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Antioxidant Properties and Hepatoprotective Effects of Ethanol Extracts, Ethyl Acetate, and n-Butanol Fractions of *Pentaclathra Macrophylla* Leaves on Paracetamol-Induced Hepatotoxicity in Wistar Rats

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ABSTRACT

The stem bark and fermented seeds of *Pentaclathra macrophylla* are recognized for their nutritional, medicinal, and economic significance. In the present investigation, Wistar rats subjected to paracetamol-induced liver injury for 56 days were used to assess the hepatoprotective and antioxidant qualities of ethanol extract (EE), ethyl acetate (EA), and n-butanol (NB) fractions of *P. macrophylla* leaf. About 60 rats weighing between 150 and 200 g, including five typical and fifty-five 3000 mg/kg paracetamol-induced toxic rats, were divided into 4 groups of 15 rats each (A, B, C, and D), which stood for the control (normal, positive, and negative control), EE (100, 200, and 400 mg/kg), as well as 100, 200, and 400 mg/kg of EA fraction and NB fraction groups, respectively. A Mindray XL-200 auto biochemical analyzer was used to assess the serum biochemical parameters. The 400 mg/kg EA and 200 mg/kg NB fractions had significantly lower levels of total bilirubin, direct bilirubin, albumin, total protein, ALT, AST, and ALP than the control group. The observed hepatoprotective effects, although not statistically significant, are believed to result from the antioxidant, anti-inflammatory, and metal-chelating properties associated with these fractions, as indicated by their phytochemical profiles. Higher dosages of the ethanol extract, however, did not significantly lower the liver enzymes, indicating possible harmful effects that vary with dose. Moreover, histopathological examinations also suggested the plant extract's hepatoprotective qualities. The findings demonstrate the medicinal potential of *P. macrophylla* leaf extracts, particularly the EA and NB fractions, in treating liver-related issues. These fractions may serve as effective hepatoprotective agents.

Keywords: Phytomedicine, Hepatotoxicity, Antioxidant, Extract

Introduction

The liver, situated in the upper right abdomen, is the largest internal organ and gland in the body. It carries out more than 500 essential tasks, such as filtering blood, detoxifying toxins, generating bile for fat digestion, metabolizing nutrients like glucose, protein synthesis for blood clotting and fluid balance (albumin), storing vitamins and minerals, and controlling hormone levels.[1] It is essential for the metabolism of carbohydrates, proteins, and fats, as well as vitamins, while also detoxifying metabolic waste and harmful substances that enter the body.[2] Damage to the liver from hepatotoxic agents can result in serious health problems.[3] Factors such as exposure to toxic chemicals, excessive alcohol consumption, viruses such as hepatitis A, B, C, D, and E, fat buildup, cancer, and drug use can contribute to liver injury.[2]

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Compounds like acetaminophen (PCM), tetracycline, ethanol, and carbon tetrachloride are known to trigger lipid peroxidation, which can harm liver cell membranes and organelles, resulting in hepatocyte swelling and death, along with the leakage of enzymes found in the cytosol, including alkaline phosphatase, aspartate transaminase, and alanine transaminase, into the bloodstream.[1,2] Liver conditions, including hepatotoxicity induced by drugs such as paracetamol, pose a significant health threat due to oxidative stress and liver injury.[2] While synthetic hepatoprotective agents are available, they often come with adverse effects, making natural alternatives more attractive. Although, *Pentaclethra macrophylla* has been traditionally used for liver protection, scientific evidence supporting its efficacy is still limited.[4] Traditional medicine has long employed natural and herbal remedies to treat various ailments, including cancers.[5] Antioxidants are essential for preventing oxidative stress, which occurs when the body's antioxidants and free radicals are out of balance. These compounds have the ability to minimize oxidative damage to cells and neutralize free radicals, thereby helping to protect against nephrotoxicity. Oxidative stress contributes to various conditions, including drug-induced nephrotoxicity linked to paracetamol. Additionally, the body uses natural antioxidants to strengthen its defenses against reactive oxygen species (ROS), helping to restore balance by countering these damaging agents.[4] Phenolic compounds' antioxidant qualities stem from processes including chelating metal ions, providing hydrogen, scavenging free radicals, squelching singlet oxygen, and serving as substrates for reactive radicals such as hydroxyl and superoxide radicals.[6] For generations, people have used herbal medicines to heal liver problems.[7] *Pentaclethra macrophylla* is indigenous to West and Central Africa and belongs to the family Fabaceae. This plant is recognized for its

