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In Vivo Determination of Effects of Fractions of *Chrysophyllum albidum* Leaf Extract on Liver Function of *Bitis arietans* Envenomated Wistar Rats

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Abstract

This study investigated the anti-venom potential of solvent-fractionated ethanol leaf extract of *Chrysophyllum albidum* against *Bitis arietans* envenomation in Wistar rats, with a particular focus on antioxidant activity and liver function. Ethanol crude extract of *C. albidum* leaves was subjected to column chromatography using a gradient mobile phase of hexane, chloroform, ethyl acetate, ethanol, methanol, and water, yielding 24 fractions. All fractions were evaluated *in vitro* for antioxidant and phytochemical properties, and three fractions (F5B, F6A, and F10B), obtained from ethyl acetate/ethanol (100:0 and 50:50) and methanol/H_2O (50:50) solvent systems, were selected for *in vivo* studies based on their superior antioxidant activities. Sixty Wistar rats were randomly assigned to 12 groups (n = 5), including normal and envenomated controls, a standard anti-venom serum group, and treatment groups receiving different doses and durations of F5B, F6A, and F10B following intraperitoneal administration of 1.25 mL/kg *B. arietans* venom. Animals in most groups were treated for three days, whereas selected high-dose groups were treated for 14 days to assess sustained pharmacological effects. Blood samples were collected via cardiac puncture for biochemical analysis of liver function markers (ALT,

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AST, ALP), and liver tissues were harvested for lipid peroxidation, endogenous antioxidant enzyme assays, and histopathological examination. Phytochemical and antioxidant profiling showed that F5B, F6A, and F10B consistently exhibited the highest DPPH and FRAP activities, β-carotene bleaching inhibition, hydrogen peroxide scavenging capacity, and elevated levels of total flavonoids, phenolics, saponins, and tannins relative to other fractions. Envenomation with *B. arietans* venom significantly ($p < 0.05$) increased ALT, AST, and ALP levels in the negative control group compared with normal rats, whereas treatment with *C. albidum* fractions (F5B, F6A, and F10B) and the conventional anti-venom serum reduced these liver enzymes toward normal values. In the 14-day, higher-dose groups, meaningful pharmacological effects were observed, indicating sustained hepatoprotective and anti-venom potential. Overall, the findings suggest that bioactive antioxidant-rich fractions of *C. albidum* can mitigate venom-induced hepatic dysfunction and support the development of plant-based adjunct therapies for *B. arietans* envenomation.

Keywords: *Chrysophyllum albidum*; Solvent Fractionation; *Bitis arietans* Envenomation; Antioxidant Activity; Wistar Rats.

INTRODUCTION

Snakebite envenomation is a significant public health emergency, especially in the tropical areas of sub-Saharan Africa, where standard antivenom is sometimes hard to get or too expensive. The puff adder (*Bitis arietans*), which is found all over Africa, is responsible for a lot of snakebites that are poisonous (Martinez *et al.*, 2024). Its venom is mostly cytotoxic, which means it damages a lot of local tissue, causes coagulopathy, and has consequences throughout the body, including damage to critical organs like the liver (Roberts *et al.*, 2022). Many rural tribes use traditional herbal treatments to treat snakebites when they can't get antivenom therapy quickly and effectively. One of these plants is *Chrysophyllum albidum*, or the African star apple, which is often utilized in West African ethnomedicine to treat many different problems (Adeleye *et al.*, 2016). The leaf extracts of *C. albidum* exhibit antioxidant, anti-inflammatory, and hepatoprotective effects. This work integrates current research on *B. arietans* venom-induced hepatotoxicity and the pharmacological potential of *C. albidum* to establish a scientific basis for its exploration as a prospective therapeutic agent for snake envenomation (Odewade and Odewade, 2023). Pathophysiology of hepatotoxicity induced by *Bitis arietans* venom is made up of a lot of different biologically active proteins and enzymes, including metalloproteinases,

phospholipase A2 (PLA2), and L-amino acid oxidases (LAAOs) (Masters, 2023). These parts work together to cause serious local and systemic disease, with liver damage being a major sign. Oxidative stress and enzyme activity, Phospholipase A2 (PLA2) enzyme breaks down membrane phospholipids, which damages cell membranes all over the body, even in liver cells. This process plays a big role in how the venom kills cells (Herzig, 2021). L-amino acid oxidases (LAAOs) flavoenzymes help amino acids go through oxidative deamination, which makes hydrogen peroxide H_2O_2 and other reactive oxygen species (ROS) (Adebayo *et al.*, 2011). The oxidative stress that happens when the body makes too many reactive oxygen species (ROS) is a major cause of tissue damage caused by venom (Pourmorad *et al.*, 2006). Research involving Wistar rats injected with *B. arietans* venom has validated this approach, demonstrating diminished concentrations of antioxidant enzymes, including superoxide dismutase (SOD) and reduced glutathione (GSH), in conjunction with heightened levels of lipid peroxidation indicators. Studies have shown that *B. arietans* venom inflicts significant histological harm to the liver of Wistar rats, characterized by hepatocyte necrosis and the destruction of cell nuclei. This immediately hurts the liver's ability to work. Increased serum levels of liver enzymes, including alanine aminotransferase (ALT) and aspartate aminotransferase (AST), are well-established markers of hepatocyte damage subsequent to snake envenomation. An increase in total bilirubin and alkaline phosphatase (ALP) levels is another sign of liver problems and blocked bile flow.

