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Review Paper

A Review on Hepatoprotective and Antioxidant Activity of Boerhavia Diffusa and Bauhinia Variegata

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ABSTRACT

Liver diseases caused by alcohol, drugs, toxins and viral infections are increasing worldwide and remain a serious health concern. Although several synthetic drugs are available for treatment, they may cause unwanted side effects, which have led to a growing interest in herbal medicines. Medicinal plants have long been used in traditional systems such as Ayurveda for maintaining liver health. Boerhavia diffusa (Punarnava) and Bauhinia variegata (kachnar) are two important medicinal plants known for their hepatoprotective potential. These plants contain several bioactive compounds including flavonoids, phenolic compounds, alkaloids, and glycosides, which contribute to their antioxidant and anti-inflammatory properties. Studies have shown that extracts of these plants can help protect liver cells by reducing oxidative stress, preventing lipid peroxidation, and improving antioxidant defense mechanisms. Research using models such as HepG2 cell lines also suggests that extracts may help restore normal liver enzyme levels and protect hepatocytes from toxin-induced damage. Overall, these plants show promising potential as natural hepatoprotective agents, and further research may support their development for the management of liver disorders

INTRODUCTION

The liver is a crucial organ that plays a vital role in our body's metabolism, detoxification, and overall well-being. Unfortunately, the liver can be negatively impacted by substances such as alcohol, drugs, and toxins, leading to various liver

diseases that pose a significant global health concern. Although several synthetic medications are available to promote liver health, they may cause unwanted side effects, which has sparked interest in plant-based remedies. Plant-based therapies are gaining popularity due to their safety, efficacy, and long-standing use in traditional

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medicine. Plants like *Boerhavia diffusa* (*punarnava*) and *Bauhinia variegata* (*kachnar*) are commonly utilized in practices like Ayurveda to address liver-related issues. *Boerhavia diffusa* is recognized for its antioxidant, anti-inflammatory, and phenolic properties. Similarly, *Bauhinia variegata* demonstrates notable antioxidant and cell-protective characteristics, indicating its potential. Recent studies, particularly those involving HepG2 cell lines and liver-toxicity models, suggest that extracts from these plants may help in restoring liver enzymes, enhancing antioxidant defenses, and safeguarding liver cells from damage caused by toxins. Therefore, *Boerhavia diffusa* and *Bauhinia variegata* hold promise as natural alternatives for developing effective treatments to support liver protection. [1]

Most of the dangerous chemicals that harm the liver primarily damage liver cells by initiating lipid peroxidation and other oxidative injuries. The increased liver peroxidation that occurs during the breakdown of ethanol in liver cells can result in hepatitis and cirrhosis. It is estimated that approximately 90% of acute hepatitis cases are caused by viruses, including Hepatitis A, B, C, D (delta agents), E, and G. Among these, Hepatitis B infections often progress to chronic liver conditions and cirrhosis. Moreover, these viruses have been associated with the development of primary liver cancer [2]

Boerhavia diffusa



Figure:1 *Boerhavia* (*Punarnava*)

Common names

English: Red Hogweed, Spreading Hogweed, Hogweed Weed spreading.

Hindi: Santh, Shothagni, Rakta

Malayalam: Thazhuthama

Bengali: Punarnnava

Kannada: Kommegida

Gujarati: Vakhakhaparo, Dholia-saturdo,

Marathi: Tambadivasu, Ghetuli

Tamil: Chattarani, mukaratte

Telugu: Galijeru [3]

Taxonomical Classification

Botanical Name: *Boerhavia diffusa*

Family: Nyctaginaceae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Caryophyllales

Genus: *Boerhavia*

Species: *Boerhavia Diffusa*

Geographical Distribution:

