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Hepatoprotective activity of ethanolic peel extract of *Saccharum officinarum* L. against thioacetamide - induced liver injury in albino rats

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ABSTRACT

The liver plays an essential role in metabolism and detoxification, making it prone to damage by chemical agents. This study evaluated the hepatoprotective activity of ethanolic peel extract of *Saccharum officinarum* (SOPE) against thioacetamide (TAA) - induced liver injury in albino Wistar rats. Twenty-five rats were divided into five groups of five each. Two groups received 125 mg/kg and 250 mg/kg of SOPE, respectively, one received zinc lactate (200 mg/kg), one served as the normal control, and one as the TAA-only group. Treatments were administered orally for six days, followed by TAA (200 mg/kg, i.p.) on day seven. Biochemical markers (ALT, AST, ALP, total bilirubin, and albumin) and histopathological changes were assessed. SOPE significantly reduced ($p < 0.001$) ALT, AST, ALP, and total bilirubin levels, while increasing albumin in a dose-dependent manner. Histological results confirmed hepatoprotection, showing preserved hepatic structures in SOPE - treated rats compared with the TAA -only group. These findings suggest that *Saccharum officinarum* peel extract possesses potent hepatoprotective activity likely due to its antioxidant phytochemicals.

Keywords: *Saccharum officinarum*, hepatoprotection, thioacetamide, liver enzymes, oxidative stress, Wistar rats

1. INTRODUCTION

The liver is an essential organ which performs a wide range of metabolic, detoxification, and synthetic functions vital for maintaining homeostasis. It processes nutrients absorbed from the intestine, metabolizes drugs and toxins, and synthesizes plasma proteins, bile, and lipids. Because of its central role in metabolism, the liver is particularly susceptible to toxic injury from xenobiotics, drugs, and environmental chemicals. Liver diseases remain a significant global health concern, contributing substantially to morbidity and mortality. Hepatotoxicity, defined as chemical-induced liver damage, is one of the most frequent causes of acute liver failure and drug withdrawal from the market.

Thioacetamide (TAA) is a well-established hepatotoxin used in experimental models to induce hepatic necrosis and fibrosis. It exerts its toxic effect primarily through the generation of reactive oxygen species (ROS) during its metabolism by cytochrome P450 enzymes. TAA is metabolized to thioacetamide-S-oxide and thioacetamide-S-dioxide, both of which bind to cellular macromolecules, leading to oxidative stress, lipid peroxidation, and cell death. The oxidative stress generated disrupts the balance between pro-oxidants and antioxidants, causing membrane lipid damage, enzyme inactivation, and DNA fragmentation. These events result in hepatocyte necrosis, inflammation, and fibrosis. Studies have shown that the use of antioxidants and free radical scavengers can mitigate the oxidative damage caused by TAA (Salma et al., 2022; Zhang & Xu, 2024).

Despite the availability of conventional hepatoprotective drugs, such as corticosteroids and synthetic antioxidants, their clinical efficacy remains limited, and they are often associated with adverse side effects upon prolonged use. Consequently, attention has shifted toward natural products and plant-derived compounds as safer alternatives for hepatoprotection. Medicinal plants contain bioactive phytochemicals that exhibit antioxidant, anti-inflammatory, and cytoprotective effects capable of counteracting oxidative stress. The use of plant extracts in hepatoprotection has been documented in numerous studies, where phytochemicals such as flavonoids, phenols, saponins, and alkaloids act as natural antioxidants and free radical scavengers (Wang et al., 2018; Ojo et al., 2021).

Saccharum officinarum (sugarcane) is a tall perennial grass belonging to the family Poaceae, widely cultivated in tropical and subtropical regions for its high sucrose content. In many countries, sugarcane peels or rinds are regarded as waste products, yet they are rich in polyphenolic compounds with important biological activities. Phytochemical analyses of sugarcane peels have revealed the presence of flavonoids, phenolic acids, and phytosterols that exhibit potent antioxidant and anti-inflammatory properties (Li et al., 2020; Chu et al., 2016). These compounds play essential roles in scavenging free radicals and preventing oxidative damage to cells.

Earlier studies demonstrated the beneficial effects of sugarcane extracts in protecting tissues against oxidative stress and inflammation. For instance, Wang et al. (2018) reported that sugarcane polyphenol extracts inhibited liver fibrosis in rats by downregulating the MAPK signaling pathway. Similarly, Ashade et al. (2014) showed that ethanolic extracts of sugarcane peel improved hematological and histopathological parameters in Wistar rats. More recently, Nwosu et al. (2022) reported that polyphenols from sugarcane rind reduced lipid peroxidation and enhanced hepatic antioxidant enzyme activity in chemically induced liver injury models. These findings collectively suggest that *Saccharum officinarum* peel extract (SOPE) contains bioactive compounds capable of protecting the liver from toxin-induced damage.

