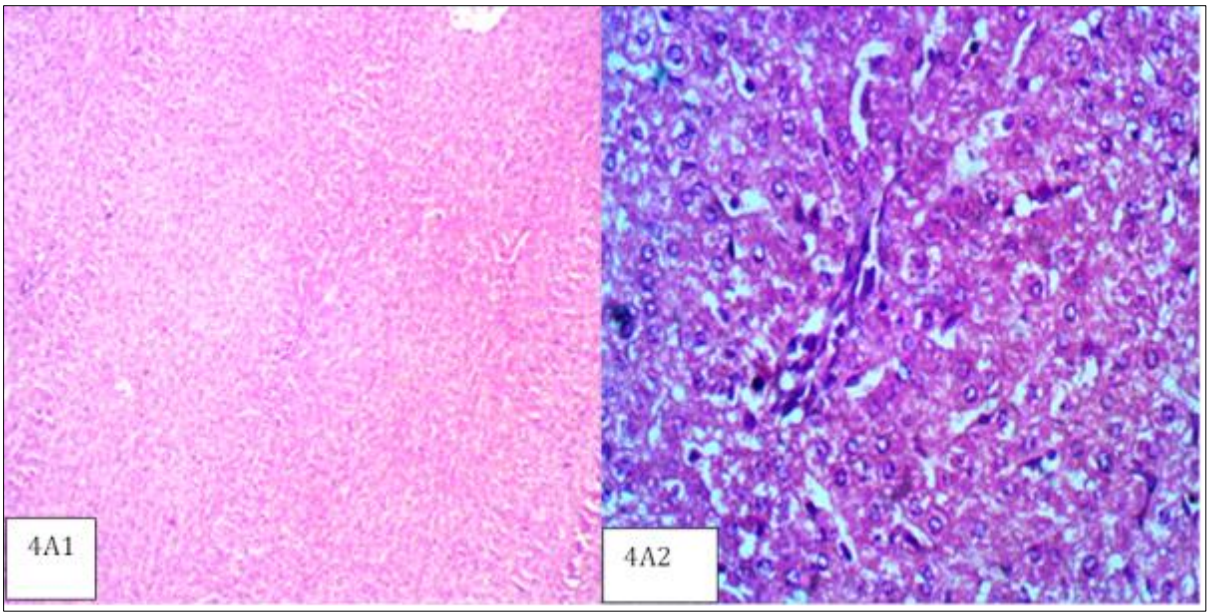


Figure 4 (4A1x 100, 4A2 x 400): HE light micrograph of liver sectional histology from control rats (group1). There is no observable lesion

