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SPONDIAS MOMBIN ETHANOLIC LEAF EXTRACT IMPROVES HEPATIC DAMAGE INDUCED BY ALUMINIUM CHLORIDE IN A RAT MODEL

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ABSTRACT

Introduction: Aluminum chloride ($AlCl_3$) is highly harmful to both humans and animals, and it is extensively present throughout the environment. *Spondias mombin* is a medicinal plant used to treat many conditions, including liver diseases. **Aim**: This study assessed the preventive efficacy of *Spondias mombin* against hepatotoxicity produced by aluminum chloride in female albino rats. **Method**: fifteen adult female rats were divided to three groups, with each group consisting of five rats. Group I served as the negative control and was administered distilled water and feed. Group II served as the positive control and was administered $AlCl_3$, whereas group III was given aluminum chloride (100mg/kg body weight) and *Spondias mombin* (100mg/kg body weight) for a duration of 14 days. The entire treatment was administered orally and spanned a duration of fourteen days. Blood samples were obtained and examined for variables including AST, ALT, MDA, GPx, and SOD. The results showed a significant decrease in the levels of GPx and SOD compared to the control group. Specifically, GPx reduced significantly from 9.03±0.26 to 8.66±0.07 (U/mg protein) and SOD decreased from 7.78±0.28 to 5.87±0.14 (U/mg protein) after treatment with AIC13 ($P<0.05$). However, the administration of *Spondias mombin* resulted in an increase in the levels of GPx and SOD from 8.66±0.07 to 9.03±0.27 (U/mg protein) for both enzymes. The concentration of MDA exhibited a significant increase in comparison to the control group. The value increased from 385.53±0.69 to 399.49±1.47 (nmol/g) after being treated with $AlCl_3$. However, the administration of spondias mombin resulted in a decrease in the level of MDA from 399.49±1.47 to 385.53±0.69 (nmol/g). This decrease was significant ($p<0.05$) compared to the control group. Additionally, there was a significant increase in the levels of GPx and SOD in the spondias mombin treated groups compared to the $AlCl_3$ treated groups. The results also indicated a notable reduction in AST, ALT, and MDA levels following treatment with $AlCl_3$ in comparison to the control group. Additionally, the administration of spondias mombin extract mitigated the negative effects of $AlCl_3$ when compared to the groups treated just with $AlCl_3$. The histomorphological tests demonstrated that aluminium chloride caused hepato-degenerative alterations, which were mitigated by *Spondias mombin*. Ultimately, *Spondias mombin* exhibits hepatoprotective properties and hence should be promoted.

KEYWORDS: Oxidative stress, hepatotoxicity, Aluminium chloride, *Spondias mombin.*

INTRODUCTION

Liver illnesses are a substantial public health problem and a primary contributor to mortality on a global scale.[31] Studies on the hepatoprotective properties of herbal plants has been identified as a promising field of study for the development of new pharmacological treatments for liver illnesses.[48] Previous studies have demonstrated that natural medicinal items offer secure and efficient alternative therapies for hepatotoxicity.[48] and[31] have linked these hepatoprotective effects to the presence of endogenous phytoextracts abundant in natural antioxidants. Because of this, more and more bioactive compounds and plant extracts are being tested to see if they can protect the liver from hepatotoxins and fight free radicals.[21] Phenolic compounds, commonly found in both consumable and traditional herbal remedies, have been linked to several biological functions., such as the ability to scavenge free radicals.[48] Phenolic chemicals and flavonoids, which are natural antioxidants found in food, may have a crucial

impact on preventing diseases related to oxidative stress.[48] Research has demonstrated that aluminum (Al), a ubiquitous environmental element, harms several tissues and organs in both humans and animals, including the liver and kidney.[10] Aluminium mostly infiltrates the human body via the digestive and respiratory systems. It has a tendency to build up in several tissues and organs, such as the liver, kidneys, brain, and heart.[10] Elevated amounts of aluminium in the body have been shown to have detrimental effects on the kidneys, liver, nervous system, and blood.[30]

In 2007, Gonzalez and his colleagues undertook a study. Aluminum intoxication is linked to the generation of reactive oxygen species (ROS), resulting in oxidative harm to cellular lipids, proteins, and DNA. In a study carried out by[31], it was demonstrated that aluminium can cause the degeneration of renal tubular cells by producing reactive oxygen species (ROS). This, in turn, leads to oxidative damage to cellular lipids, proteins, and DNAs.

According to studies by[38] and[54], lab animals that were exposed to aluminum had changes in biochemical molecules, more lipid peroxidation in cell membranes, and less activity of antioxidant enzymes in their plasma and tissues.