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nutritional, medicinal, and economic significance. The seeds are fermented to produce "ugba," a traditional Nigerian food that is rich in proteins, lipids, carbohydrates, and dietary fibers.[8] The seeds are highly valued for their abundance of proteins, oils, and bioactive compounds that offer both medicinal and nutritional benefits. Various plant parts, including the leaves, bark, and seeds, have been utilized in herbal treatments of conditions like inflammation, infections, and liver issues. The leaves and bark are utilized for treating wounds, sores, and diarrhea. The herb is also used to treat parasites, microbiological infections, discomfort, and inflammation.[9] Tannins, flavonoids, alkaloids, terpenoids, and saponins have been shown through phytochemical research to contribute to its many pharmacological effects, which include antidiabetic and antioxidant properties.[4]

Many ailments, such as gastrointestinal problems, convulsions, and gonorrhea, have been said to be cured by the *P. macrophylla* plant; many of these therapies are connected to either the seed or stem bark extracts. [10,11,9,12] Only a limited number of studies[3,4] have examined *P. macrophylla* leaf extract's effects, and none have explored its potential for hepatoprotection. Thus, the aim of this research is to assess the hepatoprotective impact of *P. macrophylla* leaf extracts against liver damage caused by paracetamol in Wistar rats.

Materials and Methods

Plant Collection and Identification

In October 2024, leaves of *P. macrophylla* were collected in Orba, Udenu L.G.A., Enugu State, Nigeria. Dr. Felix I. Nwafor from the Department of Plant Science and Biotechnology at the University of Nigeria identified and confirmed the plant. The specimen was assigned the identification number UNN/11789 upon arrival at the University of Nigeria Herbarium

Plant Materials Extraction and Fractionation

The leaves were cleaned, air-dried for two weeks, ground into a coarse powder using a milling machine, and sieved to regulate particle size. Subsequently, 200 g of *P. macrophylla* was soaked in 1 L of ethanol for 48 hours with intermittent stirring. The extract was filtered through Whatman no. 1 filter paper, concentrated using a rotary evaporator at 60 degrees Celsius, dried in an oven at 40 degrees Celsius, and stored in an amber-colored bottle in a refrigerator

Fractionation

Liquid-liquid partitioning was employed for fractionation. The aqueous extract was mixed with an equal amount of ethyl acetate in a separatory funnel, shaken, and left to separate into two layers. This process was repeated three times to enhance extraction. The top ethyl acetate layer, containing semi-polar substances like terpenoids, tannins, phenolics, and flavonoids, was collected. The ethyl acetate fractions were concentrated using a rotary evaporator and stored at 4°C for further analysis. The remaining aqueous phase was partitioned using n-butanol, and the top organic phase, containing more polar compounds such as glycosides, flavonoid glycosides, and saponins, was collected after three extractions. The n-butanol fractions were concentrated using a rotary evaporator to obtain the final fraction.

Ethical approval

The University of Nigeria Nsukka's Institutional Research and Ethics Committee (IREC UNN) granted ethical approval for the handling of experimental animals; IREC345UNN

Experimental Animal Procurement and Management

Healthy Wistar rats weighing between 100 and 150 grams were procured from the Veterinary Medicine Department at the University of Nigeria Nsukka. The rats were housed in hygienic polypropylene cages at the Department of Zoology animal house, University of Nigeria, Nsukka, at room temperature. After a two-week acclimatization period, the rats were fed a standard pellet diet and provided with unlimited access to water. The experiment was conducted in accordance with the University of Nigeria Nsukka's Committee on Animal Ethics guidelines and the National Institutes of Health's guidelines for the use and care of laboratory animals.

Design of Experiment

The rats were randomly divided into four main groups (A, B, C, and D). Groups A, B, C, and D represented the ethanol extract, n-butanol fraction, ethyl acetate, and control group, respectively. Each group was further subdivided into subgroups: A1, A2, and A3; B1, B2, and B3; C1, C2, and C3; and D1, D2, and D3, with three replicates of five rats in each subgroup. The three control groups were normal, negative, and positive, represented by groups A1, A2, and A3, respectively. The positive control received standard medical treatment (200 mg/kg of silymarin), the negative control was intoxicated with 3000 mg/kg of paracetamol without treatment, and the normal control was not intoxicated but received 1 ml/kg of distilled water. Wistar rats in groups B, C, and D were administered graded doses of 100, 200, and 400 mg/kg of *P. macrophylla* extract and fraction orally for 56 days to induce hepatotoxicity.