The pharmacological potential of *Chrysophyllum albidum* leaf extract *Chrysophyllum albidum* has been esteemed in traditional medicine for an extended period, and modern investigations are progressively corroborating its therapeutic uses (Yakubu *et al.*, 2022). Phytochemical profile: Flavonoids, tannins, saponins, phenols, and terpenoids are only some of the bioactive substances found in the leaves of *C. albidum*. Flavonoids and phenolic chemicals, especially, are strong antioxidants that can pick up free radicals and bind to metal ions (Manglik, 2024). This is a promising trait for fighting oxidative damage caused by venom. Activities that protect the liver and function as antioxidants: Multiple *in vivo* studies have validated the hepatoprotective properties of *C. albidum* leaf extracts against chemically induced hepatic injury. For instance, a study utilizing a carbon tetrachloride CCl_4 model shown that *C. albidum* extract markedly decreased increased liver enzyme levels (ALT, AST, ALP) and bilirubin in rats (Moharram *et al.*, 2025). Histopathological study corroborated the protective effect by evidencing reduced necrosis and degeneration in the livers of treated rats. *In vitro* tests have shown that *C. albidum* possesses antioxidant

properties since it can get rid of different radicals, such as DPPH, OH, and NO radicals. This back with the idea that the plant's components can help reduce the oxidative damage that snake venom does (Matković, 2025). The anti-venom potential of many therapeutic plants, Ethnomedicine has long used medicinal plants as an alternative or extra treatment for snakebites, and science is starting to back this up more and more. Reviews of anti-venom plant remedies have shown a number of phytochemicals that can neutralize venom components. These include flavonoids, phenolics, and terpenes (Kotowska *et al*., 2025). For instance, research on Jatropha gossypiifolia and Mangifera indica has demonstrated that their extracts can impede the enzymatic and pharmacological effects of snake venoms. This indicates that plants with analogous phytochemical profiles, such as *C. albidum*, may likewise exhibit anti-venom characteristics. Justification for the present study Although the hepatoprotective and antioxidant activities of *C. albidum* have been established in models of chemically induced liver injury, its effectiveness against liver damage specifically caused by *B. arietans* venom remains inadequately investigated. It is important to study the effects of different leaf extract fractions because the plant's therapeutic characteristics might vary greatly depending on the solvent employed to extract them. This method of fractionation will help find the most active chemicals that are causing any hepatoprotective benefits that are seen. In conclusion there is a lot of proof in the literature that *Bitis arietans* venom causes a lot of liver damage through oxidative stress and enzyme activity. At the same time, a lot of research on *Chrysophyllum albidum* shows that it is a strong antioxidant and protects the liver, probably because it has a lot of flavonoids and phenols. The suggested work seeks to address the information deficiency by examining the therapeutic efficacy of *C. albidum* leaf extract fractions against *B. arietans* induced hepatic injury in a Wistar rat model. The results could scientifically corroborate a conventional cure, enhance comprehension of its mechanism of action, and facilitate the advancement of accessible and cost-effective snakebite treatments.

METHODOLOGY

Determination of Total Phenolic Content (TPC)

Total polyphenol component was estimated calorimetrically using Follin-Ciocalteu reagent.

Determination of Total Flavonoid Content (TFC)

Total flavonoids were determined using the aluminum chloride colorimetric method.

Determination of Total Antioxidant Content (TAC)

Total antioxidant activity was determined spectrophotometrically at 517nm using 1,1-diphenyl-2-picrylhydrazyl (DPPH).