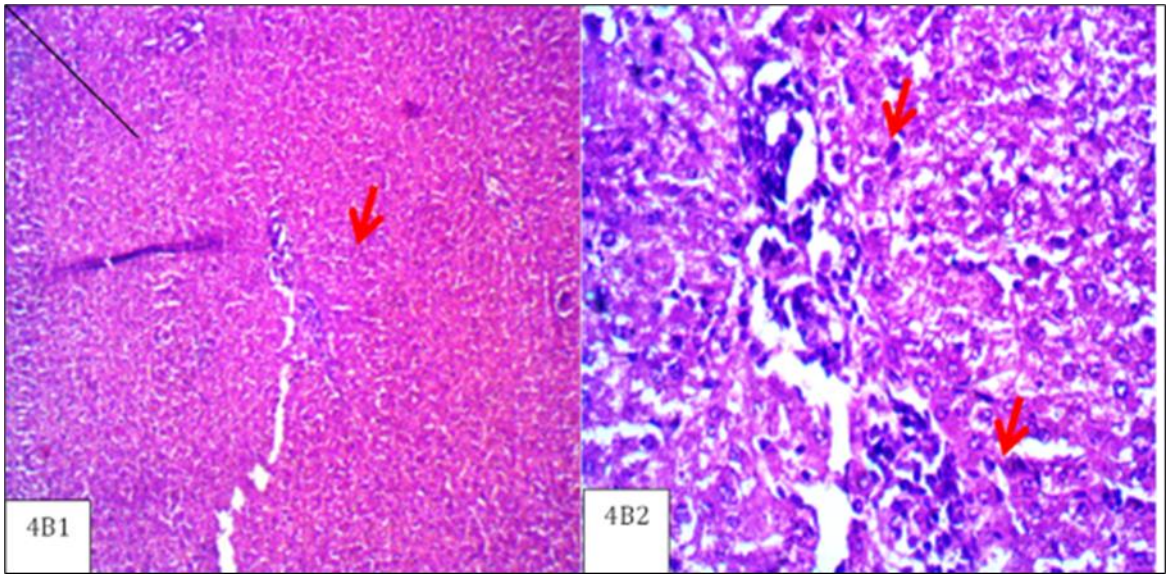


Figure 5 (4B1 x100, 4B2 x400): HE light micrograph of sections in the liver of lead acetate treated rats (Group 2). Severe portal hepatocellular degeneration, necrosis and inflammation (arrows)

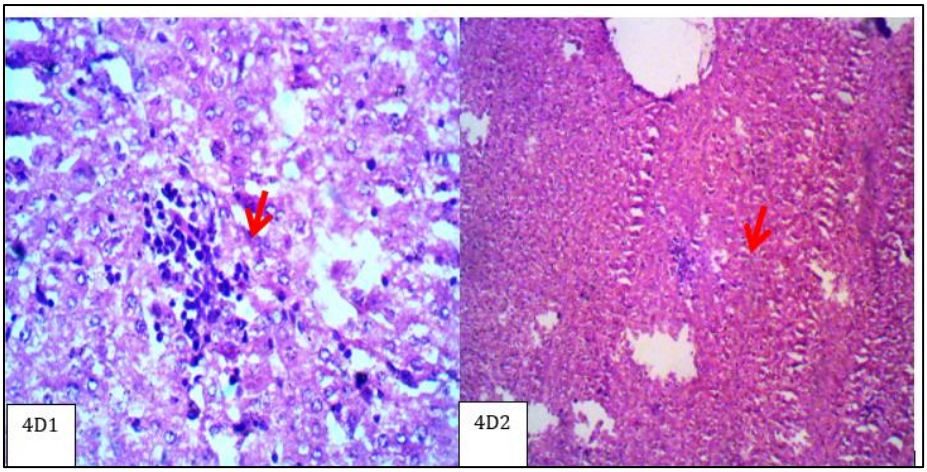


Figure 6 (4D1 x400, 4D2 x100): HE light micrograph of liver sectional histology of lead acetate and low dose garlic oil treated rats. Moderate hepatocellular degeneration and portal inflammation (arrows)

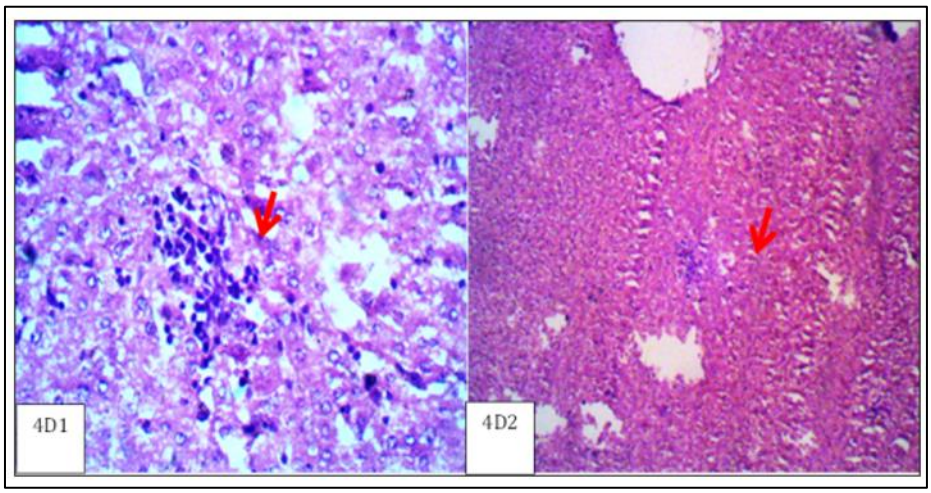


Figure 7 (4D1 x400, 4D2 x100): HE Light micrograph of liver sectional histology of lead acetate and medium dose garlic oil treated rats. Random hepatocellular degeneration and acute inflammation (arrow)