Boerhavia species are widespread, and their dispersal is mostly due to birds and human activity. The genus name *Boerhavia* was given in honour of Herman Boerhaave, a famous Dutch physician of the 18th century. The *Boerhavia* Genus is made up of 40 species and is distributed in tropical, subtropical, and temperate regions around the world. One of these species, *Boerhavia diffusa*, originally from Brazil and India, now thrives in various countries at elevations up to 1200 meters above sea level. It is widely distributed in locations like Mexico, Asia, Africa, the Indian and Pacific Oceans, Egypt, and Sudan. In India, six species of this genus are found, including *Boerhavia diffusa*, *Boerhavia chinensis*, *Boerhavia erecta*, *Boerhavia repanda*, and *Boerhavia rubicunda*. *B. diffusa*, in particular, is native to India and grows well in wastelands and

fields after the rainy season. Additionally, this plant is also cultivated in West Bengal [4]

Traditional uses:

The Punarnava plant holds a fascinating history in Ayurvedic herbal medicine, where its roots, leaves, and aerial parts have been traditionally used to treat a variety of health conditions. The roots, in particular, are renowned for their effectiveness in treating conditions such as gonorrhea, internal inflammation, dyspepsia, oedema, and jaundice. It is also valued for its

diuretic, digestive aid, laxative, and emmenagogue (menstrual-promoting) properties. When combined with Mamira, it is utilized to address eye issues such as corneal ulcers and night blindness, as well as to enhance virility in men. Among tribal communities, it is highly valued for its supportive role during childbirth. The juice extracted from *Boerhavia diffusa* leaves is used topically for eye care and consumed for its purifying and pain-relieving benefits. [5]

Bauhinia variegata



Figure:2 *Bauhinia variegata* (Kachnar)



Figure:3 *Bauhinia variegata* Plant

Common names:

Sanskrit: *Raktakanchan, Phalgu*
 Kannada: *Bilimandar, Kanchavala*
 Telugu: *Adavimandaramu, Devakankanchamu*
 Hindi: *Kachnar, Bogakatra, Koliar, Mandari*
 English: *Mountain Ebony, Orchid tree,*
 Spanish: *Flamboyantorquidea,*
 Urdu: *Kachnal*
 Gujarati: *Kovindara*
 Punjabi: *Kanchan* [6]

Plant profile:

Kingdom: Plantae
 Subkingdom: Tracheobionta - Vascular plants
 Super division: Spermatophyte – Seed plants
 Division : Magnoliopsida-Dicotyledons
 Subclass : Rosidae
 Order : Fabales

Family : Fabaceae-Pea family
 Genus : *Bauhinia* L
 Species : *Bauhinia variegata* L.

Geographical distribution

Bauhinia species can be found in various tropical and subtropical regions around the world. They are commonly found at elevations up to 1300 meters and around 900 meters in dry mixed forests. They are most commonly seen in Asia, including countries such as India, China, Nepal, Bhutan, Sri Lanka, and Myanmar. These species are also present in Africa, South and Central America, and certain parts of Australia. In India, you'll often come across *Bauhinia* species in forests, plains, and hilly areas, especially in the northern, southern, and northeastern regions. They grow as trees, shrubs, or climbers, contributing to the diverse flora of these areas. [7]



Traditional uses:

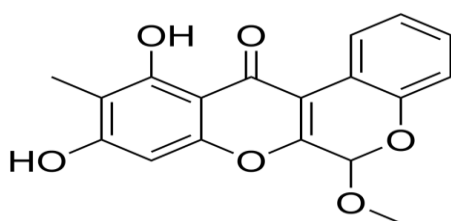
In medicine, the leaves of the tree contain a good amount of reducing sugar and are highly nutritious for the healthy growth of tasar silk worms. They are commonly used to make bidis. The roots are known for their carminative properties and are used to alleviate dyspepsia, flatulence, and even act as an antidote to snake poison. The bark of the tree is recognized for its astringent and tonic qualities, and is used in treating various conditions such as scrofula and skin diseases. The flowers and flower buds are consumed as vegetables and are also known for their laxative effects. The flower juice is used to address issues like diarrhea, dysentery, and other stomach ailments. Additionally, dried flower buds are utilized in treating diarrhea, dysentery, worms, piles, and tumors. According to ayurvedic literature, this plant is said to have a bitter taste, dry properties, cooling potency, and pungent post digestive effect. The stem bark of *Bauhinia variegata* is

traditionally used to treat conditions such as worm infections, scrofula, cervical lymphadenitis, and wounds [8]