Animal Grouping and Treatment

Groups	Dosages
Group 1	Normal control
Group 2	Negative control; 1.25 mL/kg BV
Group 3	Positive control; BV + 0.8mg/kg SVA (IP)
	First fraction of highest concentration of antioxidant activities,
Group 4	BV + 100 mg/kg F5B
Group 5	BV + 200 mg/kg F5B
	Second fraction of highest concentration of antioxidant activities
Group 6	BV + 100 mg/kg F6A
Group 7	BV + 200 mg/kg F6A
	Third fraction of highest concentration of antioxidant activities
Group 8	BV + 100 mg/kg F10B
Group 9	BV + 200 mg/kg F10B
Group 10	BV + 400 mg/kg F5B
Group 11	BV + 400 mg/kg F6A
Group 12	BV + 400 mg/kg F10B

GP: group, BV: Bitis arietans venom, SVA: snake venom antiserum, IP: intra-peritoneally, F5B: Ethylacetate/Ethanol-100:00, F6A: Ethylacetate/Ethanol-50:50, F10B: Methanol/H_2O-50:50.

Animal Sacrifice

Three days after induction and treatment, group 1 to group 9 wistar rats were sacrificed; while other group 10 to 12 were given continue treatments for fourteen days before sacrificed under chloroform anaesthesia.

Blood Collection

Blood samples were collected via cardiac puncture for analysis.

Liver Biochemistry Assessment

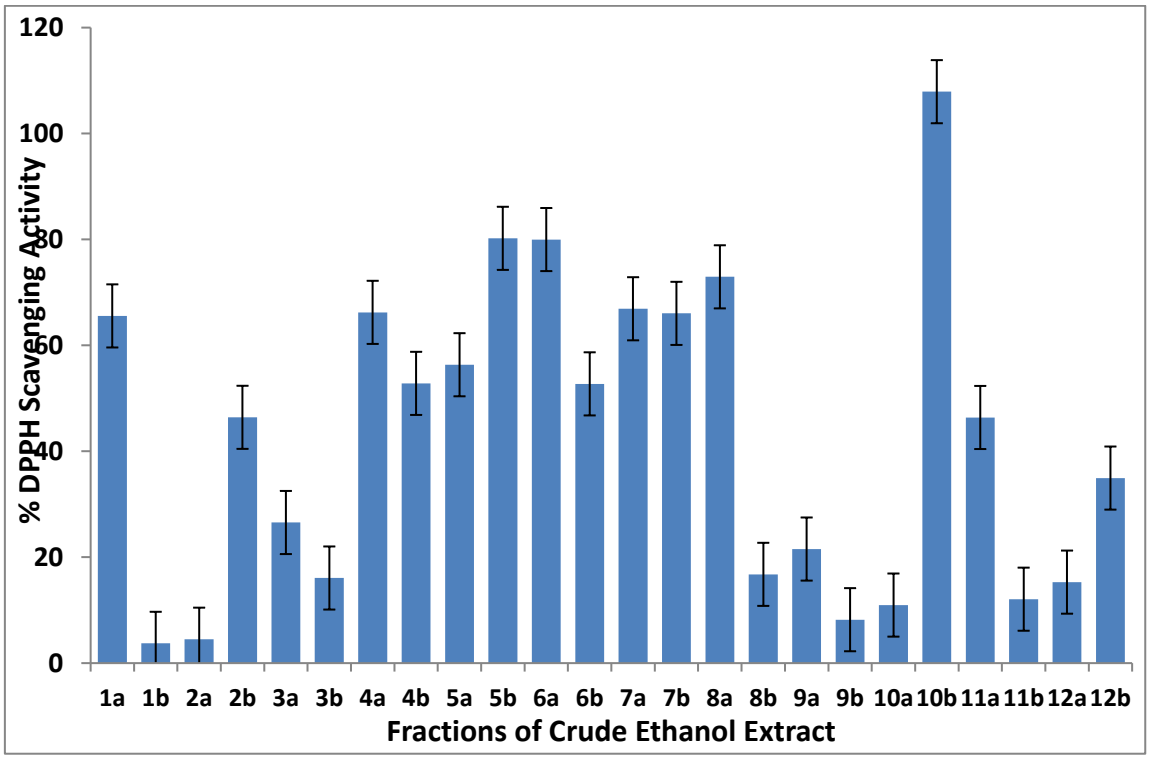
Level of the enzymes: Spectrophotometric determination of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), total protein (TP) and

albumin (ALB) determined using their respective kits (product of Randox liver function test).

Data Analysis

A one way analysis of variance (ANOVA) was used for analysis of the data followed by Duncan's multiple comparison test. The data grouped and presented as mean ± standard deviation. The statistical significance of the variances were evaluated using statistical package for social Sciences (SPSS) version 27, with a significance threshold set at $P<0.05$.