Induction of Hepatotoxicity

Hepatotoxicity was induced in Wistar albino rats using pure paracetamol. The rats were starved for 12 hours, given unrestricted access to water, and orally administered a single dose of paracetamol (3000 mg/kg) to induce hepatotoxicity. Subsequently, the rats were observed for signs of hepatotoxicity, and appropriate plant extracts or a standard drug were administered three days later.

Blood Sample Collection

The retro-orbital bleeding technique was used to obtain blood samples from the rats' eyes via the medial canthus. This process involved using a heparinized capillary tube, which was carefully angled to puncture the retro-orbital sinus. Plain tubes were utilized to collect approximately 4 ml of blood for serum analysis. After collection, the tubes were allowed to clot at room temperature for 15 to 30 minutes before undergoing centrifugation.

Identification of Liver Indicators

Serum levels of alanine aminotransferase (ALT), aspartate transaminase (AST), total bilirubin (TBIL), direct bilirubin (DBIL), alkaline phosphatase (ALP), total protein (TP), and albumin (ALB) were measured using an auto-biochemistry analyzer (Mindray XL-200).

Histological assessment of liver tissues

The kidney tissues were removed and preserved in 10% neutral buffered formalin for a minimum of 24 to 48 hours. They were then sliced to a size of 5 microns, fixed in paraffin wax, and processed using conventional methods. After deparaffinization with xylene, the H&E technique was used for histological observations. The slides were examined under a light microscope at 400x magnification

Statistical Analysis

Values are expressed using the mean ± standard error of the mean (SEM) method. The results were assessed using one-way analysis of variance (ANOVA), and the means were separated using the Duncan multiple range test. A significance level of $p < 0.05$ was set.

Results and Discussion

Table 1 displays the antioxidant content of the N-butanol fraction, ethyl acetate, and ethanol extracts of *P. macrophylla* leaves. The extract under study exhibited the highest amount of DPPH (61.33%) in the n-butanol fraction, suggesting that it possesses greater antioxidant properties than the others. The ethanol extract had the lowest antioxidant activity (59.05%) but still showed significant free radical scavenging ability, while the ethyl acetate fraction also showed a 60% scavenging ability. This observation indicates that all the extracts could ameliorate oxidative stress and may serve as hepatoprotective agents.

The effects of n-butanol fractions, ethanol extracts, and ethyl acetate fractions on *P. macrophylla* leaves on the hepatotoxicity caused by paracetamol in Wistar rats are shown in Table 2. Liver function was assessed using alkaline phosphatase (ALP), aspartate transaminase (AST), and alanine aminotransaminase (ALT). When EE was administered at 100 mg/kg (B1) and 200 mg/kg (B2), AST and ALT

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levels decreased significantly ($p < 0.05$), with B2 levels approaching normal control levels. However, B3 (400 mg/kg EE) resulted in elevated AST and ALT, suggesting potential toxicity. EA at 100 mg/kg (C1) demonstrated minimal but significant restoration of ALT ($p < 0.05$), while 200 mg/kg (C2) showed better improvement in ALP, AST, and ALT. The 400 mg/kg EA group (C3) provided the most significant hepatoprotection, with ALP, AST, and ALT closely matching the normal control ($p < 0.05$). Similarly, AST, ALT, and ALP showed a notable recovery towards normal levels when 200 mg/kg of NB was administered. The highest dose (400 mg/kg NB) exhibited increased AST and ALT, suggesting a dose-dependent effect. The 400 mg/kg and 200 mg/kg of ethyl acetate and n-butanol fractions, respectively, demonstrated the most significant ($p < 0.05$) hepatoprotective effects with values very close to normal control. Ethanol extract (200 mg/kg) was effective but not as potent as EA and NB fractions.

Table 1: Antioxidant Properties of *Pentaclethra macrophylla Leaf Extracts*

GROUPS	Ethanol Extract	N-butanol	Ethyl Acetate
% DPPH	**59.05±0.03[1]**	**61.33±0.33[2]**	**60.33±0.88[12]**

Values are expressed using mean ± SEM. While values with different numeric superscripts differ considerably ($p < 0.05$), those with similar numeric superscripts are not statistically different ($p > 0.05$). DPPH stands for 2,2-diphenyl-1-picrylhydrazyl.

