Research Article

Evaluation of nephroprotective activity of hydroalcoholic leaf extract of *Boswellia ovalifoliolata* on Gentamicin induced nephrotoxicity in albino wistar rats

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Abstract

Background: Gentamicin, a widely used antibiotic for treating bacterial infections, is known to have nephrotoxic side effects, primarily attributed to oxidative stress and the generation of free radicals. To counteract these adverse effects, natural remedies with antioxidant properties are being actively investigated. **Objectives:** To evaluate nephroprotective activity of hydroalcoholic leaf Extract of *Boswellia ovalifoliolata* on Gentamicin-induced nephrotoxicity in albino wistar Rats. To carry out the preliminary screening, analytical studies, acute toxicity studies and nephroprotective activity of hydroalcoholic leaf extract of *Boswellia ovalifoliolata*. **Materials and Methods**: The Hydroalcoholic leaf extract of *Boswellia ovalifoliolata* shows presences of saponins, alkaloids, flavonoids, terpenoids, phytosterols, tannins, phenols, phyto steroids and sterols. Acute toxicity assessments indicated that the safety threshold of HALBO is as high as 2000mg/kg. **Results**: The biochemical factors like blood urea nitrogen, urine output, serum creatinine levels in rats were decreased in first two doses (200 and 400 mg/kg) and increased in control group. The groups that received hydroalcoholic leaf extract of *Boswellia ovalifoliolata* (200 mg/kg p.o. and 400 mg/kg p.o., respectively) had lower levels of glutathione reductase and malondialdehyde than the Gentamicin control group. The groups that received hydroalcoholic leaf extract of *Boswellia ovalifoliolata* (200 mg/kg p.o. and 400 mg/kg p.o., respectively) had higher levels of reduced glutathione and catalase than the Gentamicin control group. **Conclusion:** Hydroalcoholic leaf extract of *Boswellia ovalifoliolata* (HALBO) exhibited strong nephroprotective properties due to its rich phytochemical composition. HALBO (400 mg/kg p.o.) effectively mitigated GEN-induced renal damage through its potent free radical scavenging activity.

***Keywords*:** Gentamicin, *Boswelia ovalifoliolata,* hydroalcoholic, gentamicin, nephrotoxicity, nephroprotective

Introduction

Kidney toxicity, or nephrotoxicity (from the Greek nephros, "kidney"), can be caused by exposure to any hazardous substance. Some drugs, like heparin, are mostly eliminated through the kidneys and hence require a dose change in the presence of renal impairment. Chemicals with nephrotoxicity are called nephrotoxins. Interference with renal blood flow, glomerular function, or tubular function is how drugs cause nephrotoxicosis (Hussain et al., 2012).

Acute Renal Failure (ARF): The illness known as acute renal failure (ARF) is characterized by a sharp rise in metabolic waste products (blood's urea and creatinine), which leads to the development of uraemia, and a quick start of renal dysfunction, primarily oliguria or anuria.

Chronic Renal Failure (CRF): Chronic renal failure, a condition that eventually leads to death when enough nephrons have been damaged, is characterized by a progressive and irreversible reduction in renal function caused by the slow deterioration of the renal parenchyma. With the emergence of biochemical azotaemia and clinical uraemia syndrome, acidosis is the primary issue in CRF **(**Mohan, 2015**).**

Materials and methods

Materials

Hydroalcoholic leaf extract of *Boswellia ovalifoliolata*, Gentamicin, Vitamin-E

Collection and identification of plant materials

The leaf of *Boswellia ovalifoliolata* was chosen as the study's subject because of its many potential pharmacological and

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traditional therapeutic uses. Dr. K. Madhava Chetty, a botany specialist at Sri Venkateswara University in Tirupati, Andhra Pradesh, INDIA, assessed the samples and confirmed their identity.

Chemicals: Standard Reagents in Hyderabad provided the gentamicin and vitamin E. Every chemical was of excellent analytical quality**.**

D**osage:** 100 mg/kg intraperitoneally per body weight of gentamicin 250 mg/kg p.o. per body weight of vitamin E

Animal selection

Albino Wistar rats (150-250g) is used for the present study, were purchased from the Sai nath agency, Hyderabad. Sai nath agency is a CPCSEA approved registered animal house. All procured animals kept in observation and further study in the Animal house of the Department of Pharmacy, Malla reddy College of Pharmacy, Hyderabad. The Albino Wistar rats were housed in groups of 5 in stainless steel cages (34×47×18 cm) with proper bedding and fed with normal commercial pellet diet, given water ad libitum. The pharmacological studies were conducted in accordance with internationally accepted guidelines for laboratory animal use and care. The research protocol Approved by Ethical Review Committee of the College.

Preliminary phytochemical investigation

The following phytochemical tests were carried out to check for the presence of Carbohydrates and Glycosides (Molish's test, Fehling's test, Legal's test & Borntrager's test), for Fixed oils and Fats (Saponification test) for Proteins and Amino acids (Millon's test, Biuret test &Ninhydrin test), for Saponins (Foam test) for Tannins and Phenolic compounds (Ferric chloride test, lead acetate test) for phytosterols (Libermann Burchard test) for Alkaloids (Mayer's test, Dragendroff's test, Hager's test, Wagner's test) for Flavonoids (*Shinoda test*).