The liver, the biggest organ internally in the body, is essential for detoxification, regulation of metabolic activities, and maintaining bodily homeostasis.[9],[31] Nevertheless, prolonged contact with harmful substances such as aluminum chloride might cause damage to it[9],[31],[16],[45] Despite the regular exposure of humans to aluminum through drinking water, food, and medications, there is currently no proven solution to mitigate its detrimental effects.[9],[31],[45] Medicinal plants commonly employ phytochemicals with antioxidant properties as a therapeutic approach to treat oxidative damage to organs and tissues.[43]

Southwest Nigeria's *Spondias mombin* plant is renowned for its antioxidant, anti-inflammatory, and hepato-protective properties, as noted by.[35]

The product contains a variety of biologically active plant chemicals, such as phenolic acids and flavonoids, tannins, or tannin heart glycosides, and saponins.[35],[12]

Previous studies have demonstrated that *Spondias mombin* has hepatoprotective and antioxidant properties in rats with carbon tetrachloride-induced hepatotoxicity[31] Several research studies have shown that S. *mombin* can fight free radicals, inflammation, and DNA damage.[42] It can also kill microbes[7] and protect the liver.[40] There was less alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin (TBIL), and conjugated bilirubin (CBIL) in the liver after an ethanol-based extract of *Spondias mombin*. Additionally, it increased cellular glutathione levels and decreased the levels of thiobarbituric acid-reactive compounds[31] There is a limited amount of experimental research on the use of *Spondias mombin* to treat hepatic problems caused by aluminum chloride.[9] Furthermore, researchers have not thoroughly explored the potential of plant extracts in treating oxidative damage in remote organs. It makes sense to look into *Spondias mombin's* therapeutic potential in reducing aluminum chloride-induced oxidative stress in the livers of laboratory animals, given that it is a strong antioxidant that can protect tissues from oxidative damage. The study investigated the preventive properties of *Spondias mombin* against hepatotoxicity caused by aluminium chloride in female albino rats.

The purpose of this study is to examine the beneficial benefits of an ethanolic extract of *Spondias mombin* on liver damage induced by aluminum chloride ($AlCl_3$) in rats, based on existing research evidence on the therapeutic qualities of *Spondias mombin*.

MATERIALS AND METHODS

Chemicals/Reagents

All reagents utilized for the study were of analytical grade quality:.

Experimental Animals

The experimental animals were managed by procuring fifteen (15) healthy adult female Wistar rats, with weights ranging from 117g to 250g, within the animal house of the Department of Pharmacy at Niger Delta University in Bayelsa State. We housed the rats in cages and transferred them to the Department of Medical Biochemistry, where we gave them a two-week acclimatization period before providing them with standard food (Pellet) and purified water. The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) mandated that we conduct the procedures in accordance with the guidelines of the Institutional Animal Ethical Committee (IAEC) for the regulation and oversight of research with animals.

Preparation of S*pondias Mombin*Leaf Extract

Aba et al. (2014) provided the method for preparing the Spondias mombin leaf extract. Professor Ching F. Poh from the Department of Pharmacology, Faculty of Basic Clinical Sciences, College of Health Sciences at Niger Delta University, Wilberforce Island, Amassoma, Bayelsa State, carefully gathered leaves of *Spondias mombin* in Amassoma Community, Bayelsa State. Professor Ajibesin Kolawole, from the Department of Pharmacognosy at Niger Delta University in Wilberforce Island, Amassoma, Bayelsa State, skillfully performed the plant's botanical identification and authentication. the leaves from the stems were detached, washed them with fresh water, and allowed them to naturally dry at ambient temperature. The desiccated leaves were ground into a fine powder using a grinding mill machine and then stored in an airtight container to inhibit the growth of

microorganisms. A quantity of approximately 450 grams of the powdered leaf was subjected to extraction using 1350 ml of an ethanol solution with a concentration of 75%. The decoction was filtered, evaporated, and a specific residue was administered orally to each rat, based on their weight, using a water bath at 60°C.

Experimental Design

Fifteen adult Wistar rats were divided to three groups, with each group consisting of five rats. The control group, Group I, was administered distilled water and pelleted feed for a period of fourteen (14) days. For fourteen (14) days, Group II, the positive control group, received a daily oral gavage of 100 mg/kg of aluminum chloride($AlCl_3$). Group III: Administered with 100 mg/kg of aluminum chloride ($AlCl_3$) orally, Subsequently, a dose of 100 mg/kg of ethanolic extract of Spondias mombin was administered orally one hour later, and this regimen was continued for a period of fourteen (14) days.