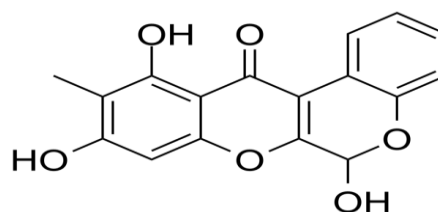
Phytochemical profile of the biherbal extract:

Phyto-chemical components of *Boerhavia diffusa*:

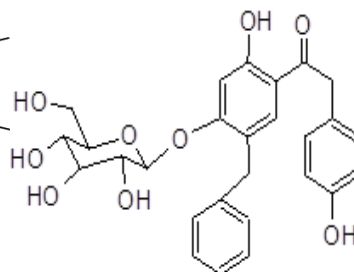
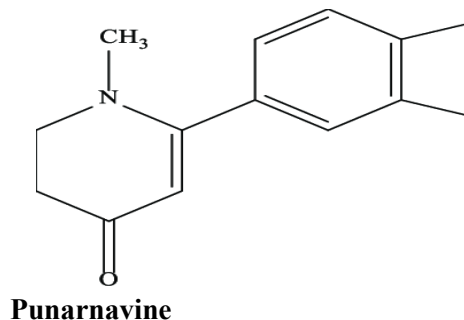
This herb contains a wide range of natural compounds, including flavonoids such as (C-methylflavone, 5,7-dihydro-3',4'-dimethoxy-6,8-dimethylflavone, and more), alkaloids: punarnavine, and glycosides like punarnavoside. Researchers have also found rotenoids: (boeravinone B) steroids, triterpenoids, lipids, lignans, carbohydrates, proteins, and glycoproteins in this plant. Numerous studies have highlighted the herb's various biological, pharmacological, and clinical properties along with those of its natural components [9]



Boeravinone A



Boeravinone B



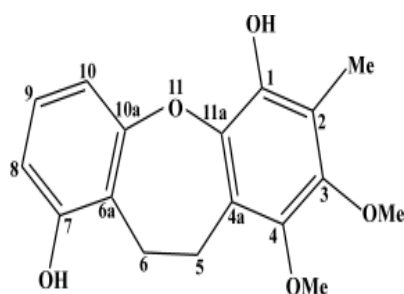
Punarnavoside

Phytochemical Component of *Bauhinia Variegata*:

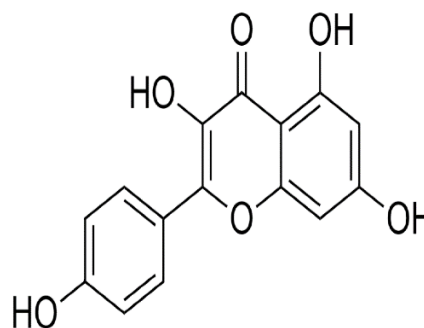
Bauhinia variegata is rich in a variety of compounds, including flavonoids, glycosides, saponins, triterpenoids, phenolic compounds,

oxepins, fatty acids, and phytosterols. The stem specifically contains β -sitosterol, lupeol, kaempferol-3-glucoside, and 5,7 dihydroxy and 5,7-demethoxy flavanone-4-O- α -L-rhamnopyranosyl- β -D-glucopyranosides. The pale violet flowers are known to contain cyanidin -3-diglucoside and peonidin-3-diglucoside, while the white flowers contain kaempferol-3-galactoside

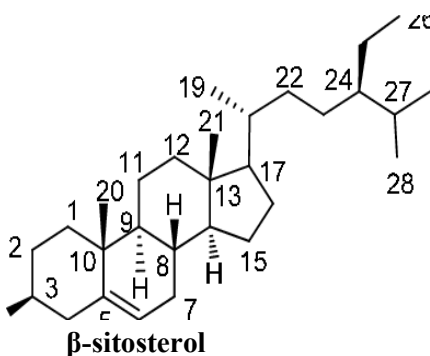
and kaempferol. Various flavonoids, such as quercetin, rutin, and apigenin-7-O-glucoside, have been identified in different parts of *Bauhinia variegata*. Additionally, phytochemical analysis of the root bark has revealed the presence of compounds like 3',4'-methylenedioxyflavonoid And a new dihydrobenzoxepine compound [10]