GCMS significance: "The significance of GC-MS, or Gas Chromatography-Mass Spectrometry lies in its ability to provide precise and detailed analysis of complex mixtures. This analytical technique allows researchers and analysts to identify and quantify a wide range of compounds within a sample, including trace amounts of substances. GC-MS plays a vital role in fields such as chemistry, pharmacology, environmental science, and forensics, enabling the detection of impurities, contaminants, and metabolites. Its high sensitivity, selectivity, and reproducibility make it an indispensable tool for research, quality control, and safety assessment across various industries.

Acute toxicity studies

In accordance with OECD-423 criteria (Organisation of Economic Cooperation and Development) (Acute Toxic Class Method, 2001), an acute oral toxicity study was conducted. Three rats were used in each phase of a stepwise approach that was carried out in accordance with OECD rules. A chemical can be graded and classified using the Globally Harmonized System (GSM) based on the results of the procedure, which employed defined doses of 5, 50, 300, and 2000 mg/kg body weight. Three female rats, each weighing between 150 and 200 grams, were randomly chosen from each of the four groups of rats and utilized for the acute oral toxicity testing of the plant extract separately. The starting dose of *Boswellia ovalifoliolata* was given to the corresponding group at a rate of 2000 mg/kg, p.o. Following the delivery of plant extracts, the animals were fasted for the entire night with unrestricted access to water and food, and they were monitored for any indications of toxicity for an additional three to four hours. Three more rats were given the same dosage, and any toxicity symptoms were observed.

Experimental design

Thirty Albino Wistar rats, each weighing between 150 and 250 grams, were chosen for the study and divided into five groups of six rats each (n=6).

Group I: It serves as a normal control was receive vehicle for 7 days

Group II: This group of animals was receive Gentamicine (100mg/kg i.p) for 7 days (Negative control)

Group III: This rats was receive Gentamicine (100mg/kg i.p) +vitaminE(250mg/kg),p.o for 7 days (standard)

Group IV: *Boswellia ovalifoliolata* hydroalcoholic leaves extract (200mg/kg ,p.o) + Gentamicine (100mg/kg i.p) for 7 days

Group V: *Boswellia ovalifoliolata* hydroalcoholic leaves extract (400mg/kg ,p.o) + Gentamicine (100mg/kg i.p) for 7 days

Rats were put to sleep by inhaling carbon dioxide on the eighth day in order to collect blood samples for biochemical analyses. In order to test antioxidant parameters and perform histological investigation, kidneys were separated.

Preparation of serum sample: The animals were killed by carbon dioxide euthanasia on the eighth day, and blood was drawn via the retro-orbital puncture method. A Remi cold centrifuge was used to centrifuge the blood for 15 minutes at 4000 rpm. A number of biochemical markers, including blood urea nitrogen (BUN), serum creatinine, and urine output, were measured by separating the serum.

Evaluation of biochemical parameters

1. **Blood urea nitrogen (BUN):** The amount of urea nitrogen in the blood is determined by a blood urea nitrogen (BUN) test. A waste product is urea nitrogen. It appears

when the protein in your food is broken down by your body. After forming in your liver, it passes through your bloodstream and is subsequently filtered out by your kidneys. Urine (pee) is how it exits your body.

2. Urine output: The urine output test is a clinical assessment used to measure the amount of urine excreted by the kidneys over a specific time, often to monitor kidney function, fluid balance, or hydration status.

3. PH OF URINE: Dip Stick kit is used for testing the P^H of urine with the sample of urine.

Evaluation of antioxidant parameters

1. Malondialdehyde (MDA): Reactive oxygen species promote lipid peroxidation, which transforms polyunsaturated fatty acids from cell membrane lipids into Thio Barbituric reactive substances (TBARS), such as MDA. TBARS rises in tissue and plasma when there is oxidative stress. These aldehyde synthesis is serves as a biomarker to gauge an organism's degree of oxidative stress. A luminous pink color that can be measured spectrophotometrically at 532 nm with an extinction value of 156 mM-1 cm-1 is produced when MDA and other Thio Barbituric reactive compounds condense with two equivalents of Thiobarbituric acid.

2. Reduced Glutathione (GSH): Tissue GSH concentration was measured by method described by (concentration of GSH = Absorbance x D x L x E).

3. Catalase (CAT): Catalase activity in tissue was determined by measuring the rate of decomposition of H_2O_2 at 240 nm, according to the method given by Aebi et al

4. Glutathione Reductase (GR): Glutathione reductase activity in the tissues was determined by measuring the decrease in the absorbance caused by oxidation of NADPH at 340 nm. GR assay kit was used (sigma Aldrich) according to the specifications mentioned in the kit.