Table 2: Effects of *Pentaclethra macrophylla* Leaf Extracts on Liver Enzyme Markers

GROUPS	ALP (U/L)	AST(U/L)	ALT(U/L)
A1 Normal control	133.00±13.00[1]	441.77±105.57[23]	127.37±40.14[123]
A2 Negative control	160.33±17.90[12]	237.87±5.98[12]	76.73±1.36[1]
A3 Positive control	90.66±0.88[1]	237.90±3.94[12]	64.53±4.13[1]
B1 100 mg/kg EE	174.33±30.47[12]	369.13±130.26[123]	100.17±19.78[12]
B2 200 mg/kg EE	124.33±13.66[1]	421.17±10.77[123]	80.90±11.40[12]
B3 400 mg/kg EE	227.33±3.33[23]	482.53±3.33[3]	160.53±3.33[3]
C1 100 mg/kg EA	163.66±0.66[12]	238.73±3.33[12]	65.23±0.33[1]
C2 200 mg/kg EA	286.00±80.77[3]	388.40±76.55[123]	88.77±19.93[12]
C3 400 mg/kg EA	123.33±9.33[1]	230.13±15.04[1]	181.13±28.87[3]
D1 100 mg/kg NB	109.33±5.67[1]	452.40±102.00[3]	141.60±21.20[23]
D2 200 mg/kg NB	126±11.69[1]	236.43±3.49[12]	81.67±6.44[12]
D3 400 mg/kg NB	173.00±44.09[12]	508.10±41.40[3]	166.83±19.78[3]

Values are expressed as the mean ± SEM of three replicates. Values with different numeric superscripts differ considerably ($p < 0.05$), while those with similar numeric superscripts are not statistically different ($p > 0.05$). Aspartate transaminase is referred to as AST, alanine aminotransaminase as ALT, and alkaline phosphatase as ALP. Ethyl acetate (EA), ethanol extract (EE), and N-butanol (NB).

The hepatoprotective qualities of the ethyl acetate and n-butanol fractions are further supported by the measurement of liver enzymes such as ALP, AST, and ALT. The marked decrease in AST and ALT levels in the 400 mg/kg EA and 200 mg/kg NB groups suggests enhanced liver cell integrity and less enzyme leakage into the blood, signifying hepatoprotection.[15,16,6] The results suggest that *P. macrophylla* leaf extracts, specifically the ethyl acetate and n-butanol fractions, may function as organic liver-protective agents. Their numerous phytochemical qualities and antioxidant capabilities, which lessen oxidative stress and liver damage, may be connected to this. This finding corroborates the study on the hepatoprotective effects of the aqueous extract of Erythrina senegalensis, which demonstrated that the extract exhibited substantial and dose-dependent hepatoprotective activities, leading to a reduction in the activity of ALT, ALP, and AST liver enzymes.[17] Higher dosages of ethanol and n-butanol extracts raise AST and ALT levels, which emphasizes the significance of cautious dosage selection to avoid potential hepatotoxic consequences.[18]

Table 3 displays the effects of *Pentaclathra macrophylla* leaf ethanol extracts, ethyl acetate, and N-butanol fractions on TBL, DBL, ALB, and TP of paracetamol-induced hepatotoxic rats. Wistar rats in various treatment groups showed significant improvements in total bilirubin (TBIL), direct bilirubin (DBIL), albumin (ALB), and total protein (TP). When compared to the normal control, B1 (100 mg/kg EE) demonstrated a moderate improvement in TBIL and DBIL ($p < 0.05$), whereas B2 (200 mg/kg EE) demonstrated a considerable improvement in TBIL that was close to that of the normal control group ($p < 0.05$).

Table 3: *Pentaclathra macrophylla* Leaf Effects on Ethanol Extracts, Ethyl Acetate, and N-Butanol Fractions on TBL, DBL, ALB, and TP of Paracetamol-Induced Hepatotoxicity in Wistar Rats