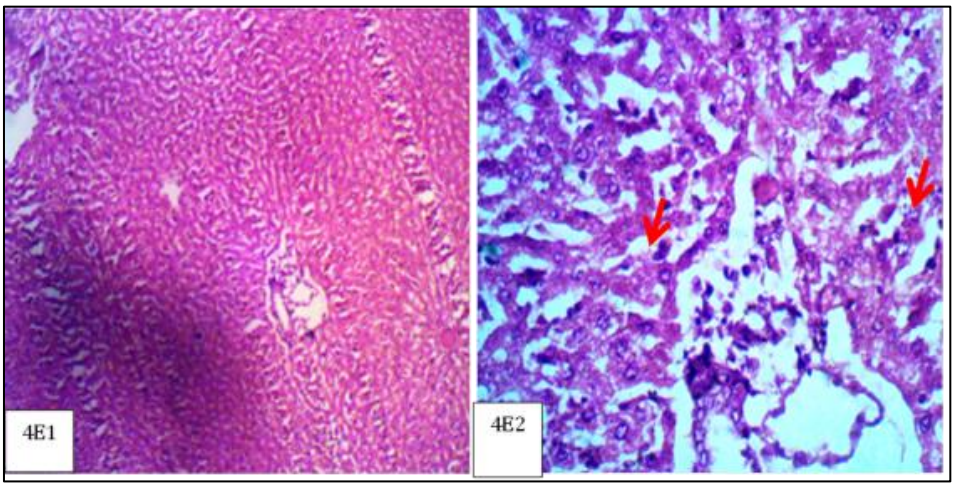


Figure 8 (4E1 x100, 4E2 x400): HE light micrograph of liver sectional histology of lead acetate rats and high dose garlic oil treated rats. Diffuse hepatocellular atrophy (arrow)

4. Discussion

In this study, lead acetate has adverse effects on the liver. The effect of garlic oil on body weight in lead-treated rats have shown promising results. For instance, El-Sayyad *et al.* (2020) conducted an experiment where rats exposed to lead acetate were treated with garlic oil. The results indicated that garlic oil significantly improved body weight gain in lead-exposed rats compared to those that did not receive the treatment. The mechanism is believed to involve the reduction of oxidative stress and improvement in metabolic function, as evidenced by increased activity of antioxidant enzymes and reduced lipid peroxidation.

In a similar study, Sharma *et al*. (2017) found that garlic oil supplementation in lead-exposed rats resulted in a significant improvement in body weight gain. This study also highlighted the role of garlic oil in enhancing liver function, which is crucial for metabolic processes and overall growth. The protective effect of garlic oil on body weight gain in lead-exposed rats is primarily attributed to its antioxidant properties. Garlic oil helps in maintaining the integrity of cellular membranes, reducing oxidative damage, and improving the function of vital organs such as the liver and kidneys, which are crucial for metabolism and growth (Sadeek *et al*., 2015). Moreover, garlic oil has been shown to chelate lead, reducing its bioavailability and toxicity (Anwar *et al.*, 2016) thereby enhancing growth in lead-treated rats. These findings suggest that garlic oil could be a beneficial dietary supplement for individuals at risk of lead exposure.