RESULTS

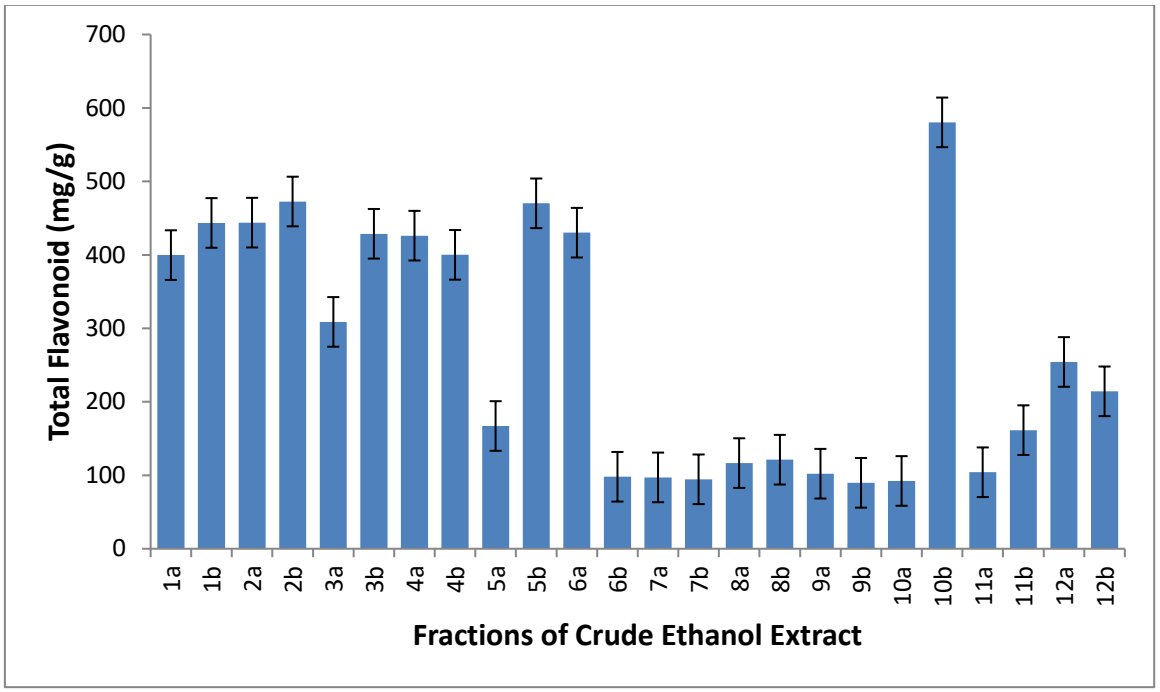


The 2, 2-diphenyl-1-picrylhydrazyl (DPPH) Scavenging Activity of Fractions of *Chrysophyllum albidum* Leaf Extracts

F1a and b = hexane-100; F2a and b = hexane : chloroform- 50:50; F3a and b = chloroform- 100 F4 aand b = chloroform : ethylacetate- 50:50; F5a and b = ethylacetate - 100; F6 aand b = ethylacetate/ethanol = 50:50; F7a and b = ethanol- 100; F8a and b = ethanol : methonol- 50:50; F9 aand b = methanol- 100; F10a and b = methanol : water- 50:50; F11a and b = water- 100; F12a and b = water : hexane- 50:50.

The free radical scavenging ability of fractions of *C. albidum* leaf extract on DPPH was investigated and the % inhibition values of different concentrations were determined and used to extrapolate the IC_{50} as presented in Figure 4.1. There was an increase in % inhibition with increased consentration of many fractions of *C. albidum* leaf extract. The IC_{50} was extrapolated at 50% inhibition. From the result, the DPPH scarvenging activity of fraction 10b, 5b, 6a, 8a, 4a, 1a, 7a and 7b performed greatly in the order of the arrangement followed by others as they are in figure 4.1; this explains the extract has antioxidant ability to scarvage free radicals.