GROUPS	TBIL (mg/dl)	DBIL (mg/dl)	ALB (g/dl)	TP (g/dl)
A1 Normal control	2.99±0.16[5]	1.97±0.02[1]	33.23±1.45[2]	64.70±1.40[12]
A2 Negative control	3.44±0.20[67]	2.77±0.38[1]	37.00±0.58[34]	68.47±2.57[1234]
A3 Positive control	3.12±0.07[56]	12.22±3.62[2]	38.37±0.79[4]	73.83±2.78[4]
B1 100 mg/kg EE	2.13±0.06[234]	1.66±0.51[1]	37.70±0.85[4]	71.80±3.01[34]
B2 200 mg/kg EE	2.03±0.05[1234]	1.91±0.01[1]	34.97±0.43[23]	64.70±1.50[12]
B3 400 mg/kg EE	3.65±0.01[7]	11.86±0.03[2]	36.23±0.03[34]	74.67±0.33[4]
C1 100 mg/kg EA	2.33±0.03[34]	2.32±0.01[1]	34.87±0.03[23]	64.63±0.33[12]
C2 200 mg/kg EA	1.96±0.04[123]	4.31±3.06[1]	28.63±1.11[1]	67.50±2.24[123]
C3 400 mg/kg EA	1.62±0.03[1]	0.82±0.41[1]	35.13±0.70[23]	69.63±1.66[234]
D1 100 mg/kg NB	2.03±0.00[1234]	1.90±0.00[1]	32.93±0.27[2]	63.06±2.43[1]
D2 200 mg/kg NB	1.83±0.05[12]	0.77±0.38[1]	29.97±0.82[1]	62.40±1.15[1]
D3 400 mg/kg NB	2.39±0.34[4]	4.42±1.84[1]	36.20±1.10[34]	67.17±1.25[123]

Mean + SEM of three replicates is used to express values. Values with similar numeric superscripts are not statistically different ($P > 0.05$), while those with differing numeric superscripts differ significantly ($p < 0.05$). ALB stands for albumin, TP for total proteins, NB for N-butanol, EE for ethanol extract, and EA for ethyl acetate.

However, B3 (400 mg/kg EE) shows higher TBIL, suggesting inefficacy at this dose. C1 (100 mg/kg EA) exhibited moderate recovery in TBIL and DBIL compared to the normal control, whereas C2 (200 mg/kg EA) significantly improved TBIL levels ($p < 0.05$), though DBIL remained elevated compared to the normal control. C3 (400 mg/kg EA) demonstrated significant ($p < 0.05$) hepatoprotection, with TBIL and DBIL levels closely matching the normal control, while ALB and TP levels also significantly improved ($p < 0.05$), suggesting enhanced liver function. D1 (100 mg/kg NB) moderately ($p < 0.05$) restores TBIL and DBIL levels, but ALB remains lower than the normal control. D2 (200 mg/kg NB) exhibits the best improvement in DBIL ($p < 0.05$), indicating effective hepatoprotection, while TP is also significantly restored ($p < 0.05$). D3 (400 mg/kg NB) shows the highest TP level, indicating improved protein synthesis and overall liver function ($p < 0.05$), with a significant decrease ($p < 0.05$) in TBIL and DBIL when compared with the treated group. Ethyl acetate (400 mg/kg) and n-

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butanol (200 mg/kg) fractions demonstrated the most significant hepatoprotective effects with values close to normal control levels ($p < 0.05$). Ethanol extract (200 mg/kg) was effective but not as potent as EA and NB fractions.

The 400 mg/kg and 200 mg/kg ethyl acetate and n-butanol fractions, respectively, exhibited the most notable hepatoprotective properties, indicated by their capacity to bring TBIL, DBIL, ALB, and TP levels back to nearly normal values. These results align with earlier research that has emphasized the dose-dependent liver-protective properties of plant extracts. [19,8,17] The recovery of these biochemical indicators implies that these fractions improve liver function by facilitating protein synthesis and decreasing bilirubin buildup, which are essential markers of liver health.

While the ethanol extract proved to be effective, it exhibited minimal hepatoprotective activity when compared to the EA and NB fractions. This could be attributed to the lower concentrations of flavonoids and phenolic compounds in the ethanol extract, which are essential for reducing inflammation and oxidative stress in liver cells. [20,10,4] The ineffectiveness of the ethanol extract at 400 mg/kg, as evidenced by increased TBIL levels, indicates a possible toxic limit, emphasizing the need for dose optimization in therapeutic applications.[4]

Histopathological analyses of paracetamol-induced hepatotoxicity in Wistar rats treated with ethanol extracts, ethyl acetate, and N-butanol fractions of *P. macrophylla* leaf were depicted in Figures 1, 2, and 3. Rats from experimental groups A1 (normal control) and A3 (positive control) had photomicrographs of their liver slices that appeared to show normal hepatocytes and central veins (Figure 1).