Results and discussion

GCMS analysis

The figure 1 represents a Total Ion Chromatogram (TIC) from a mass spectrometry analysis of Sample S4, showing multiple peaks at different retention times. The highest abundance peaks occur at retention times 2.143, 18.331, and 24.907 minutes, indicating major detected compounds.

Preliminary phytochemical analysis of hydralcoholic leaf extract of *Boswellia ovalifoliolata*

The table 1 presents the phytochemical screening results of the hydroalcoholic leaf extract, indicating the presence (+) or absence (-) of various chemical constituents. Alkaloids, flavonoids, phenolic compounds, tannins, saponins, terpenoids, phytosteroids, sterols, and coumarins tested positive, while carbohydrates and glycosides were absent. Reducing sugars showed mixed results, with Benedict's test being positive and Fehling's test negative.

Analysis of general parameters

Body weight

The effects of hydroalcoholic *Boswellia ovalifoliolata* extract (HALBO) (200 and 400 mg/kg per oral) and vitamin E (250 mg/kg p.o.) on the B.W. of rats that were nephrotoxically treated with gentamicin are displayed in Table 2. Before starting a dose and 24 hours after the treatment ends, all of the animals are weighed. It was established how gentamicin, vitamin E, and HALBO affected body weight. When compared to other experimental groups, the mice in the gentamicin-induced group displayed a drop in body weight. When compared to the toxic group, which was the group that was caused by gentamicin, the rats who received vitamin E treatment displayed an increase in body weight. In comparison to the toxic group, the rats in the treatment groups that received

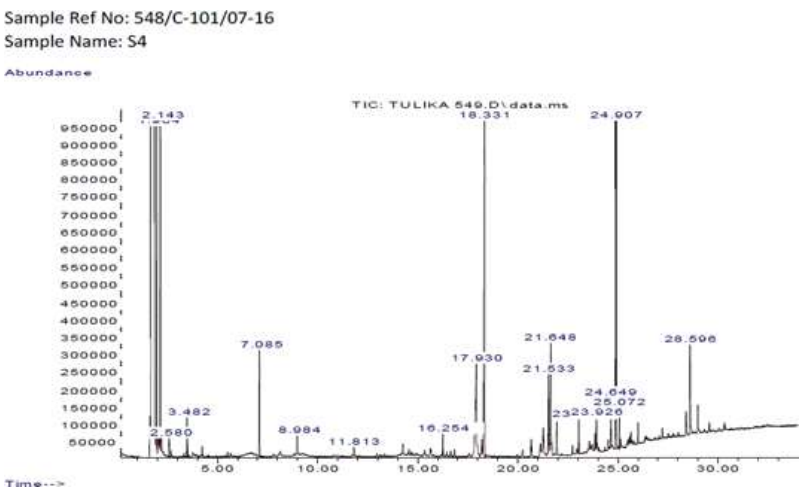

Figure 1: GCMS analysis of hydroalcoholic leaf extract of *Boswellia ovalifoliolata*

Table 1: Preliminary phytochemical analysis of hydroalcoholic leaf extract of *Boswellia ovalifoliolata*

Chemical constituent	Test	Hydroalcoholic leaf extract
Alkaloids	Wagner's test, Mayer's test, Hager's test, Dragendroff's test	+
Carbohydrates	Molisch's test	-
Reducing sugar's	Benedict's test	+
	Fehling's test	-
Flavanoid's	Alkaline reagent test, Ferric chloride test	+
Phenolic compounds	Lead acetate test	+
Tannins	Bromine waster test,Ferric chloride test,	+
	Acetic acid sol.	+
Saponins	Froth test	+
Terpenoids	Salkowski's test	+
Phytosteroids and Sterols	Liebermann Burchard test	+
Caumarin's	FeCl3 test	+
Glycosides	Brontrager's test	-

Table 2: The Impact of HALBO and Vitamin E on the Body Weight of Nephrotoxic Rats Induced by GEN

S. No	Groups	Body Weight (g)
1.	Normal vehicle (10 ml/kg p.o)	200.5 ±0.23
2.	Gentamicin (100 mg/kg i.p)	175.6 ± 0.26**
3.	GEN (100 mg/kg i.p) + Vit-E (250 mg/kg p.o)	204.6 ± 0.13*
4.	GEN (100 mg/kg i.p) + HALBO (200 mg/kg p.o)	188.06 ± 0.72*
5.	GEN (100 mg/kg i.p) + HALBO (400 mg/kg p.o)	196.13 ± 0.86**

Mean ± SEM, one-way ANOVA, and Dunnett's Multiple Comparison test are used with GraphPad Prism 5.0 software for n=6. Important at **p<0.01 versus the normal control group, *p<0.05, and **p<0.01 versus the GEN group. Vitamin E, GEN, and gentamicin, HALBO-(Hydro alcoholic leaf extract of *Boswellia ovalifoliolata*).

hydroalcoholic leaf extract of *Boswellia ovalifoliolata* (HALBO) displayed a dose-dependent increase in body weight.