Sample Collection

Sample Collection: The study involved euthanizing animals using chloroform inhalation and collecting a blood specimen from each group using a heart puncture technique. The blood was then coagulated and centrifuged at 800g for 10 minutes, resulting in a liquid portion called the supernatant. The animals were then dissected, and the liver was washed in a standard saline solution. A portion of the liver was placed in a sample container containing a 10% diluted solution of formalin for histological investigation. The liver tissue was then mixed with 0.1 M Tris buffer (pH 7.4) and mixed for 10 minutes. The levels of malondialdehyde and enzymatic activity of catalase and superoxide dismutase in the liver solution were quantified.

Analysis of Biochemical Parameters

The study used homogenized liver and serum samples to estimate biochemical parameters, including superoxide dismutase (SOD) activity, malondialdehyde (MDA), and Alanine Transaminase (ALT/SGPT) levels. Test kits were manufactured by Randox Diagnostics, a UK-based company, to quantify these levels. The study followed Reitman and Frankel's 1957 method to determine ALT and AST, and assessed SOD activity using Misra and Fridovich's techniques. The concentration of MDA was determined using a method developed by Hunter et al. in 1963 and later improved by Gutteridge and Wilkins in 1980.

Histopathological Analysis

The liver tissues were processed using an automated tissue processor, Histokinette. The tissues were encased in paraffin wax and cut into 20 micron slices using a rotary microtome. The slices were sectioned to a thickness of 5 microns. The tissues were affixed to slides, treated with xylene, stained with hematoxylin and eosin, and analyzed using a compound light microscope. The stained slides were then analyzed to produce photomicrographs.

Statistical Analysis

The data was analyzed using SPSS software, one-way ANOVA, Bonferroni multiple comparison, and a significance level of $p < 0.05$, comparing the control and test groups.

RESULTS

The results for the effect of *Spondias mombin* on liver of female wistar albino rats is presented in Tables 3.1 and 3.2.

Table 3.1: Mean values of body weight, liver weight and liver weight to body weight ratio.

Treatment	Body weight (g)	Liver weight (g)	liver weight
			Bod weight htx 100 $^0/_0$
Control (Distilled water)	191.23±1.67a	9.92±0.54 [a]	5.18[a]
AIC1$_3$	165.80±3.93[b]	6.89±0.17[b]	4.16[b]
Spondias mombin (100mg/kg bw) + $AlCl_3$	193.39±3.30[a]	9.70±0.54 [a]	5.01[c]

The data are presented as the mean value plus or minus the standard deviation, with a sample size of 5. Values in the same column with different superscript letters are statistically significant at a significance level of $P<0.05$.

The experimental results revealed a significant decrease ($P<0.05$) in the body weight, liver weight, and the ratio of body weight to liver weight of wistar albino rats after the administration of $AlCl_3$, compared to the control group. This decrease indicates a possible harmful impact of $AlCl_3$ on the physiological parameters of the rats, suggesting a disturbance in metabolic processes and organ function.

In contrast, the administration of the *Spondias mombin* extract led to a significant increase in liver weight, body weight, and the liver to weight ratio of the $AlCl_3$-treated group. This observation suggests that the extract of *Spondias mombin* may have a possible protective or beneficial effect against the harmful effects of $AlCl_3$ on the liver and regulation of overall body weight in the experimental animals.

Table 3.2: The Mean values of liver homogenate antioxidant activities and lipid peroxidation levels.

Treatment	GPx (unit/mg protein	MDA (unit/mg protein	SOD (Unit/mg protein
Control (Distilled water)	9.03±0.26a	385.53±0.69 [a]	7.78±0.28 [a]
$AIC1_3$	8.66±0.07[b]	399.49±1.47[b]	5.87±0.14[b]
Spondias mombin (100mg/kg bw) + $AIC1_3$	9.23±0.27[a]	389.33±0.49 [a]	7.79±0.28 [a]

The data are presented as the mean value plus or minus the standard deviation, with a sample size of 5. Values in the same column with different superscript letters are statistically significant at a significance level of P<0.05.

The findings indicated a significant decrease (P<0.05) in the GPx and SOD concentrations in Wistar albino rats after being given AIC13. Nevertheless, the administration of $AIC1_3$ to rats resulted in a significant elevation in MDA levels.

Conversely, the administration of the *Spondias mombin* extract resulted in a significant elevation (P<0.05) in the levels of GPx and SOD in Wistar albino rats after being treated with *Spondias mombin* and $AICl_3$. Nevertheless, administration of S*pondias mombin* to rats resulted in a significant decrease in MDA levels. This data suggests that the extract of *Spondias mombin* could potentially provide protection or benefits against the detrimental effects of $AICl_3$ on the liver and body weight regulation in the experimental animals.