The mechanism of hepatoprotection by such extracts is generally attributed to their antioxidant potential, which enhances endogenous defense systems like glutathione and catalase while reducing oxidative stress markers. Flavonoids and phenolic compounds in sugarcane peels can neutralize ROS, chelate transition metals, and stabilize cell membranes, thereby preventing hepatic injury. Moreover, the presence of saponins and alkaloids may contribute to membrane stabilization and anti-inflammatory effects. However, despite these promising properties, scientific evaluation of *Saccharum officinarum* peel extract in the prevention of TAA-induced hepatotoxicity remains limited.

The exploration of this plant's hepatoprotective activity aligns with the global shift toward discovering natural, affordable, and effective therapeutic alternatives. Using experimental animal models provides a reliable approach to assessing hepatoprotection, as they mimic biochemical and histopathological alterations observed in human liver diseases. In this study, thioacetamide was used to induce hepatic injury in albino Wistar rats, while the crude ethanolic peel extract of *Saccharum officinarum* was evaluated for its potential to mitigate this damage.

This research was therefore undertaken to assess the hepatoprotective effect of crude ethanolic peel extract of *Saccharum officinarum* (SOPE) on thioacetamide-induced liver injury in albino Wistar rats. The study examined key biochemical parameters such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, and albumin, alongside histopathological evaluation of liver tissues. The findings are expected to contribute to the growing body of evidence supporting the therapeutic use of natural products in the management of liver diseases and to highlight the potential value of sugarcane peel, an agricultural by-product, as a source of bioactive compounds with hepatoprotective potential.

2. MATERIALS AND METHODS

All chemicals and reagents used in this study were of analytical grade and obtained from Randox Laboratory Ltd., Antrim, UK. Diagnostic kits were used to determine the serum levels of ALT, AST, ALP, total bilirubin, and albumin.

Fresh sugarcane peels were collected from Orba, Udenu Local Government Area, Enugu State, Nigeria. The plant material was authenticated at the International Centre for Drug Development (InterCEDD), Nsukka, and a voucher specimen (INTERCEDD/1340) was deposited in the herbarium. The peels were washed, air-dried at room temperature, and ground into a fine powder. About one kilogram of the powder was extracted with five liters of ethanol using a Soxhlet extractor. The extract was filtered, concentrated under reduced pressure, and stored in an airtight container until use.

Twenty-five male albino Wistar rats weighing between 110 g and 150 g were obtained from the Animal House, Faculty of Biological Sciences, University of Nigeria, Nsukka. The animals were housed under standard laboratory conditions with a 12-hour light/dark cycle and had free access to food and water. All animal handling procedures were carried out in accordance with institutional ethical guidelines.

The rats were randomly divided into five groups of five animals each. Group I served as the normal control and received distilled water. Group II received 200 mg/kg TAA intraperitoneally on the seventh day and served as the toxic control. Group III received 125

mg/kg SOPE orally for six days followed by TAA injection. Group IV received 250 mg/kg SOPE orally for six days followed by TAA injection. Group V received zinc lactate (200 mg/kg) orally for six days followed by TAA injection.

Acute toxicity testing was performed using Lorke's method. The extract was administered orally at doses up to 5,000 mg/kg, and the animals were monitored for 72 hours for any signs of toxicity or mortality. No toxic effects or deaths were observed, suggesting that the extract is safe at these doses.

Phytochemical screening was carried out using standard qualitative methods to detect the presence of alkaloids, flavonoids, tannins, saponins, carbohydrates, phenols, proteins, and glycosides.

After treatment, blood samples were collected through the retro-orbital sinus, and serum was separated for biochemical analysis. The liver tissues were harvested, washed in ice-cold saline, and fixed in 10% formalin for histopathological examination. Serum enzyme activities were determined using standard colorimetric methods: ALT and AST by Reitman and Frankel, ALP by King and Armstrong, total bilirubin by Jendrassik–Grof, and albumin by bromocresol green method. Data were analyzed using one-way ANOVA, followed by Tukey's post hoc test, with $p < 0.05$ considered statistically significant.