Histologically, the hepatocytes appeared irregularly arranged with disorganization of hepatic architecture. The central vein appeared dilated and congested with massive hemorrhage extending to the nearby cells. Also, there were focal degenerative and necrotic changes along with inflammatory cell infiltration. This is in agreement with many authors who reported the toxicity of lead on the liver (Nakhaee *et al.,* 2019; And Amin, 2020). Similar observations were reported by Suradkar *et al*., (2010). (Ibrahim *et al*., 2012). who found that lead acetate can cause lesion characterized by engorgement of blood vessels along with sinusoidal hemorrhages, perivascular mononuclear cell infiltration, dilatation of central veins, vacuolar degeneration of hepatocytes and increased cytoplasmic eosinophilic granularity, swelling of hepatocytes with the variable degree of nuclear changes, distortion of hepatic chords and areas of diffused vacuolar and granular degeneration. Lead exposure produced pronounced hepatic histopathology evidenced by histological alternations in liver including focal necrosis with inflammatory cells, congestion at places, sinusoids not patent, centre lobular swelling, hepatocyte vacuolization and swelling, parenchyma disorganization, dilation of the inter hepatocyte space, and hemorrhagic clots. The appearance of inflammatory cells in the hepatic tissue, due to lead chronic exposure, may suggest that lead could interact with proteins and enzymes of the hepatic interstitial tissue interfering with the antioxidant defense mechanism and leading to reactive oxygen species generation which in turn may imitate an inflammatory response (Ibrahim *et al*., 2012). Cell necrosis and vacuolization induced by lead toxicity as shown in the present study was described previously by other studies (Ekeh *et al*., 2015; Jarrar *et al*., 2012). Robbins *et al*. (1976) regarded such vacuolation to represent primary morphologic response to many forms of cell injury. They also attributed it to the noxious effects of treatment on the cell membranes, both structurally and functionally, causing marked disturbances in its permeability system. This presumably leads to enhanced imbibition of water into the cells. When it sufficiently accumulates in the cells, such intracellular water produced clear cytoplasmic vacuoles indicating the occurrence of the pathologic symptoms commonly referred to as hydropic degeneration or fatty degeneration caused by lipid abundance in such instance. The patho-morphological lesions in liver may be due to the action of lead on hepatic glycogen, DNA content and the ability to incorporate amino acid into protein (Barrat *et al*., 1989). Mechanisms of lead-induced liver injury include increased production of reactive oxygen species, and induced oxidative stress which results in DNA damage (Hari *et al*., 2023). These reactive species interfere with cellular macromolecules and deactivates cellular antioxidant pool (Flora *et al*., 2012). Many heavy metals, including lead, are known to induce over production of Reactive Oxygen Species and consequently enhance lipid peroxidation (Chaurasia *et al*., 1997) decrease the saturated fatty acids and increase the unsaturated fatty acid contents of membranes (Ibrahim *et al*., 2012), which become a hindrance in membrane transport (Pratap *et al*., 2014).

Recent studies have indicated that garlic oil has significant protective effects on the liver histology of lead-treated rats. Lead toxicity is known to cause extensive histopathological changes in the liver, including hepatocyte degeneration, necrosis, and inflammation. However, garlic oil has demonstrated the ability to mitigate these adverse effects.

Properties of garlic oil exhibiting hepatoprotective effects can be attributed to several of its bioactive properties; antioxidant activity. Garlic oil is rich in sulfur-containing compounds such as allicin, diallyl disulfide (DADS), and diallyl trisulfide (DATS), which have strong antioxidant properties. These compounds help in scavenging free radicals and enhancing the activity of endogenous antioxidant enzymes like superoxide dismutase (SOD) and glutathione peroxidase (GPx), thereby reducing oxidative stress (Ried *et al*., 2016). Anti-Inflammatory Effects; garlic oil has been shown to inhibit the production of pro-inflammatory cytokines and reduce the activity of inflammatory enzymes such as cyclooxygenase (COX) and lipoxygenase (LOX). This anti-inflammatory action helps in mitigating the inflammatory

response in the liver induced by lead toxicity (Banerjee *et al.,* 2019). Detoxification Support; garlic oil enhances the activity of detoxifying enzymes and facilitates the excretion of heavy metals such as lead from the body. This detoxification support reduces the overall toxic burden on the liver and protects it from histological damage (El-Sayyad *et al*., 2020).