Table 3.3: The The Mean values of serum liver function enzymes ALT and AST.

Treatment	AST (IU/L)	ALT (IU/L)
Control (Distilled water)	71.01±1.41 [a]	42.47±0.43 [a]
$AIC1_3$	80.18±1.30[b]	61.45±0.71[b]
Spondias mombin (100mg/kg bw) + $AIC1_3$	70.79±1.39 [a]	44.45±1.15 [a]

The data are presented as the mean value plus or minus the standard deviation, with a sample size of 5. Values in the same column with different superscript letters are statistically significant at a significance level of P<0.05.

The results demonstrated a significant increase (P<0.05) in the enzyme levels, specifically ALT and AST, in the liver of albino male rats after the administration of AIC13 compared to the control in albino male rat liver after the administration of the AIC13. The administration of the extract, however, has shown promise in ameliorating the effects of AIC13-induced damage. The extract has been observed to decrease ALT and AST concentrations, suggesting a protective or restorative effect on the liver.

Histology Photomicrograph

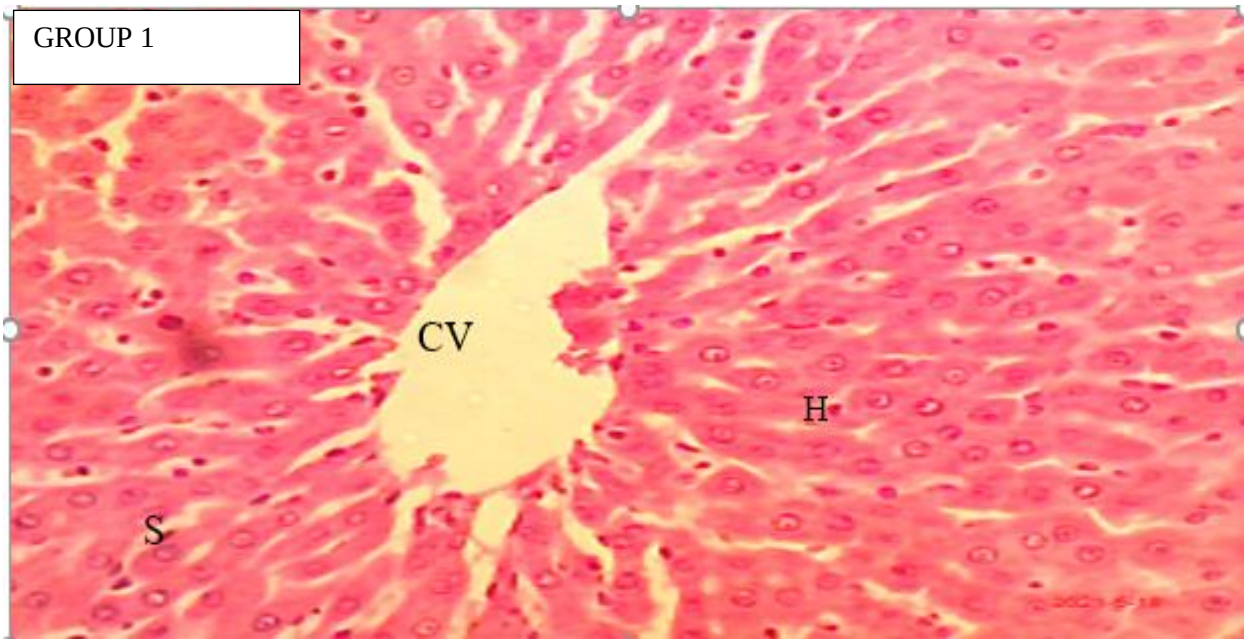

Plate 1: Photomicrograph Microscopic image of a rat liver (negative control) displaying a healthy central vein (CV), hepatocytes with polygonal shapes (H), and normal sinusoids (S). The tissue section exhibits typical histology of the liver. (Magnification: X400; stained with Hematoxylin ndEosin).