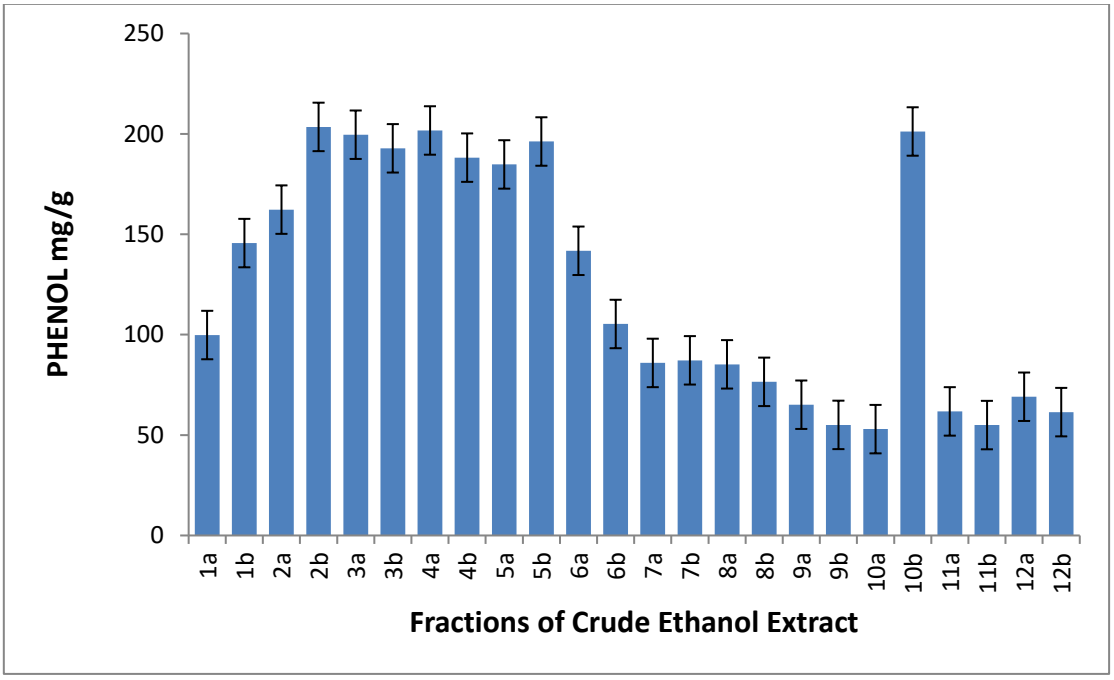
The bar chart shows how well the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity of *Chrysophyllum albidum* leaf extract fractions works. The chart's high bars demonstrate DPPH scavenging activity, which means that fraction has more antioxidant potential. The fractions are arranged by the extraction solvent, with less polar solvents like hexane at the top and more polar solvents like water at the bottom. The 100% water extract, Fraction 11a, exhibits the most DPPH scavenging activity. It scavenges more than 100%, which is more than any other fraction. F1a and F1b (100% hexane extract), F8a (50:50 ethanol : methanol), and F11b (100% water extract) have the least antioxidant activity, as seen by their lowest bar heights. The result shows that there is a wide range of scavenging activity among fractions. This shows that the antioxidant molecules in *Chrysophyllum albidum* leaves are not evenly spread out and are better extracted by some solvents or mixtures of solvents. There is no consistent relationship between the polarity of the solvent and the DPPH scavenging activity. The 100% water extract (F11a) is the most active, whereas the 50:50 ethylacetate/ethanol extracts (F6a and F6b) are both 80% active. On the other hand, 100% methanol and 100% chloroform are not as good at scavenging. The activity levels of most paired fractions (e.g., F1a/F1b) are similar, while F11a and F11b are very different. This shows that the extraction procedure or the plant antioxidant compounds can change.



Total Flavonoid Contents of Fractions of *Chrysophyllum albidum* Leaf Extract

F1a and b = hexane-100; F2a and b = hexane : chloroform- 50:50; F3a and b = chloroform- 100 F4 aand b = chloroform : ethylacetate- 50:50; F5a and b = ethylacetate - 100; F6 aand b = ethylacetate/ethanol = 50:50; F7a and b = ethanol- 100; F8a and b = ethanol : methonol- 50:50; F9 aand b = methanol- 100; F10a and b = methanol : water- 50:50; F11a and b = water- 100; F12a and b = water : hexane- 50:50.

The total flavonoid concentration (TFC) of different fractions of *Chrysophyllum albidum* leaf extract, the fact that fractions (10b, 5b, 6a, 2b, 2a, 1b, 3b, 4a, 4b, 1a, and 3a) perform well means that they probably have a lot of flavonoids, understanding the high flavonoid content in some fractions Flavonoids are a type of polyphenolic chemical that is well-known for its ability to fight free radicals. It is not surprising that many fractions, notably those with moderate to high polarity like F5b, F6a, and F10b, feature a lot of flavonoids. This proves that the solvent gradient worked to separate substances with comparable polarity into different fractions.



Phenol Contents of Fractions of *Chrysophyllum albidum* Leaf Extracts

F1a and b = hexane-100; F2a and b = hexane : chloroform- 50:50; F3a and b = chloroform- 100 F4 aand b = chloroform : ethylacetate- 50:50; F5a and b = ethylacetate - 100; F6 aand b = ethylacetate/ethanol = 50:50; F7a and b = ethanol- 100; F8a and b = ethanol : methonol- 50:50; F9 aand b = methanol- 100; F10a and b = methanol : water- 50:50; F11a and b = water- 100; F12a and b = water : hexane- 50:50.