Analysis of biochemical parameters

1. **Blood Urea Nitrogen (BUN):**

   Upon analyzing the data from each group, it was found that the BUN levels of the GEN-induced group were significantly greater than those of the normal group (table 3 and figure 3). Compared to the GEN-induced group, the Vit-E-treated group had decreased BUN levels. The BUN levels in the treatment groups dropped in a dose-dependent fashion in comparison to the GEN-induced group.

2. **Serum Creatinine:**

   Serum Creatinine levels were considerably greater in the GEN-induced group than in the normal group when the

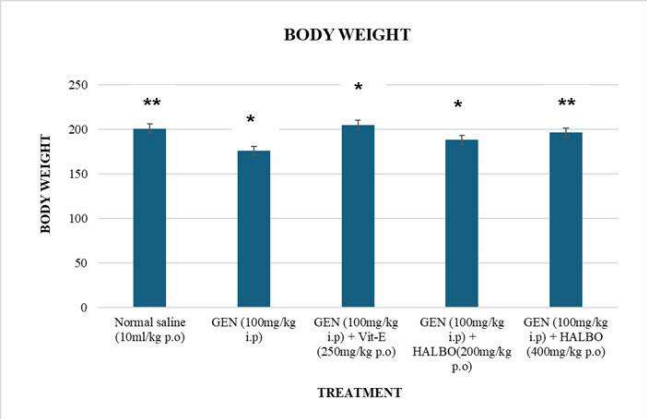

Figure 2: The Impact of HALBO and Vitamin E on the Body Weight of nephrotoxic rats induced by GEN

Table 3: Impact of Vitamin E and HALBO on Biochemical Parameters in Nephrotoxic Rats Induced by GEN

S. No	Groups	Blood Urea Nitrogen	Serum Creatinine	Urine Output	pH of Urine Samples
1	Normal vehicle (10ml/kg p.o)	18.8683 ± 0.6128	0.873 ± 0.029	3.26 ± 0.12	7.40 ± 0.4013
2	GEN (100mg/kg i.p)	34.2683 ± 0.4657***	3.8316 ± 0.021**	5.98±0.20**	4.83 ± 0.3073**
3	GEN (100 mg/kg i.p) + Vit-E (250 mg/kg p.o)	16.173 ± 0.3384*	0.893 ± 0.015*	3.50 ± 0.03*	7.65 ± 0.401*
4	GEN (100 mg/kg i.p) + HALBO (200 mg/kg p.o)	30.0616 ± 0.5063*	3.5316 ± 0.020*	4.76 ± 0.04	5.33 ± 0.33
5	GEN (100 mg/kg i.p) + HALBO (400 mg/kg p.o)	25.2016 ± 0.5540	3.1716 ± 0.021**	4.50± 0.21*	5.66 ± 0.307*

Mean ± SEM, one-way ANOVA, and Dunnett's Multiple Comparison test are used with GraphPad Prism 5.0 software for n=6. **p<0.01, ***p<0.001 in comparison to the normal control group, *p<0.05, **p<0.01 in comparison to the GEN group is significant. HALBO (*Boswellia ovalifoliolata* hydroalcoholic leaf extract), GEN (gentamicin), and vitamin E (vitamin E).

data from each group were analyzed (table 3 and figure 4). Compared to the GEN-induced group, the Vit-E-treated group had reduced serum creatinine levels. Serum Creatinine levels in the treatment groups dropped in a dose-dependent fashion in comparison to the GEN-induced group.

3. Urine Output:

Urine output levels were considerably higher in the GEN-induced group than in the normal group when the data from each group were analyzed (table 3 and figure 5). Compared to the GEN-induced group, the Vit-E-treated group's urine output levels were lower. The urine output levels in the treatment groups dropped in a dose-dependent manner in comparison to the GEN-induced group.

4. pH of Urine Samples:

Upon analyzing the data from each group, it was found that the GEN-induced group's urine PH was noticeably lower than that of the normal group (table 3 and figure 6). In contrast to the GEN-induced group, the vitamin E-treated group's urine PH rose. The PH of urine in treatment groups rises in a dose-dependent manner in comparison to the GEN-induced group.

Estimation of anti-oxidant parameters

1. Malondialdehyde (MDA) Estimation:

Upon analyzing the results from each group, it was found that the MDA levels in the GEN-induced group were