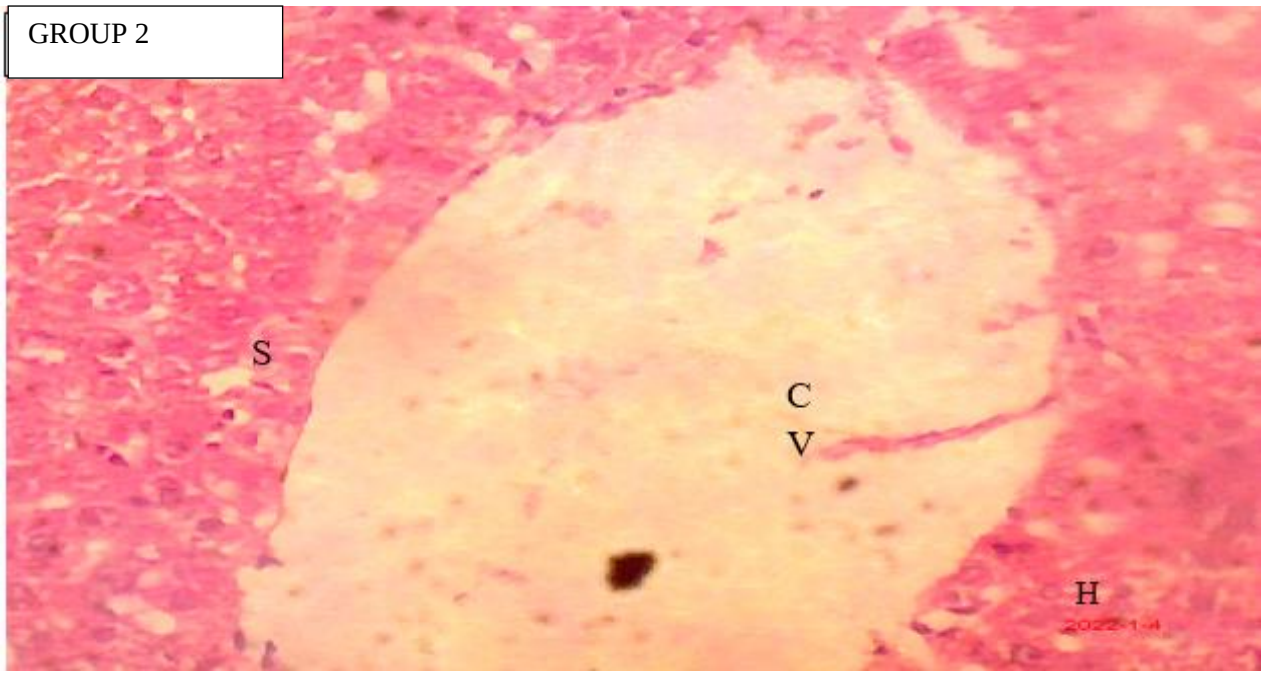

Plate 2: Photomicrograph of a rat liver treated with 100mg/kg per body weight (b.w.) of $AICl_3$ displaying degeneration of the central vein (CV), necrotic areas, blocked sinusoidal space (S), and swelling of hepatocytes (H) at a magnification of X400 using H&E staining.