The result show that the phenol content of the *Chrysophyllum albidum* leaf fractions is related to the different amounts of phenolic compounds they contain. These compounds are known for their strong antioxidant and antibacterial effects. The specific percentage exhibited the highest phenolic content is contingent upon the experimental approach, particularly the solvent systems employed. Larger amount of phenolic Polarity and extraction efficiency, fractions (F10b, 5b to 1b, 6a, 6b, and 1a) have more phenols in them means that the solvent mixes utilized for those fractions were the best at getting the phenolic chemicals out. For example, a fraction extracted with a more polar solvent, such as ethanol (e.g., F7), may produce more phenols and have superior antioxidant ability compared to a nonpolar extract like petroleum ether. The greater concentration of these chemicals is directly associated with enhanced biological activity. A fraction with a higher phenol concentration probably has better antioxidant qualities, which can help fight oxidative stress. These chemicals also help the plant fight off diseases. The order of elution in column chromatography depends on how polar the chemicals and solvents are. Phenols,

which have a moderate amount of polarity, should elute with solvent systems that are more polar. There is a polarity gradient in collection of fractions (F1-F12). It is likely that fractions like F6, F7, and F8, which use more polar solvents (ethyl acetate/ethanol, ethanol, and ethanol/methanol), will have more phenolic chemicals.

Levels of Selected Liver Function Markers in *Bitis arietans* envenomed Wistar Rats Treated with Active Fractions of *Chrysophyllum albidum* Leaf Extract

Group	ALP (IU/L)	AST (IU/L)	ALT (IU/L)	TP (mg/dL)	ALB (mg/dL)
GP 1	53.00 ± 2.52^{ab}	183.90 ± 1.95^{e}	573.44 ± 7.88^{c}	4.85 ± 0.45^{b}	7.17 ± 0.04^{e}
GP 2	176.70 ± 3.86^{c}	271.20 ± 0.57^{f}	605.44 ± 10.89^{d}	1.44 ± 0.17^{a}	2.12 ± 0.06^{a}
GP 3	102.85 ± 76.77^{b}	170.90 ± 0.74^{c}	544.32 ± 2.63^{b}	5.98 ± 0.74^{c}	7.52 ± 0.07^{f}
GP 4	47.30 ± 31.56^{ab}	175.70 ± 1.82^{d}	538.56 ± 8.28^{b}	8.00 ± 0.31^{f}	6.46 ± 0.66^{d}
GP 5	59.95 ± 94.57^{ab}	177.60 ± 11.23^{d}	530.56 ± 4.75^{b}	7.85 ± 0.67^{ef}	5.97 ± 0.05^{bc}
GP 6	61.60 ± 31.99^{ab}	178.50 ± 2.55^{d}	539.52 ± 15.94^{b}	6.12 ± 0.45^{c}	6.04 ± 0.06^{c}
GP 7	56.65 ± 25.84^{ab}	183.40 ± 0.42^{e}	540.16 ± 5.50^{b}	6.81 ± 0.49^{d}	6.32 ± 0.11^{d}
GP 8	101.75 ± 55.58^{b}	183.60 ± 1.08^{e}	528.00 ± 4.80^{b}	7.37 ± 0.09^{de}	6.35 ± 0.07^{d}
GP 9	83.05 ± 53.73^{ab}	183.60 ± 1.85^{e}	531.20 ± 2.99^{b}	6.93 ± 0.22^{d}	6.53 ± 0.08^{d}
GP 10	33.55 ± 51.68^{ab}	117.50 ± 3.20^{a}	419.36 ± 15.58^{a}	5.00 ± 0.14^{b}	5.85 ± 0.04^{bc}
GP 11	11.00 ± 53.92^{a}	123.00 ± 1.17^{b}	406.08 ± 1.34^{a}	5.75 ± 0.68^{c}	5.70 ± 0.07^{b}
GP 12	24.75 ± 24.21^{a}	126.80 ± 1.79^{b}	404.48 ± 1.34^{a}	6.07 ± 0.07^{c}	5.79 ± 0.08^{bc}

N = 5, results are in mean ± standard deviations. Values with different superscript down the column vary significantly at ($p < 0.05$).

GP1: Normal control; GP2: 1.25 mL/kg BV; GP3: BV + 0.8mg/kg SVA (IP); GP4: BV + 100 mg/kg F5B; GP5: BV + 200 mg/kg F5B; GP6: BV + 100 mg/kg F6A; GP7: BV + 200 mg/kg F6A; GP8: BV + 100 mg/kg F10B; GP9; BV + 200 mg/kg F10B. GP10: BV + 400 mg/kg F5B; GP11: BV + 400 mg/kg F6A; GP12: BV + 400 mg/kg F10B.

5B: Ethylacetate/Ethanol-100:00, 6A: Ethylacetate/Ethanol-50:50, 10B: Methanol/H_2O-50:50. ALP: Alanine phosphatase, AST: Aspartate aminotransferase or transaminase, ALT: Alanine transaminase, TP: Total Protein, ALB: Albumin. GP: group, BV: Bitis arietans venom, SVA: snake venom antiserum, IP: intra-peritoneally.