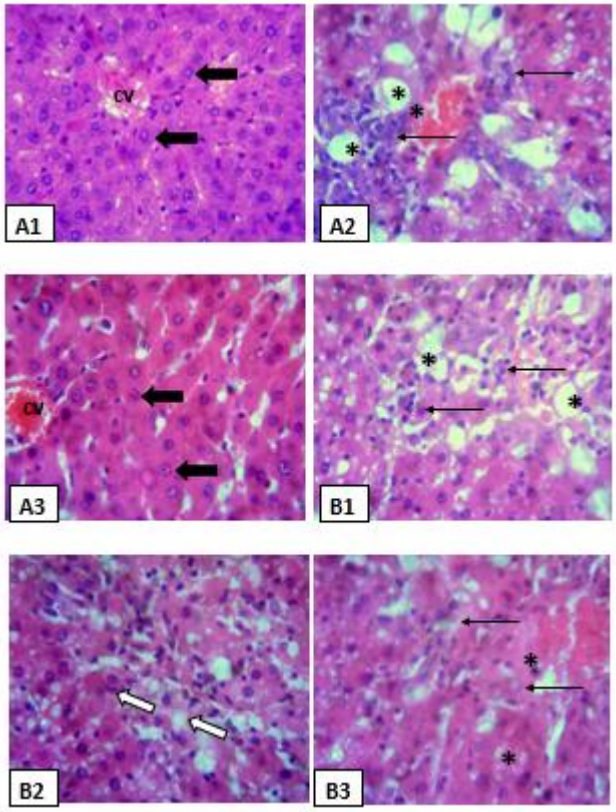

Figure 1: Photomicrograph of rat liver slices from experimental group A1 (normal control) and A3 (positive control) showing apparently normal central vein (cv) and hepatocytes (arrows). Groups A2 (negative control), B1 (100 mg/kg EEMP), and B3 (400 mg/kg EEMP) show moderate centrilobular hepatocyte degenerations and coagulative necrosis (asterisk) associated with inflammatory cell infiltrations (thin arrows), and B2 (200 mg/kg EEMP) shows mild centrilobular hepatocyte degenerations and necrosis (white arrows). (H and E stain × 400)

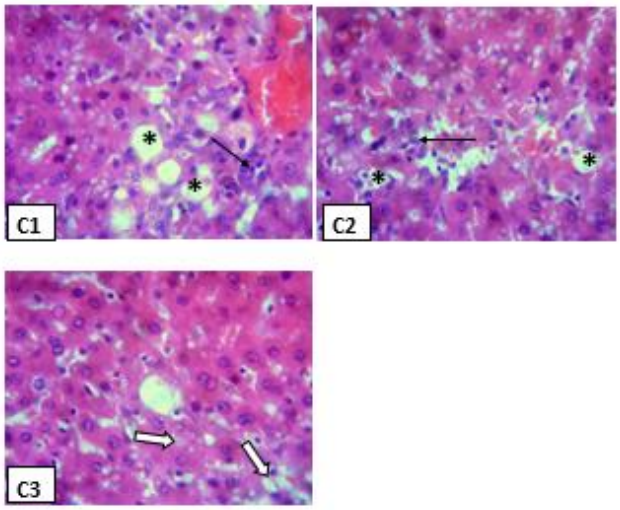

Figure 2: Photomicrograph of rat liver slices from experimental group C1 (100 mg/kg EAFMP) and C2 (200 mg/kg EAFMP) showing moderate centrilobular hepatocyte degenerations and coagulative necrosis (asterisk) associated with inflammatory cell infiltrations (thin arrows), and C3 (400 mg/kg EAFMP) showing mild centrilobular hepatocyte degenerations and necrosis (arrows). (H and E stain × 400)