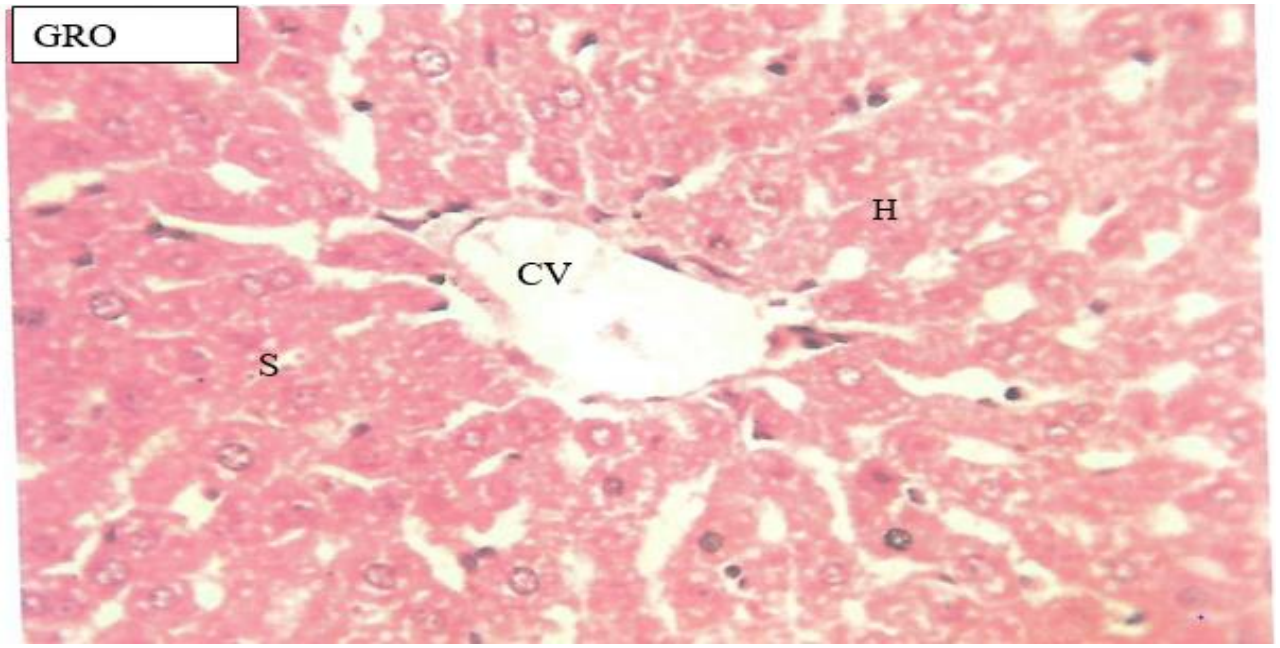

Plate 3: Photomicrograph of rat liver treated with a combination of 100mg/kg body weight of $AICl_3$ and Spondias mombin displaying a normal liver section including a central vein (CV), well-shaped hepatocytes (H), and regular sinusoids (S). The section exhibits typical liver histology at 400x magnification using hematoxylin and eosin staining.

DISCUSSION

People have long used plant-based products as a safe and effective source of medication for treating a wide range of illnesses. This gave rise to the phrase "herbal medicine," which describes the application of herbs for their medical or therapeutic properties.[2] According to World Health Organization estimates[59], over 75% of the world's population gets their medical needs from herbs, and many modern medicine classes have a medicinal plant prototype.[25] Drugs derived from plants, especially phytotherapeutic ones, have attracted a lot of attention in the last ten years.[55] According to[17], plants are the direct or indirect source of 25% of all contemporary medications. This study assessed the impact of *Spondias mombin* extract on the liver enzymes and hormones of Wistar strain female rats. *Spondias mombin* was chosen

based on its widespread use in Nigeria and numerous other African and global regions.[21] Researchers have linked *Spondias mombin's* alkaloids, flavonoid glycosides, and phenolic chemicals to the plant's documented effects on hormones and liver enzymes.[4] It is crucial to carefully and extensively treat disorders involving the blood and liver. Few herbal treatments for liver illnesses have undergone pharmacological evaluation to determine their efficacy, despite the fact that several are known to exist.[25] A lot of individuals assume that because herbal remedies are not synthetic, they are safe. Nonetheless, reports and evidence of the toxicity of traditional therapies exist.[4] Thus, developing natural therapies continues to be difficult. According to our findings, oral *Spondias mombin* treatment for 14 days increased the body weight, liver weight, and liver-to-body weight ratio of female rats considerably ($P<0.05$). We investigated the plant's effects on rats' weight, liver enzymes, and antioxidant systems to see if the compounds in *Spondias mombin* have any protective qualities. There were no appreciable changes in body weight in animals treated with *Spondias mombin.*[21] It is well known that GPx and SOD shield cells from the harmful consequences of lipid peroxidation.[40] The levels of GPx and SOD in this study dropped significantly ($P<0.05$) after treatment with AIC13 compared to the control group. For GPx, they went from 9.03±0.26 to 8.66±0.07 (U/mg protein), and for SOD, they went from 7.78±0.28 to 5.87±0.14 (U/mg protein) (Table 3.2). Conversely, *Spondias mombin* treatment raised the levels of SOD and GPx, with SOD levels rising from 8.66±0.07 to 9.03±0.27 (U/mg protein) and GPx from 8.66±0.07 to 9.03±0.27 (U/mg protein). The SOD and GPx levels found in this study are higher than those found in a previous study by[21], which looked at how well *Spondias* can protect the liver from the harmful effects of CC14. The study found that administering *Spondias mombin* extract counteracted the negative effects of CC14. The liver's GPx level decreased after AIC13 treatment, suggesting an increase in GPx consumption due to oxidative stress.[8] The present study's findings are at odds with those of[24] investigation, which found no discernible impact of aluminum treatment on the activity of rat liver superoxide dismutase in rats. Superoxide dismutase (SOD) is a crucial antioxidant defence mechanism that facilitates the conversion of the superoxide radical (O2) into either hydrogen peroxide (H2O2) or regular molecular oxygen (O2). This process occurs in nearly all oxygen-exposed living cells.

Studies conducted on animal models and cell cultures have demonstrated that aluminium chloride affects the expression of GPX and SOD, which may result in membrane fragility. These findings were reported by[30],[47] and.[15] Research has shown that oxidative stress plays a significant part in the cellular dysfunction caused by aluminium chloride. If this is true, antioxidants found in *Spondias mombin* could potentially provide protection.