3. RESULTS AND DISCUSSION

The phytochemical analysis of the ethanolic peel extract of *Saccharum officinarum* showed that it contains several bioactive compounds such as carbohydrates, alkaloids, flavonoids, tannins, saponins, phenols, and proteins. These compounds are known for their antioxidant and anti-inflammatory properties, which may contribute to the protective effect observed in this study. Flavonoids and phenolic compounds, especially, are natural antioxidants that can scavenge free radicals and prevent oxidative damage in body tissues. This agrees with the findings of Wang et al. (2018) and Li et al. (2020), who reported that similar plant compounds play important roles in liver protection.

The acute toxicity test showed that the extract was safe, with no signs of toxicity or mortality at doses up to 5,000 mg/kg body weight. This suggests that *Saccharum officinarum* peel extract (SOPE) has a wide margin of safety and may be suitable for therapeutic use.

Table 1 presents the phytochemical constituents of the extract, while Table 2 shows the effects on serum biochemical parameters. The administration of thioacetamide (TAA) to the negative control rats caused a significant increase in the levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and total bilirubin, together with a decrease in albumin concentration when compared with the normal control group. This shows that TAA caused serious liver damage, which may be due to oxidative stress and the breakdown of hepatocyte membranes.

Rats that received the sugarcane peel extract at doses of 125 mg/kg and 250 mg/kg showed much lower levels of ALT, AST, ALP, and total bilirubin compared with the TAA-only group, and their albumin levels increased toward normal. This means that the extract protected the liver from damage and maintained its normal function.

The 250 mg/kg dose gave a stronger protective effect, showing that the action of the extract was dose dependent. A similar trend was seen in the group treated with zinc lactate, which is a known antioxidant drug.

Table 1. Phytochemical constituents of the ethanolic peel extract of *Saccharum officinarum*.

Phytochemical	Relative abundance
Carbohydrates	++
Alkaloids	+
Flavonoids	++
Tannins	+
Saponins	++
Phenols	++
Proteins	+

(+ = Present; ++ = Moderately abundant).

Table 2. Effects of ethanolic peel extract of *Saccharum officinarum* on liver biochemical parameters in TAA-induced rats.

Group	ALT (U/L)	AST (U/L)	ALP (U/L)	Total bilirubin (mg/dL)	Albumin (g/dL)
Normal control	24.6 ± 2.1	36.8 ± 3.2	58.2 ± 4.5	0.82 ± 0.06	4.10 ± 0.15
TAA only	85.4 ± 4.3	120.5 ± 6.8	154.7 ± 7.2	2.85 ± 0.20	2.16 ± 0.10
125 mg/kg SOPE + TAA	47.3 ± 3.5	69.1 ± 4.9	88.4 ± 5.2	1.43 ± 0.12	3.22 ± 0.13
250 mg/kg SOPE + TAA	34.8 ± 2.8	51.2 ± 4.2	70.5 ± 3.8	1.02 ± 0.08	3.75 ± 0.18
Zinc lactate + TAA	31.5 ± 3.0	47.6 ± 3.5	66.3 ± 4.0	0.97 ± 0.06	3.82 ± 0.15

Values are mean ± SD; p < 0.001 compared with TAA control.

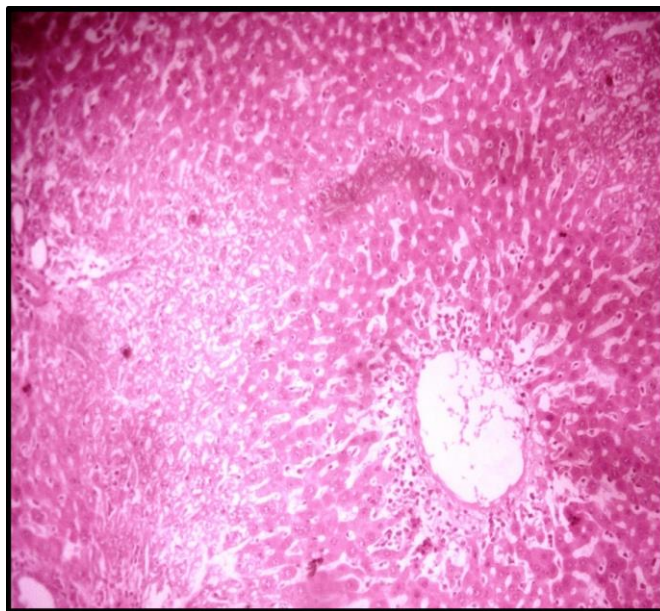


Figure 1. Liver section photomicrograph of GROUP A rat treated with 125 mg/kg body weight (LOW dose) of PD prior to TAA-induced injury showing protection of the tissue histoarchitecture. The portal tract (PT) and periportal hepatocytes are intact; however, mild inflammatory cellular infiltration is observed at the centrilobular region (arrows). [Stain: HandE] [Mag: $\times 100$].