Different treatments impact the liver function of rats induced by *Bitis arietans* venom. It consists of conventional anti-venom (SVA) and three active fractions of *Chrysophyllum albidum* leaf extract: F5B, F6A, and F10B, administered at different dosages. When compare the venom-only group (GP2) to the usual control (GP1), high levels of ALP, AST, and ALT in GP2 show that the liver is injured. The levels of TP and ALB are much lower in GP2, which means that the liver's ability to make proteins is not working properly. The venom from *Bitis arietans* induces significant hepatotoxicity, expected from this type of snake venom. Comparing the extracts and the conventional anti-venom (GP3 vs. GP4–GP12); standard anti-venom (GP3): Compared to the venom-only group (GP2), SVA lowers ALP and AST levels by a lot. It also helps bring TP and ALB levels back to normal. All three fractions (F5B, F6A, and F10B) protect the liver against damage caused by venom. Higher doses (200 mg/kg and 400 mg/kg) usually work better, as seen by lower enzyme levels and higher protein levels. When compare GP11 and GP3 directly, fraction F6A (GP11) has very low levels of ALP and ALT at 400 mg/kg. In fact, it works better than the normal anti-venom (GP3) for these enzymes. The plant extracts work well to lessen the hepatotoxic effects of the venom. Comparing the active parts (F5B, F6A, and F10B); all three fractions work very well to preserve the liver at the maximum dose (400 mg/kg). F6A (GP11) has the strongest effect on lowering ALP and ALT, with values that are even lower than those of the usual control (GP1). F5B (GP10): Also works very well, with very low levels of ALP and ALT. F10B (GP12): Offers good protection, with enzyme levels that are low but not as low as F6A. Compared to GP2, all three fractions exhibit big increase in total protein (TP) and albumin (ALB) levels, F10B at 400 mg/kg (GP12) has the greatest TP level, which means it has a considerable influence on liver synthesis. Comparing the fractions at 400 mg/kg (GP10, GP11, GP12), they are all similar at the maximum dose. However, F6A seems to be a little better at restoring liver enzyme balance, and F10B is very good at restoring total protein. This study demonstrates that the active portions of *Chrysophyllum albidum* leaf extract provide significant hepatoprotective effects against *Bitis arietans* envenomation. The protective effects vary on the dose, and in some situations (such F6A at 400 mg/kg), the fractions work better than the normal snake venom antiserum for certain liver measures. This backs up the traditional use of this plant to treat snakebites and shows that it could be used to make novel medicines.

DISCUSSION

The studies conducted *in vivo* showed that *Bitis arietans* venom in Wistar rats, resulted in a series of harmful effects on vital organs, indicating severe systemic damage. In particular, elevated liver enzymes (ALT, AST, and ALP), which indicate hepatotoxicity, were caused by the venom (Oršolić and Jembrek, 2024). Hassan *et al.* (2014) reported that the venom from the Egyptian cobra (*Naja haje*) is a powerful inducer of toxin-mediated hepatotoxicity, which is associated with apoptosis in the liver. Similarly, Abd El-Moneim *et al.* (2013) found an increase in liver enzymes AST and ALT in rats after exposure to cobra venom, indicating liver damage. In a recent case, researchers noted that while neurotoxic effects are more common from elapid bites, hepatotoxicity can occur as a rare manifestation (Sharan *et al.*, 2025). Multiple studies have demonstrated that venom, particularly from elapid species like the Egyptian cobra (*Naja haje*), can cause hepatotoxicity, leading to elevated liver enzymes such as ALT and AST (Hassan *et al.*, 2014; Sharan *et al.*, 2025). The venom of *Bitis arietans*, also known as puff adder, causes serious systemic damage in Wistar rats, affecting multiple organ systems through a variety of toxic mechanisms, according to *in-vivo* studies. The venom increased the liver enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP), indicating severe damage to the liver (hepatotoxicity).

Similar to this, liver failure may arise from the hepatotoxic effects indicated by elevated liver enzymes (ALT, AST, and ALP), especially in cases of severe envenomations. The results of the study, which include increased liver enzymes, are in line with the multi-systemic assault that the complex cocktail of toxins in *B arietans* venom has planned. This offers a more thorough, mechanistic explanation for the observed clinical and pathological outcomes and supports the conventional wisdom regarding puff adder bites.