Research has demonstrated the effectiveness of plant-based products, such as *Spondias mombin*, in treating various illnesses, including liver disorders. We used female Wistar strain rats in this work to assess the effects of *Spondias mombin* on liver hormones and enzymes. *Spondias mombin* was chosen based on its widespread use in Nigeria and other global regions. The study's findings demonstrated that giving female rats oral *Spondias mombin* for 14 days dramatically raised the rats' body weight, liver weight, and liver-to-body weight ratio. We investigated the plant's effects on rats' weight, liver enzymes, and antioxidant systems to see if the compounds in *Spondias mombin* have any protective qualities. The body weight of the *Spondias mombin*-treated animals did not significantly change. It is well known that GPx and SOD shield cells from the harmful consequences of lipid peroxidation. In this investigation, treatment with AIC13 resulted in a substantial decrease in the levels of GPx and SOD relative to the control. *Spondias mombin* administration, however, raised GPx and SOD levels, suggesting its protective properties. After receiving AIC13 therapy, there was a notable rise in the amount of lipid peroxidation (MDA). *Spondias mombin* treatment, however, resulted in a decrease in MDA levels, indicating that it has anti-lipid peroxidation properties. These results are consistent with earlier research that showed aluminum chloride alters the expression of glutathione peroxidase and superoxide dismutase (SOD), potentially resulting in membrane fragility[30],[47] and [15. Conversely, in comparison to the control, the MDA level rose significantly ($P<0.05$) from 385.53±0.69 to 399.49±1.47 (nmol/g). Even though the animals were treated with AIC13, giving them Spondias mombin caused their MDA levels to drop from 399.49±1.47 to 385.53±0.69 (nmol/g) (Table 3.2).[24] reported similar findings, finding that treating rats with aluminum chloride increased MDA levels and decreased liver catalase activity. Also, the rise in lipid peroxidation (MDA) levels seen in this study is similar to what was found in a study by.[13] In that study, rats that were exposed to aluminium had a significant increase ($p<0.05$) in lipid peroxidation. Increased lipid peroxidation in biological membranes can lead to impaired membrane function.

Another study[52] made this clear by showing that mercuric chloride is bad for plasma membrane enzymes, which may change the physical and chemical properties of liver membranes. Certain theories suggest that the production of free radicals could partially mediate the toxicity of aluminum chloride.[54]

[58]utilize the assessment of serum levels of basic liver function enzymes to indirectly evaluate the condition of tissues following exposure to pharmacological substances. In this investigation, the levels of AST and ALT showed a significant rise ($P<O.05$) compared to the control group. Specifically, the AST level climbed from 71.01±1.41 (U/L) to 80.18±1.30 (U/L), while the ALT level increased from 42.47±0.43U/L to 61.45±0.71 (U/L)

following treatment with AIC13. The levels of AST and ALT, on the other hand, dropped significantly ($P<0.05$) when *Spondias mombin* was given. They went from 61.45±0.71 (U/L) to 44.45±1.15 (U/L) (Table 3.3).[3] research, which documented the effectiveness of *Spondias mombin* in treating hepatic toxicity, aligns with these findings. The raised levels of enzymes indicate damage to the liver, as higher plasma levels of ALT and AST are signs of liver injury. The publications by Marza et al. in 2021 and Ahmed et al. in 2022. The release of these enzymes from the liver cytosol into the bloodstream occurs due to liver malfunction and rupture of cellular membranes. The references cited are[32] and [61] stopping peroxidation in membrane lipids and maintaining the integrity of cell membranes, the extract stops the release of enzymes from the liver. The publication "Ahmed et al. 2022" is referenced. The extract's antioxidant capabilities could potentially enhance its protective effect, given that AIC13 generates liver damage through oxidative stress.[48]

A previous study found that giving rats an ethanolic leaf extract of *Vernonia amygdalina* for 21 days resulted in a decrease in AST, ALT, and SOD levels, which was dependent on the dosage. The observed decline may be attributed to the deterioration of the extract, as stated by.[29] The ALT and AST levels obtained in this investigation are consistent with the findings reported by[11],[18] and [14] The therapeutic benefits of *Spondias* have been ascribed to a range of secondary metabolites, such as phenolics, sterols, triterpenes, saponins, essential oils, amino acids, and polysaccharides, according to this research.