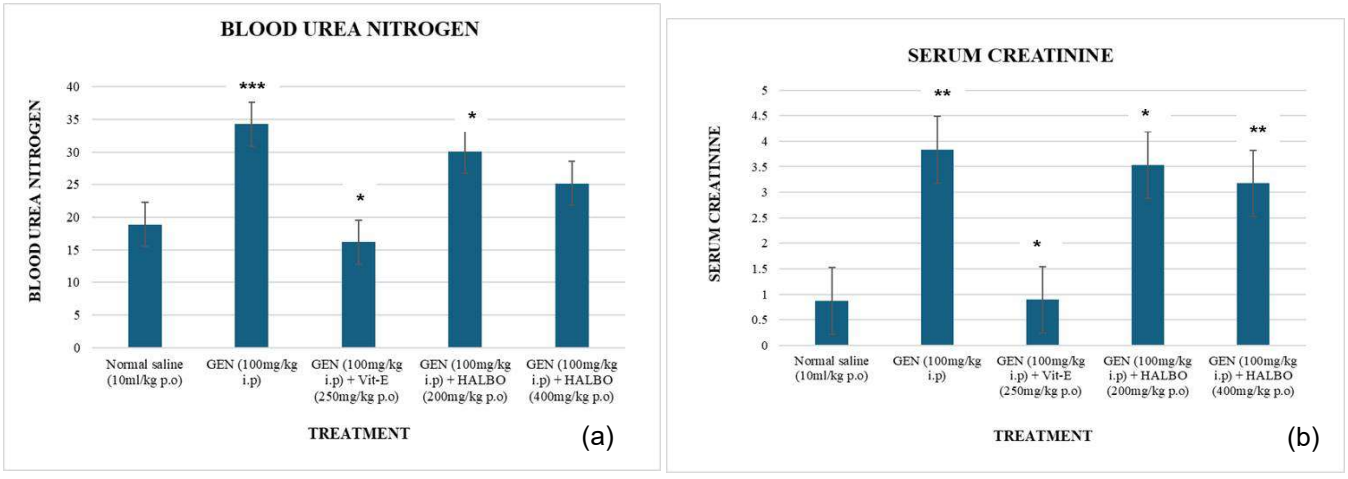

Figure 3: The impact of HALBO and Vit-E in nephrotoxic rats induced by GEN on (a) Serum BUN (b) Creatinine

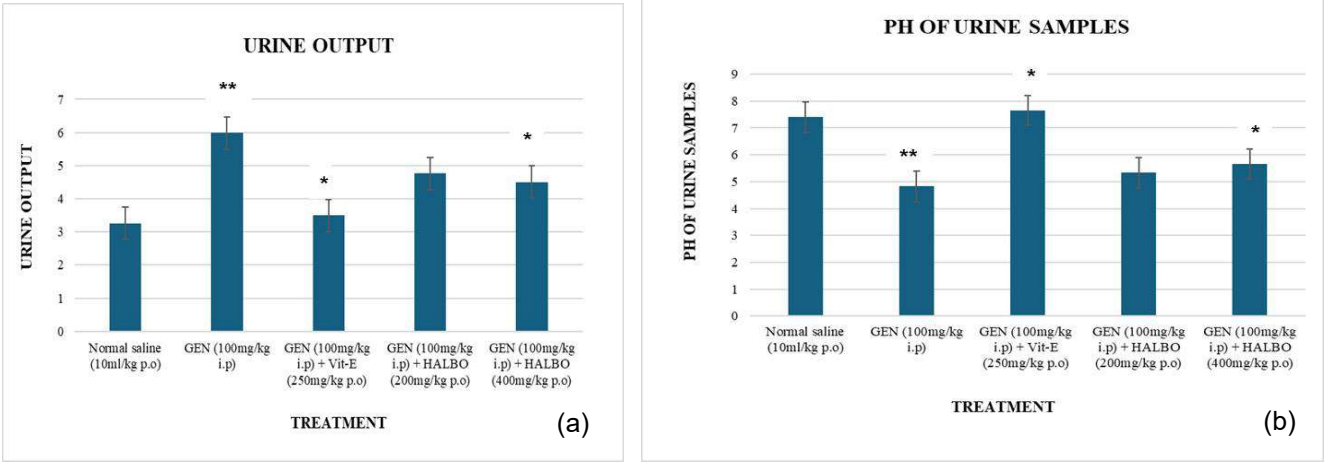

Figure 4: The impact of HALBO and Vit-E in nephrotoxic rats induced by GEN: (a) Urine Output; (b) PH of Urine

significantly greater than those in the normal group (table 4 and figure 7). Compared to the GEN-induced group, the Vit-E-treated group had decreased MDA levels. The MDA levels in the treatment groups dropped in a dose-dependent fashion in comparison to the GEN-induced group.

2. Reduced Glutathione (GSH) Estimation:

GSH levels were considerably lower in the GEN-induced group than in the normal group when the data from each group were analyzed (table 4 and figure 8). In contrast to the GEN-induced group, the vitamin E-treated group's GSH levels rose. The GSH levels in the treatment groups rise in a dose-dependent manner in comparison to the GEN-induced group.

3. Catalase (CAT) Estimation:

After analyzing the data from each group, it was found that the GEN-induced group had significantly lower catalase levels than the normal group (table 4 and figure 9). In contrast to the GEN-induced group, the Vit-E-treated group's catalase levels rose. The treatment groups showed a dose-dependent increase in catalase levels compared to the GEN-induced group.

4. Glutathione reductase (GR) Estimation:

Upon analyzing the data from each group, it was found that the GEN-induced group's levels of GR were much higher than those of the normal group (table 4 and figure 10). GR levels were lower in the Vit-E treated group than in the GEN-induced group. The GR levels in the treatment groups dropped in a dose-dependent fashion in comparison to the GEN-induced group.