Treatment with the chosen *C albidum* is the study's most convincing finding. *C. albidum* fractions (F5B, F6A, and F10B) successfully lessened the negative effects of the venom. With outcomes similar to the typical anti-venom serum, the treated groups demonstrated a significant improvement in all measured parameters across a range of dosages and durations. Research shows that extracts from *C. albidum* have therapeutic qualities that can lessen the negative effects of venom through antioxidant and anti-inflammatory pathways (Ajayi *et al.*, 2020). Studies investigating the chemical compounds of *C. albidum* have found that specific fractions contain active compounds capable of

neutralizing venom components like metalloproteinases and phospholipases A2 (The Guardian News, 2021). For example, Okhuakhin and Onyekpe (2015) examined the venom of *Echis Ocellatus*, a viper, showing that plant extracts could mitigate the venom's histopathological effects on the liver and kidney, this research provides strong evidence of the plant's effectiveness. The notion that the plant's effect is similar to standard antivenom serum requires careful consideration, as traditional antivenoms are antibody-based, and plant extracts function differently (Ajayi *et al.*, 2020). However, studies have demonstrated that certain plant-based treatments can significantly improve physiological parameters, even neutralizing venom-induced effects like edema and hemorrhage, sometimes showing effectiveness even after envenomation (The Guardian News, 2021). Therefore, while their mechanisms differ, some outcomes might appear functionally comparable.

According to the *in-vivo* research, the particular *Bitis arietans* (puff adder) venom's detrimental systemic effects were successfully countered in Wistar rats by *C. albidum* fractions F5B, F6A, and F10B. The promising antivenom potential of these plant-derived compounds was demonstrated by the treated rats' notable improvements in all measured parameters, with results comparable to the standard anti-venom serum. The *C. albidum* efficacy, the abundance of bioactive compounds found in *C. albidum* fractions is thought to counteract venom activity in a number of ways. According to *in-vivo* research, extracts from the African star apple (*C. albidum*) demonstrate therapeutic qualities that can lessen the negative effects of venom through antioxidant and anti-inflammatory pathways (Ajayi *et al.*, 2020; The Guardian News, 2021). The effectiveness of *C. albidum* is linked to its rich antioxidant compounds, such as saponins, tannins, flavonoids, and phenols, which help neutralize the oxidative stress and elevated lipid peroxidation caused by venom (Ogunleye *et al.*, 2020; The Proximate Analysis..., 2024).

Specifically, studies investigating the effects of snake venoms, including that of the puff adder (*Bitis arietans*), have documented significant oxidative stress and histopathological damage in Wistar rats (Effect of the *Bitis arietans* snake venom..., 2025). The ability of *C. albidum* to counteract venom activity through various mechanisms, including neutralizing specific venom components and inhibiting enzymes, supports its therapeutic potential (The Guardian News, 2021).

The plant's strong antioxidants have hepatoprotective and nephroprotective properties, which probably shield the liver and kidneys from oxidative stress and lipid

peroxidation brought on by the venom. The treated rats' improved liver and kidney function indicators provided evidence for this. Numerous studies have documented the protective effects of *C. albidum* extracts on liver and kidney function, often in response to toxic agents (Ajayi *et al.*, 2020; Ogunleye *et al.*, 2020). For instance, Obasi *et al.* (2022) conducted a study on albino rats and found that administering *C. albidum* leaf extract significantly reduced the levels of liver enzymes (ALT, AST, and ALP). This suggests the extract has both hepatoprotective and nephroprotective effects that could be useful in managing liver and kidney damage (Obasi *et al.*, 2022).

This protective action is supported by findings from other researchers who have studied the plant's potent antioxidant activity (The Proximate Analysis..., 2024). Oxidative stress, which is a key mechanism of venom toxicity, leads to an imbalance between the production of reactive oxygen species and the body's ability to neutralize them (Hassan *et al.*, 2014). By scavenging free radicals and inhibiting lipid peroxidation, the antioxidants in *C. albidum* counteract this toxic effect, preventing damage to the liver and kidney tissues (Ajayi *et al.*, 2020). Research has shown that *C. albidum* extracts can increase antioxidant enzyme status while reducing lipid peroxidation in induced hepatotoxicity models (Ajayi *et al.*, 2020). While these findings strongly suggest that the plant's antioxidant properties protect the liver and kidneys from venom-induced damage (Hassan *et al.*, 2014).

CONCLUSION

The effects of *Bitis arietans* venom in Wistar rats, indicate multi-organ damage, particularly to the liver, the research explores the potential of *Chrysophyllum albidum* leaf ethanol extract fractions (F5B, F6A, and F10B) in mitigating these effects in rats, noting improvements in biochemical parameters. This research suggests a potential area for further investigation into plant-based compounds, highlighting their antioxidant properties as a possible mechanism. It is critical to understand that research conducted in animal models does not automatically translate to human treatment. Snakebites are medical emergencies, and the only proven and recommended treatment is timely administration of appropriate antivenom serum by qualified medical professionals. Any exploration of plant-based compounds is still in the research phase and should not be considered a substitute for established medical protocols.

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