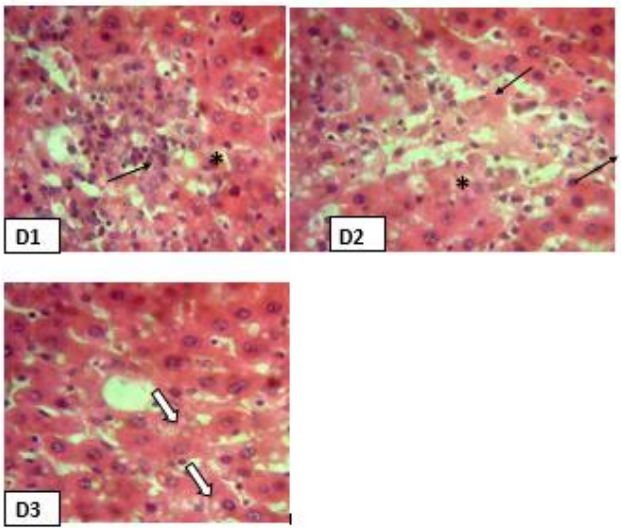

Figure 3: Photomicrograph of rat liver slices from experimental groups D1 (100 mg/kg NBEMP) and D2 (200 mg/kg NBEMP) showing moderate centrilobular hepatocyte degenerations and coagulative necrosis (asterisk) associated with inflammatory cell infiltrations (thin arrows), and D3 (400 mg/kg NBEMP) showing mild centrilobular hepatocyte degenerations and necrosis (arrows). H and E stain × 400.

Moderate centrilobular hepatocyte degenerations and coagulative necrosis were observed in the negative control group alongside those treated with 100 mg/kg, 200 mg/kg, and 400 mg/kg of EE, respectively, which could be associated with inflammatory cell infiltrations. Rats from experimental groups C treated with 100 mg/kg and 200 mg/kg had liver sections displaying moderate centrilobular hepatocyte degenerations and coagulative necrosis linked to inflammatory cell infiltrations, while rats from experimental group C3 (400 mg/kg) had mild centrilobular hepatocyte degenerations and necrosis (Figure 2).

According to Figure 3, rats from experimental groups D1 (100 mg/kg),

D2 (200 mg/kg), and D3 (400 mg/kg) exhibited coagulative necrosis and significant centrilobular hepatocyte degenerations linked to inflammatory cell infiltrations.

Histopathological alterations noted in the microscopic analysis of liver sections include moderate/mild degenerations of centrilobular hepatocytes and coagulative necrosis associated with inflammatory cell infiltrations, primarily at high doses. This aligns with the research conducted[21, 22] regarding the impact of ethanolic extract from *Euphorbia hirta* leaves on rat liver histology. However, the elevated levels of the liver enzymes ALT and AST in the treated animals were significantly and dose-dependently reduced by the ethyl acetate fraction therapy. This indicates the anti-necrotic characteristics and the capacity of this extract to maintain the structural integrity and safeguard the hepatocellular membrane, as shown by the histological examination.[11] This effect is supported and may even be attributed to the strong in vitro antioxidant property of the extract on lipid peroxidation.[11]

Conclusion

P. macrophylla leaf extract may have hepatoprotective effects due to its antioxidant qualities, which reduce oxidative stress and protect the liver from damage. We recommend investigating the molecular mechanisms of action to gain a deeper understanding of their therapeutic potential

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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References