Histopathological studies

Table 4: The impact of HALBO and Vit-E on Anti-oxidant parameters in Nephrotoxic rats induced by GEN

S. No	Groups	Malondialdehyde	Reduced Glutathione	Catalase	Glutathione Reductase
1	Normal saline (10ml/kg p.o)	102 ± 0.24117	24.5 ± 0.0192	182.0 ± 0.578	19.98 ± 0.1302
2	GEN (100 mg/kg i.p)	185.3± 0.2300***	14.363 ± 0.016**	101.8 ± 0.0946***	42.05 ± 0.0764***
3	GEN (100 mg/kg i.p) + Vit-E (250 mg/kg p.o)	105.8 ± 0.2349*	25.6 ±0.021*	158.2 ±0.478**	24.05 ±0.0764***
4	GEN (100 mg/kg i.p) + HALBO (200 mg/kg p.o)	155.132 ± 0.2163	18.363 ± 0.124	120.0 ± 0.365*	36.43 ± 0.115**
5	GEN (100 mg/kg i.p) + HALBO (400 mg/kg p.o)	133.26 ± 0.214**	20.352 ± 0.214**	146.2 ± 0.478**	29.05 ± 0.112*

Mean ± SEM, one-way ANOVA, and Dunnett's Multiple Comparison test are used with GraphPad Prism 5.0 software for n=6. **p<0.01, ***p<0.001 in comparison to the normal control group, *p<0.05, **p<0.01, ***p<0.001 in comparison to the GEN group is significant. GEN (gentamicin), HALBO (*Boswellia ovalifoliolata* hydroalcoholic leaf extract), and vitamin E (vitamin E).

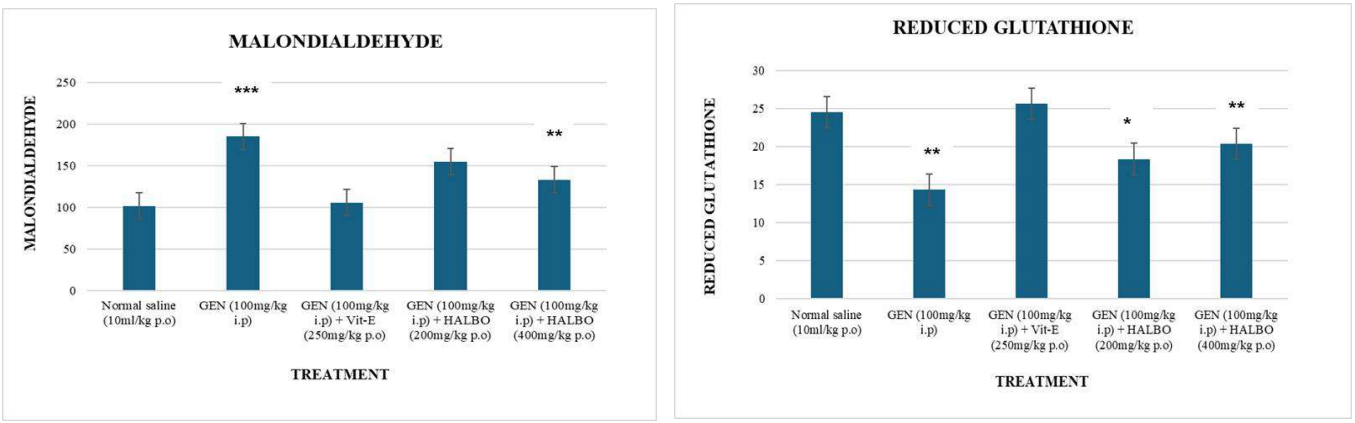

Figure 5. The impact of HALBO and Vit-E in Nephrotoxic rats induced by GEN on (a) MDA levels (b) GSH levels

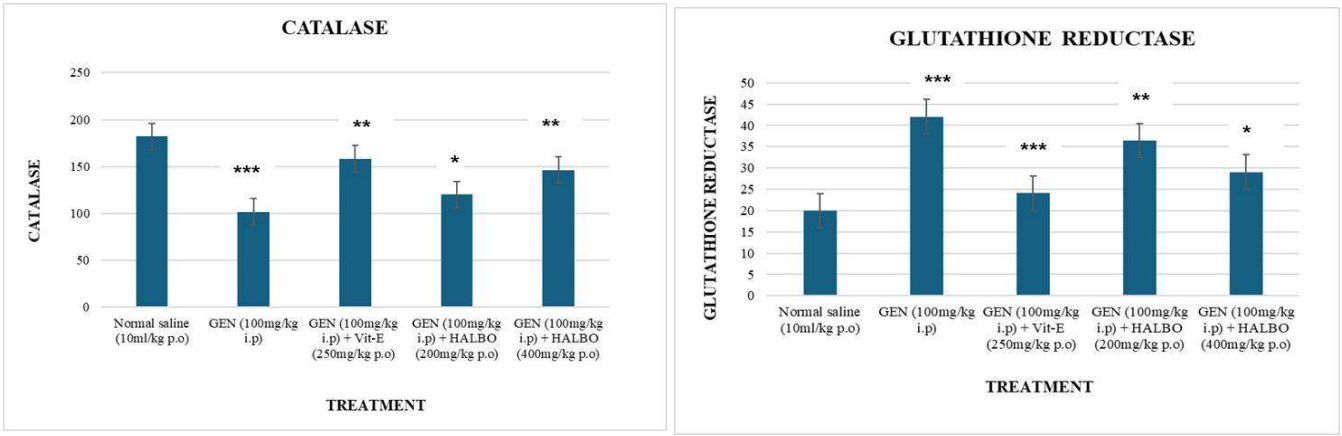

Figure 6. The impact of HALBO and Vit-E in Nephrotoxic rats induced by GEN (a) Catalase levels (b) Glutathione reductase