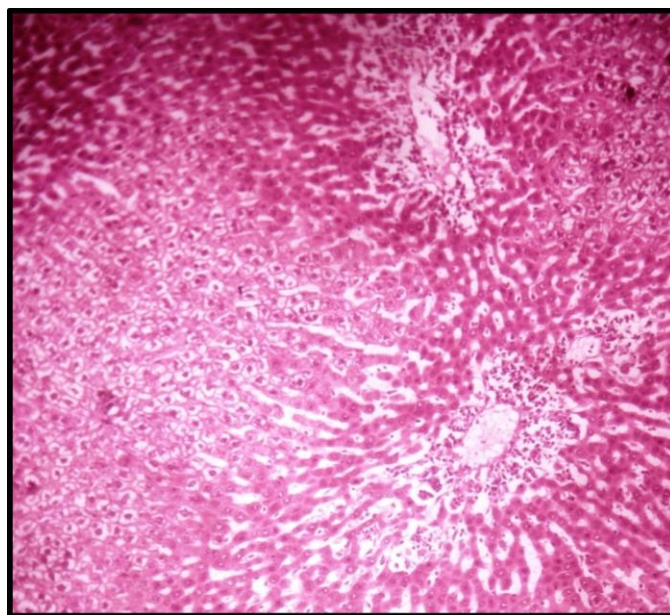


Figure 2. Liver section photomicrograph of GROUP B rat treated with 250 mg/kg body weight (HIGH dose) of PD prior to TAA-induced liver damage showing normal lesions (arrows). The portal tracts are intact but periportal hepatocytes (h) show scanty cytoplasm with central round nuclei (h). [Stain: HandE] [Mag: $\times 100$].

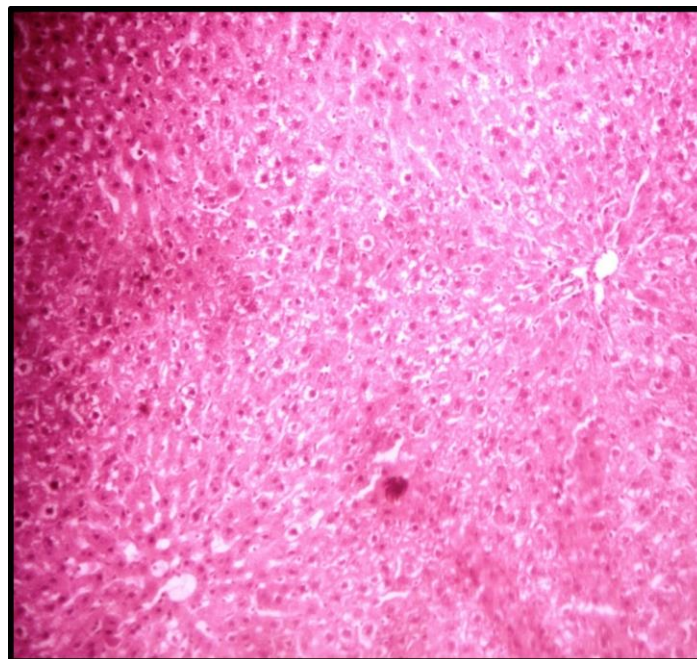


Figure 3. Photomicrograph of NORMAL control (GROUP C) rat liver section showing normal tissue parenchyma. The central vein (CV), portal tract (PT), sinusoids (S) and hepatocytes (h) are normal. [Stain: HandE] [Mag: $\times 100$].