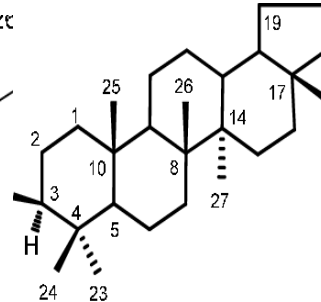
Dihydrobenzoxepin



Kaempferol



β -sitosterol



Lupeol

Antioxidant Activity and Its Role in Hepatoprotective:

Oxidative stress is a key player in the progression of liver diseases, as the liver is highly susceptible to oxidative harm due to its crucial roles in metabolism and detoxification. This susceptibility leads to an excess production of reactive oxygen species (ROS). Antioxidants play a vital role in protecting liver cells by neutralizing free radicals and maintaining redox balance.

Role of Oxidative stress in liver injury:

Certain hepatotoxic substances such as carbon tetrachloride, paracetamol, alcohol, and

environmental toxins, induce oxidative stress leading to liver damage. This results in: -

- Damage to cell membranes
- Release of liver enzymes (ALT, AST, ALP)
- Disturbances of mitochondrial function
- Triggering of inflammatory reactions
- Liver cell death via apoptosis and necrosis

Hence the oxidative stress is a key factor in the development of liver damage. [11, 12]

Antioxidant activity of *Boerhavia diffusa*:



Boerhavia diffusa's significant phytochemical composition which includes flavonoids, phenolic compounds, and rotenoids like boeravinones, is responsible for its potent antioxidant effect. In hepatotoxicity models, *B. diffusa* extracts dramatically lower lipid peroxidation while raising antioxidant enzyme levels, according to experimental research. Its hepatoprotective potential is largely dependent on this antioxidant characteristic. [13]

Antioxidant Activity of *Bauhinia variegata*:

Bauhinia variegata's hepatoprotective efficacy is mainly due to its antioxidant compounds, which include quercetin, rutin, and kaempferol. These chemicals have free radical scavenging activity and boost endogenous antioxidant levels in liver tissues. *B. variegata* extracts have been shown to normalize oxidative stress indicators and liver enzymes levels in experimental models. [14]

Mechanism of Hepatoprotection:

Hepatoprotective agents are substances that help shield liver cells (hepatocytes) from harm caused by toxins, medications, alcohol, and oxidative stress. Numerous medicinal plants display hepatoprotective benefits through various mechanisms including antioxidant properties, anti-inflammatory actions, stabilization of hepatocyte membranes, and boosting detoxification systems. The protective effects are primarily attributed to bioactive compounds like flavonoids, phenolics, alkaloids, terpenoids, and glycosides. [15]

1. Antioxidant Mechanism

Oxidative stress plays a crucial role in the development of liver diseases. During liver injury, excessive production of reactive oxygen species (ROS) such as superoxide radicals, hydroxyl radicals and hydrogen peroxide leads to lipid

peroxidation and cellular damage. Hepatoprotective phytochemicals act as antioxidants that neutralize these free radicals and reduce oxidative stress. They also enhance endogenous antioxidant defence systems by increasing the activity of enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). These enzymes help maintain redox balance and prevent damage to hepatocyte membranes. [16]

2. Anti-inflammatory Activity

Inflammation plays a significant role in the progression of liver injury and various liver diseases. During hepatic damage, inflammatory cells release several pro-inflammatory cytokines, including tumor necrosis factor α (TNF), interleukin-1 β (IL-1 β), and interleukin-6 (IL-6), which contribute to further tissue damage and impaired liver function. Many hepatoprotective compounds derived from medicinal plants have been reported to exhibit strong anti-inflammatory properties. These phytochemicals can suppress the production and release of pro-inflammatory cytokines and modulate important inflammatory signalling pathways such as nuclear factor-kappa B (NF-kB) and mitogen-activated protein kinase (MAPK). By regulating these pathways, plant-based compounds help reduce hepatic inflammation and protect liver tissues from further damage. [17]