Group-I: Albino Wistar rats fed normal saline had normal renal glomeruli and a functional Bowman's capsule. Sections through the proximal convoluted tubules revealed a brush-like epithelium shaped like a cube. Particularly noticeable was the thin cuboidal epithelium covering the thick macula and distal convoluted tubules.

Group-II: Granular deposits, lymphocytic infiltration, tubular epithelial cell desquamation, and epithelial cell degeneration were all observed in the PCT area. Cortical tubules feature necrosis and dilatation of the tubular epithelium in less than half of the tubules.

Group-III: Under high magnification, these sections showed no signs of apoptosis. The glomerular capillaries were not broken down and there were no vacuoles in the tubule lumen.

Group-IV: Tubular epithelial cell vacuolar degeneration, glomerular congestion, and glomerular capillary rupture were also identified when minor hyaline cast development was seen in PCT. Mice displayed modest necrotic changes, including cytoplasmic vacuolation, nuclear pyknosis, and karyolysis.

Group-V: The PCTs are see-through, devoid of any hyaline cast, and feature a few tubular dilatation. The inside is lined with cuboidal epithelium. Renal architecture, including the distinctive epithelial growth of proximal convoluted tubules and the regeneration of glomerular tufts, both increased by 50%.

Discussion

A condition known as nephrotoxicity occurs when medications and other chemicals have toxic effects on the kidneys, leading to a rapid decline in kidney function **(**Al-Naimi et al., 2019**).** The negative impact of chemicals on renal function is another definition of nephrotoxicity **(**Barnett and Cummings, 2018**)** is known as drug-induced renal toxicity or drug-induced renal diseases. Certain drugs have the potential to either directly or indirectly result in renal failure. In US hospitals, drug-induced nephrotoxicity is linked to around 18–27% of all acute renal toxicities, making medication-induced renal toxicity a significant contributor to morbidity and death **(**Taber and Pasko, 2008**).** Animal and experimental studies, as well as human case reports, have linked a variety of environmental and occupational nephrotoxins to both acute and chronic kidney impairment **(**Orr and Bridges, 2017**).**