Furthermore, the findings indicate that the extract does not possess hepatotoxic properties. The tests AST and ALT are very important for finding liver damage caused by drugs or dangerous chemicals.[6],[60] Elevated levels of liver enzymes beyond the normal range are indicative of liver injury. According to[6] and [60], the injection of $AlCl_3$ affects liver function, but extracts from *Spondias mombin* help restore normal function. This implies that $AlCl_3$ might have adverse effects, whereas *Spondias mombin* could offer therapeutic advantages in mitigating liver toxicity due to heavy metals. This observation is consistent with the findings of,[51] and [56] Elevated serum AST, ALT, and ALP levels, which indicate liver damage, distinguish aluminum-induced hepatotoxicity. The fact that the liver had changes in its structure, like hepatocytes getting swollen and dying all over, was more proof of this conclusion.[6],[60] Exposure to aluminum causes an increase in the generation of reactive oxygen species (ROS), which harms cellular structures and causes oxidative stress. This oxidative stress has been associated with several clinical disorders, such as inflammation and cellular dysfunction.[6],[60] Aluminum primarily builds up in the liver and kidney, causing an increase in free iron inside cells and the accumulation of membrane lipids. These organs are particularly susceptible to oxidative damage, which ultimately results in lipid peroxidation.[6][,60] However, studies have shown that Spondias mombin extracts possess hepatoprotective properties, which can shield the liver from aluminum-induced damage. Observations of normal liver tissue structure and reduced levels of transaminase enzymes in the blood[6],[60] support this.[6] and [60] have previously documented histological alterations in the liver caused by aluminum, which aligns with our own findings. However, other studies[6][60] have not found any significant changes in rats and mice exposed to aluminum through drinking water or feeding for extended periods. Commonly, researchers use the rat model to assess the toxicity of aluminum (Al) and determine its potential harm to humans. The present investigation aimed to investigate the effectiveness of Spondias mombin extract in reducing the liver damage resulting from exposure to $AlCl_3$. Assaying aspartate transaminase (AST) and alanine transaminase (ALT) is crucial for diagnosing liver damage resulting from drug toxicity or exposure to hazardous substances.[38] Elevated levels of liver enzymes outside the standard range are indicative of liver impairment. Administration of $AlCl_3$ causes changes in liver function, whereas administration of extracts from *Spondias mombin* reverses these changes and returns the liver to its normal function. This indicates a potential detrimental impact of $AlCl_3$ on the liver while demonstrating the therapeutic efficacy of *Spondias mombin* in reducing liver toxicity caused by heavy metals. This observation fits with what[51] found and backs up the claim that traditional medicines often have a lot of active phytochemicals that work on different processes.[56] The hazardous substance $AlCl_3$ caused liver damage, as evidenced by markedly elevated levels of AST and ALT. Elevated levels of serum aminotransferases indicate liver damage. CC14 therapy induces hepatic damage, leading to elevated levels of serum transaminases and alkaline phosphatase activity.[22]

Following the administration of AIC13, the examination of the liver histology showed an increase in the size of hepatocytes together with the presence of vacuoles in the cytoplasm. Furthermore, the sinusoid experienced compression. Conversely, administration of *Spondias mombin* extracts led to a liver section that was within normal.

A central vein surrounded the polygonal-shaped hepatocytes. The sinusoids were also normal, indicating a normal liver histology. The liver histological alterations seen in the $AlCl_3$ group showed the presence of a hepatic injury. The observed alterations in the group treated with *Spondias mombin* suggested the efficacy of *Spondias mombin* to alleviate hepatotoxicity. Prior studies have established that exposure to aluminium leads to changes in the liver's histology, which is consistent with our own results[34][20][33] found that giving varying amounts of aluminium chloride (50, 100, and 200 mg/kg/day) between days 9 and 13 of pregnancy led to the formation

of areas of inflammation, damage to liver cells, and the buildup of connective tissue around the liver's central vein. Alternatively, additional research has investigated the liver histological alterations induced by aluminium nitrate in rats, administered at a dose of 284 mg/kg/day, over a span of 100 days. Similarly, mice were subjected to aluminium sulphate in their diet, with doses of 49 mg Al/kg/day and 979 mg Al/kg/day, for a period of 20 months. These investigations did not observe any substantial alterations in the liver.[45] study serves as the reference.

The rat model is widely used to assess the toxicity of Al to prove its toxicity in humans, and the current study aimed to investigate the effectiveness of the Spondias mombin extract to alleviate the hepatotoxicity induced by AlCl3 exposure.

CONCLUSION

From the results of this study, the *Spondias mombin* had a significant effect on the liver enzymes and antioxidant enzymes and increased the level of enzymes in the liver. This justifies the conclusion that the extract might help improve the level of liver damage as such might be recommended for hepatotoxicity.

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Disclosure of conflict of interest.

The authors declare that there is no conflict of interest.

Statement of ethical approval.

The study protocol was approved by the Ethical and Research Committee of Niger Delta University, Bayelsa State, Nigeria. The ethical principles for medical research involving animal subjects as outlined in the Helsinki declaration in 1975 and subsequent revisions were strictly followed in the course of this study.

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