1. Zhang X, Li S, Hao L, Jia F, Yu F, and Hu X. Influencing factors and mechanism of hepatocyte regeneration. J Transl Med. 2025; 23:493-506. https://doi.org/10.1186/s12967-025-06278-9
2. Lee W M. Global burden of liver disease: 2023 update. J Hepatol. 2023; 78(3):436-457. https://doi.org/10.1016/j.jhep.2023.01.001
3. Shaarawy M, Abdel-Rahman A, and Hamouda MA. Liver injury induced by acetaminophen and other drugs. Toxicol. Reports. 2023; 10:451-460. https://doi.org/10.1016/j.toxrep.2023.03.005
4. Okonkwo O, Ude C, and Amadi C. Hepatoprotective effects of ethanolic extracts of *Pentaclethra macrophylla* on paracetamol-induced liver toxicity in rats. Afr J. Biotechnol. 2023; 22(1):15–22. https://doi.org/10.5897/AJB2023.17523
5. Almatroodi SA, Alsahli MA, Almtroudi A, and Rahmani AH. Curcumin, a natural antioxidant with therapeutic potential in inflammatory and oxidative stress-related conditions. Int J. Mol Sci. 2020; 21(20):7722. https://doi.org/10.3390/ijms21207722
6. Lai W, Zhou S, Bai Y, Che Q, Cao H, Guo J, and Su Z. Glucosamine attenuates alcohol-induced acute liver injury via inhibiting oxidative stress and inflammation. Curr Res Food Sci. 2024; 8:100699 https://doi.org/10.1016/j.crfs.2024.100699
7. Power S, Barritt AS 4th. A Yellow Flower with Jaundice Power: Liver Injury Attributed to Greater Celandine. ACG Case Rep J. 2024; 11(5): e01347. Published 2024 Apr 26. doi:10.14309/crj.0000000000001347
8. Sinda P, Ponou B, Tsafack B, Kühlborn J, Tchuenguem R, Teponno R, Dzoyem J, Opatz T, and Tapondjou L. Ethnobotany, Pharmacology, and Phytochemical Investigations of the Seeds of *Pentaclethra macrophylla* Benth (Mimosaceae). Adv Biol Chem. 2021; 11:126-141. doi: 10.4236/abc.2021.113009.
9. Onwuzuruike U, Inyang UE, Edima-Nyah AP, Okwunodulu IN, Anyanwu CU. Chemical Composition, Quality Indices, and Viscosity of Edible Oils from Blends of African Oil Bean Seed Oil and Sesame Seed Oil. J. Bio Geo Mat and Energy. 2024; 4(1):33-47
10. Ugbogu EA, Nwoku CD, Ude VC, Emmanuel O. Evaluating bioactive constituents and toxicological effects of aqueous extract of fermented *Pentaclethra macrophylla* seeds in rats. Avicenna J. Phytomed, 2020; 10(1): 101-113. doi: 10.22038/ajp.2019.13557
11. Amaku JF, Ogundare SA, Akpomie KG, Conradie J. *Pentaclethra macrophylla* stem bark extract anchored on functionalized MWCNT-spent molecular sieve nanocomposite for the biosorption of hexavalent chromium. Int J Phytoremediation. 2022; 24(3):301-310. doi:10.1080/15226514.2021.1937930
12. Nnamani PO, Diovu EO, Peter IE, Onwuka AM, Ogbuanwu CV, Abonyi OE, Loretz B, Lehr C-M. Anti-Inflammatory and Antinociceptive Activity of Herbal Lipospheres of *Pentaclethra macrophylla* (Fabaceae) Stem Bark Extract. Processes. 2023; 11(9):2557. https://doi.org/10.3390/pr11092557
13. Ukoro B, Chike CPR, Olorunfemi OJ. Effects of Aqueous Extract of *Pentaclethra macrophylla* Leaves on Blood Pressure and Oxidative Stress in Albino Wistar Rats. Int J. Sci Res Eng Dev. 2020; 3:1095–1108
14. Abdelhadi A. Effect of Captopril on Paracetamol Induced Nephrotoxicity in Rats: Histological Study. AI Jinan. 2018; doi:10.33986/0522-000-010-020
15. Jaeschke H, Ramachandran A. The role of oxidant stress in acetaminophen-induced liver injury. Curr Opin Toxicol. 2020; 20-21:9-14. doi:10.1016/j.cotox.2020.03.003
16. Machado IF, Miranda RG, Dorta DJ, Rolo AP, Palmeira CM. Targeting Oxidative Stress with Polyphenols to Fight Liver Diseases. Antioxidants. 2023; 12(6):1212. https://doi.org/10.3390/antiox12061212
17. Ojimelukwe PC. Health benefits and medicinal values of *Pentaclethra macrophylla*. J Traditional Med Applications. 2024; 3(1):01 -10
18. Phan T, Desmond C. Hepatitis E Infection with Acute Liver Failure. ACG Case Rep J. 2020; 7(3):e00361. doi:10.14309/crj.0000000000000361
19. Pandey N, Gupta SC, and Yadav SK. Antioxidant and hepatoprotective properties of fenugreek (*Trigonella foenum-graecum*) seed extract during alcohol consumption in rats. Phytomed. 2023; 112: 154678. https://doi.org/10.1016/j.phymed.2023.154678
20. Afia K. A Review of *Pentaclethra macrophylla* (African Oil Bean) Seed. IDOSR J. Exp Sci. 2020; 5(1):1-7.
21. Izunya AM, Akpamu U, Uzzi HO, Oaikhena GA, and Ujaddughe OM. Effects of ethanolic extract of Euphorbia hirta leaf on the biochemical parameters and histology of liver and kidney in rats. FUOYE J. Biomed Res. 2024; 1(2):148 -158.
22. Madubuike KG, Anaga AO, and Asuzu IU. Effect of Methanol Leaf Extract of *Pterocarpus santalidoides* L' Herit ex DC on the Antioxidant and Lipid Profile of Wistar Rats. Trop. J. Nat. Prod. Res. 2021; 5(7), 1295-1299. doi.org/10.26538/tjnpr/v5i7.22.