3. Mitochondrial Protection

Mitochondria play an essential role in cellular energy production and metabolism. Toxic substances can damage mitochondrial membranes, resulting, in reduced ATP production and increased oxidative stress. Hepatoprotective compounds help maintain mitochondrial integrity by preserving membrane potential, reducing oxidative stress, and preventing apoptosis. This



helps maintain normal hepatocyte function and promotes liver cell survival. [18]

4. Stabilization of Hepatocyte Membranes

Many hepatotoxic substances cause lipid peroxidation in hepatocyte membranes, leading to leakage of liver enzymes such as alanine

aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) into the bloodstream. Hepatoprotective plant compounds stabilize liver cell membranes and prevent enzyme leakage, thereby maintaining normal liver function and reducing tissue damage.[19]

Other plants used in Hepatoprotective Activity

S. no	Biological name	Local name	Family	Part used	Solvent	Active constituent	Pharmacological Activity	References
1	<i>Allium cepa L.</i>	Onion	amaryllidaceae	Bulb	Methanol	Flavonoids Saponins Vitamins (C, B-complex)	Hepatoprotective, Antioxidant & Anti-inflammatory activity	[11]
2	<i>Silybum marianum</i>	Milk thistle	Asteraceae	Seeds	Ethanol	Silibinin, Silychristin, Silydianin	Hepatoprotective activity, and antioxidant activity	[12]
3	<i>Curcuma longa L.</i>	Haldi, Turmeric	Zingiberaceae	Rhizome	Ethanol	Curcuminoid, Dimethoxy-curcumin	Hepatoprotective, Antioxidant, Anticancer	[13]
4	<i>Cyperus rotundus</i>	Nut grass	Cyperaceae	Ethanol	rhizome		Stomachic astringent, sedative, diuretic	[14]
5	<i>Limonia Acidissima L.</i>	Wood apple	Rutaceae	Ethanol, Acetone	Whole plant	Alkaloids, Flavonoid, Phenolics, Tannins, Steroids	Hepatoprotective, antidiuretic, Analgesic, antioxidant activities	[15]
6	<i>Zingiber officinale Rosc.</i>	Red ginger	Zingiberaceae	Ethanol	Rhizome	Gingerols Shogaols Zingiberene	Hepatoprotective, Antioxidant & Anti-inflammatory activities	[16]
7	<i>Rosmarinus officinalis</i>	Rosemary	Lamiaceae	Ethanol	Leaves	Carnosol, Rosmanol	Antioxidant, Hepatoprotective, Antimicrobial, anti-inflammatory Activities	[17]

8	<i>Berberis vulgaris L.</i>	Barberry	Berberidaceae	Ethanol	Roots	Berberine	Anti-oxidant, Anti-diabetic, Anti-cancer Activities	[18]
9	<i>Phyllanthus emblica L.</i>	Amla	Phyllanthaceae	Methanol	Fruit	Triaccontanol, triaccontanoic acid	Antidiarrheal, Antioxidant, Hepatoprotective, Gastroprotective Activities	[19]
10	<i>Azadirachta Indica</i>	Neem	Meliaceae	Distilled Water	seed	Azadirachtin-A Nimbin, Nimbidin	Antioxidant, Anti-inflammatory, Hepatoprotective Activities	[20]
11	<i>Tridax procumbens L.</i>	Coat buttons	Asteraceae	Ethanol	Aerial	quercetin, glucoluteolin, isoquercetin	Antioxidant, Hepatoprotective Activities	[21]
12	<i>Cinnamomum verum</i>	Cinnamon	Lauraceae	Ethanol	Bark	Cinnamaldehyde, Eugenol	Hepatoprotective Antimicrobial, Antioxidant, antipyretic, immunomodulatory activities	[22]
13	<i>Solanum nigrum L.</i>	Black nightshade	Solanaceae	Ethanol / Methanol / Aqueous	Leaves	Solanine, Solamargine, Solasonine	Antiulcer, Anticancer, Antidiabetic, activities	[23]
14	<i>Moringa oleifera L.</i>	Drumstick tree	Moringaceae	Ethanol	Leaves	Carotenoids, α -Tocopherol, niazirinin,	antioxidant, anti-inflammatory, lipid-modulating activities	[24]
15	<i>Ocimum sanctum</i>	Tulsi	Lamiaceae	Ethanol	Leaves	Eugenol Uroslic acid Flavonoids	Antioxidant anti-inflammatory antimicrobial antiasthmatic activities	[25]
16	<i>Solanum nigrum L.</i>	Kamanchi	Solanaceae	Ethanol	Whole plant	Solanine, Solasonine, rutin	Antitumor, anti-inflammatory	[26]