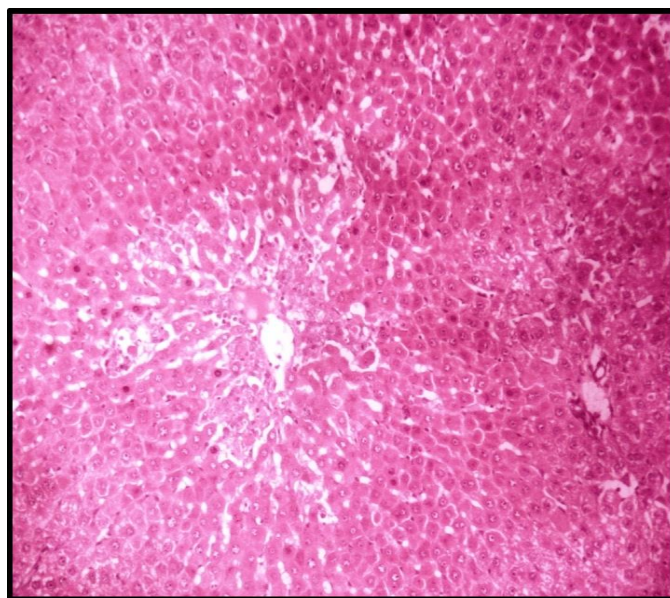


Figure 4. Liver section photomicrograph of POSITIVE control (GROUP D) rat, treated with zinc lactate prior to TAA-induced liver damage. The tissue architecture is preserved. The portal tract (PT), central vein (CV) and surrounding hepatocytes (h) appear normal. However, mild cellular infiltration is observed at the centrilobular region (arrows).[Stain: HandE] [Mag: $\times 100$].

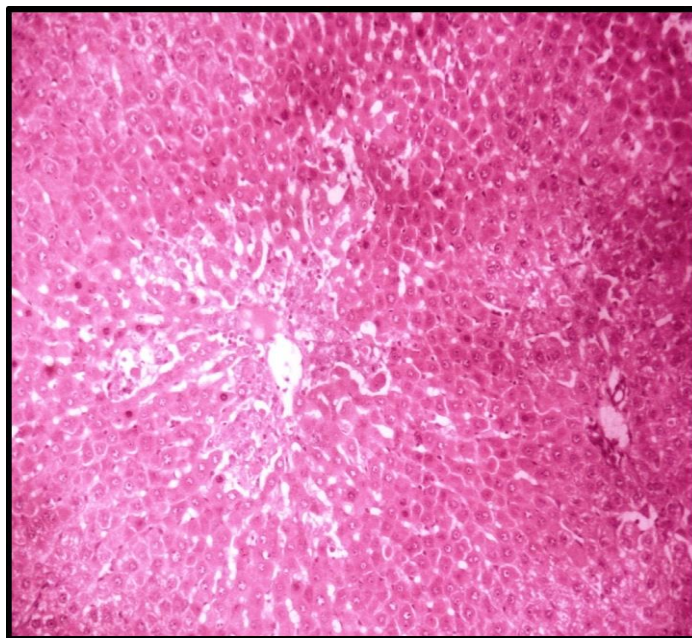


Figure 5. Photomicrograph of NEGATIVE control rat liver section (Group E) treated with only TAA showing extensive tissue derangement. There is inflammatory cellular infiltration within necrotic and degenerating hepatocytes at centrilobular and periseptal regions (arrows). The sinusoidal spaces (iS) appear increased. [Stain: HandE] [Mag: $\times 400$].

Histopathological results supported the biochemical findings. The liver of the normal control rats showed normal structure with clear central veins and hepatocytes. The TAA-only group had severe tissue damage, with necrosis, vacuolation, and inflammation. In the rats treated with 125 mg/kg of the extract, mild degeneration and focal inflammation were observed, while the 250 mg/kg group showed nearly normal liver cells. The zinc lactate-treated group also showed good liver protection.

The improvement in biochemical and histological parameters may be linked to the antioxidant compounds present in the sugarcane peel extract. Flavonoids and phenols help neutralize free radicals and prevent oxidative stress, which is a major cause of liver damage.

This observation is in line with the findings of Nwosu et al. (2022), who reported similar protection against chemical-induced liver injury using plant polyphenols. The result also supports earlier reports by Wang et al. (2018) and Ojo et al. (2021), which showed that extracts rich in natural antioxidants lower serum enzyme levels and improve liver architecture.

4. CONCLUSION

The findings of this study have shown that the crude ethanolic peel extract of *Saccharum officinarum* (SOPE) has significant hepatoprotective effects against thioacetamide-induced liver injury in albino Wistar rats. The extract improved liver function by reducing the serum levels of ALT, AST, ALP, and total bilirubin, while increasing albumin concentration in a dose-

dependent manner. Histopathological observations also confirmed that the extract preserved the normal structure of the liver and reduced tissue damage caused by thioacetamide.

These effects may be attributed to the presence of antioxidant phytochemicals such as flavonoids, phenols, and saponins, which help neutralize free radicals and protect hepatocytes from oxidative stress. From this research, it can be concluded that *Saccharum officinarum* peel extract possesses promising hepatoprotective potential and could serve as a natural, safe, and affordable alternative in the management of liver disorders caused by chemical toxins. Further studies are recommended to isolate and characterize the specific active compounds responsible for this effect and to evaluate their mechanism of action in more detail.

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