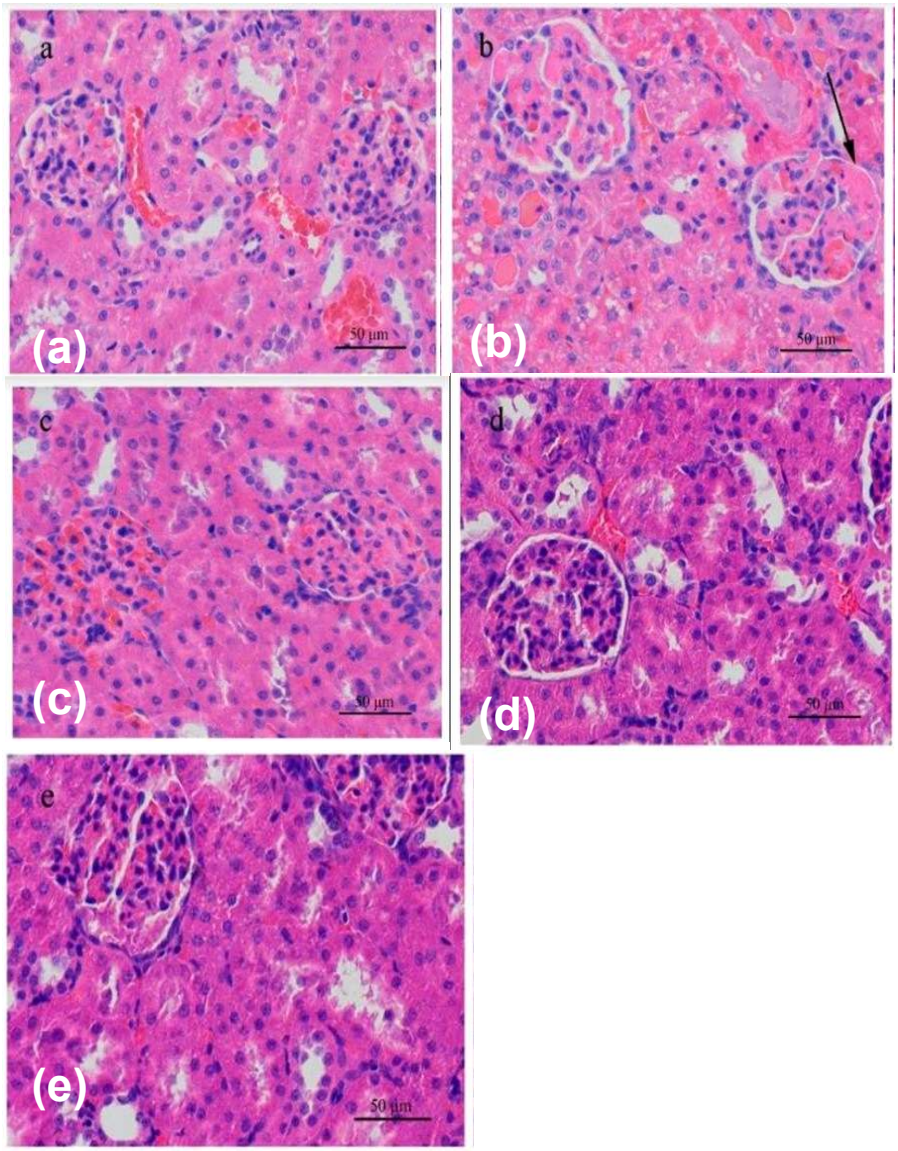

Figure 7: Histopathological observation of renal tissues: (a) normal kidney, (b) 100mg/kg i.p GEN; (c) 100mg/kg i.p GEN + 250mg/kg p.o Vit-E; (d) 100mg/kg i.p GEN + 200mg/kg p.o HALBO (e) 100mg/kg i.p GEN + 400mg/kg p.o HALBO

A class of antibiotics known as aminoglycosides, which includes gentamicin, induce nephrotoxicity by triggering necrotic (Edwards et al., 2007) and apoptotic (Li et al., 2009; Laurent et al., 1983; El Mouedden et al., 2000) cell death in the kidney's tubular epithelial cells. Additionally, renal injury results in systemic and metabolic toxicity (Naughton, 2008) as well as delayed drug excretion.

Gentamicin treatment significantly reduced body weight, likely due to nephrotoxicity-induced metabolic impairments and loss of appetite. Co-treatment with Vitamin E or *Boswellia ovalifoliolata* leaf extract helped mitigate this weight loss, with better results observed at higher doses of the extract. These findings highlight the potential of the protective agents to counteract gentamicin-induced systemic effects.

Both Blood Urea Nitrogen (BUN) and serum creatinine levels were significantly elevated in the gentamicin group, reflecting impaired kidney function and reduced Glomerular Filtration Rate (GFR). Co-administration of Vitamin E or the extract significantly reduced these levels, with a dose-dependent effect observed for the extract. The ability of the treatments to restore these markers suggests their renoprotective effects, likely mediated through antioxidant and anti-inflammatory mechanisms.

Gentamicin-treated rats showed increased urine output, indicative of tubular dysfunction and polyuria. Co-treatment with Vitamin E or *Boswellia ovalifoliolata* helped normalize urine output, especially with the higher doses. Additionally, the gentamicin group had significantly acidic urine, suggesting impaired tubular handling of acid-base balance. Vitamin E showed the greatest ability to restore

normal pH levels, while the extract provided moderate improvements.

Malondialdehyde (MDA) levels, an indicator of lipid peroxidation, were markedly elevated in the gentamicin group, highlighting oxidative damage to cellular components (Ajami et al., 2010; Turner et al., 2018). Co-treatment significantly reduced MDA levels, particularly with the higher dose of the extract. Conversely, reduced glutathione (GSH), a critical antioxidant, was depleted in gentamicin-treated rats. The treatments restored GSH levels, suggesting enhanced antioxidant defences (Shaheen et al., 2014; Sohn et al., 2003; Haque et al., 2003; Helal et al., 2018).

Catalase (CAT) activity, crucial for neutralizing hydrogen peroxide, was significantly reduced in gentamicin-treated rats, indicating oxidative stress. Co-treatment increased CAT activity, with the higher dose of the extract nearly normalizing it. Interestingly, glutathione reductase (GR) activity was elevated in the gentamicin group, likely as a compensatory mechanism to regenerate depleted GSH. Co-treatment with Vitamin E or the extract restored GR activity closer to normal levels, reflecting reduced oxidative stress **(**Botros et al., 2022; Sawhney et al., 2024; Kim et al., 2006**)**

Conclusion

Boswellia ovalifoliolata's hydroalcoholic leaf extract (HALBO) has strong nephroprotective properties. The current investigation found that the plant extract's nephroprotective properties were caused by tannins, phenols, alkaloids, flavonoids, terpenoids, phytosterols, sterols, and saponins. GEN100 mg/kg, i.p. induced significant renal impairment, as evidenced by histological damage and oxidative stress in the renal tissue. It was discovered that HALBO's strong free radical scavenging action provided protection against GEN-induced kidney damage. HALBO is therefore recognized as a nephroprotective medication against kidney damage in the current study. This study showed that 400 mg/kg p.o. of HALBO was more efficacious than 200 mg/kg p.o. in reducing kidney GEN-induced renal damage.

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