Similar research on other fractions of garlic such as garlic extract and aged garlic extract (AGE), have also demonstrated hepatoprotective properties in various studies. For instance, a study by Saad *et al.* (2017) found that aged garlic extract reduced the liver damage caused by cadmium exposure in rats. The protective effects were associated with enhanced antioxidant defense and reduced lipid peroxidation. Similarly, Liu *et al*. (2018) reported that garlic extract could ameliorate acetaminophen-induced liver injury in mice by reducing oxidative stress and inflammation. The study highlighted the role of garlic-derived sulfur compounds in maintaining cellular redox balance and protecting liver tissue from damage.

In this work, treatment of Wistar rats with lead acetate caused a significant increase of the activities of serum AST, ALT and ALP . Similar observations were reported in many experimental investigations on animals exposed to lead (Ibrahim *et al*., 2012; Azoz *et al*., 2012). In addition, Shalan *et al*. (2005) has reported that serum ALT, AST and ALP activities were elevated in rats treated with lead acetate as early as the end of the second week of treatment and ALT was elevated significantly more than AST on lead exposure. The increase in such enzymes might be due to increased cell membrane permeability (Rubin *et al*., 1995), or damage of hepatocytes caused by lead acetate (Tatjana *et al*., 2003). Increasing levels of AST and ALT in the plasma of treated rats is mainly due to the leakage of these enzymes from the liver cytosol into the blood stream (Conception *et al*., 1993). Releasing of AST and ALT from the cell cytosol can occur as secondary changes to cellular necrosis (Gaskill *et al*., 2005). Furthermore, Ibrahim *et al*. (2012) reported that the high plasma AST and ALT activities are accompanied by high liver microsomal membrane fluidity, free radical generation and alteration in the liver tissue. Lead toxicity is a significant public health concern due to its ability to cause widespread damage to various organs, particularly the liver. One of the critical markers of liver damage is the alteration in liver enzyme levels. Research has shown that garlic oil can have protective effects on liver enzymes in lead-treated rats.

Similar protective effects have been observed in other studies investigating different fractions of garlic. For instance, El-Sayed *et al*. (2019) reported that aged garlic extract (AGE) reduced the levels of liver enzymes in rats exposed to cadmium. The study found that AGE treatment significantly decreased the levels of ALT, AST, and ALP, suggesting a protective effect on liver function. The reduction in enzyme levels was attributed to the antioxidant and anti-inflammatory properties of the garlic extract (El-Sayed *et al*., 2019).

Additionally, a study by Hassan *et al*. (2020) examined the effects of garlic extract on acetaminophen-induced liver injury in mice. The results showed that garlic extract significantly reduced the levels of liver enzymes and protected liver tissue from damage. The study concluded that the bioactive compounds in garlic, such as allicin and its derivatives, play a crucial role in protecting the liver from various toxic insults (Hassan *et al*., 2020).

5. Conclusion

Lead exposure has adverse effects on the liver, resulting in severe portal hepatocellular degeneration, necrosis, lesions, and inflammation. This is evidenced by elevated levels of liver enzymes (AST, ALT, and ALP), indicating impaired liver function. Garlic oil demonstrates effective hepatoprotective action against lead acetate by ameliorating structural damage, reducing enzyme release into the plasma in Wistar rats, and mitigating lead-induced body weight loss.

Recommendations

Further research is needed to clarify the mechanisms by which garlic oil protects the liver from lead-induced damage, and studies should be conducted in higher animal models.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Ethical approval was obtained from the health research committee (HREC) (CREC/UGP/125), College of Health Sciences, Benue State University, Makurdi. All experimental procedures carried out in accordance with the guidelines on animal experimentation, care and use in the laboratory as prescribed by the Ethics Committee.

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