							antioxidant activities	
17	<i>Allium sativum</i>	Garlic	Amaryllidaceae	Aqueous Extract	Bulb	alliin, allicin	Hepatoprotective, Antioxidant, Anti-inflammatory	[27]
18	<i>Terminalia arjuna</i>	Arjuna	Combretaceae	Methanol	Leaves	quercetine, luteolin, Triterpenoids	Hepatoprotective, Antioxidant, Cardioprotective, Antimicrobial Activities	[28]
19	<i>Origanum vulgare L.</i>	oregano	Lamiaceae	Aqueous	Leaves	Terpenoids, tannins, saponins, Flavonoids	Antioxidant, Anti-inflammatory, Antispasmodic, Antimicrobial Activities	[29]
20	<i>Acacia mellifera</i>	Black Thorn	Fabaceae	ethanol + water	Leaves	Tannins, Sterols, saponins,	Antioxidant, Hepatoprotective, antimicrobial Activities	[30]
21	<i>Glycyrrhiza glabra</i>	Licorice	Fabaceae	Methanol	Roots	Glycyrrhizin, Isoliquiritin	Antimicrobial, Antioxidant, Hepatoprotective Activities	[31]
22	<i>Phyllanthus niruri L.</i>	Bhumi amla	Phyllanthaceae	Ethanol	Whole plant	1H- indole, α -Amyrin, Phenol,	Anti-inflammatory, Antioxidant, Hepatoprotective activities	[32]
23	<i>Eclipta alba</i>	Bhingara j	Asteraceae	Ethanol / Water	Whole plant	coumestans, wedelolactone, desmethylwedelolactone	Antioxidant, Antimicrobial, Anticancer, antidiabetic activities	[33]
24	<i>Fumaria Indica</i>	Pitpapra	Fumariaceae	Methanol	whole plant	protopine, flavonoids	Hepatoprotective, Antioxidant, Antipyretic Activities	[34]

25	<i>Cichorium m intybus</i>	Chicory	Asteraceae	Hydro- alcoholi c	Leaves	lactucin, lactucopicrin	Antihyperlipide mic, Gastroprotective , Nephroprotectiv e, Antioxidant, hepatoprotective	[35]
26	<i>Punica granatu m</i>	pomegra nate	Punicaceae	Methan ol	Peel (fruit rind)	flavonoids phenolic acid, tannins.	Hepatoprotectiv e, Antioxidant, Anti- inflammatory activities	[36]
27	<i>Withania somnifer a</i>	Ashwaga ndha	Solanaceae	Aqueou s extract	Root	withanolides, withaferin, steroidal lactone	Hepatoprotectiv e, Neuroprotective, Inflammatory Activities	[37]
28	<i>Tephrosi apurpure a</i>	Sarapunk ha	Fabaceae	Ethanol	Aerial parts	quercetin, rutin, Rotenoids	Hepatoprotectiv e Antioxidant, Anti- inflammatory Activities	[38]
29	<i>Cassia fistula</i>	Amaltas	Caesalpinac eae	Ethanol	fruit	flavonoids, tannins, Phenols	Antioxidant, antimicrobial, Hepatoprotectiv e Activities	[39]
30	<i>Tylophor a Indica</i>	Antamul	Asclepiadac eae	Methan ol	Leaves	tylophorine, tylophorinine	Hepatoprotectiv e, Antioxidant, Anti-asthmatic Anticancer Activities	[40]

CONCLUSION

In conclusion, *Boerhavia diffusa* and *Bauhinia variegata* are important medicinal plants that show promising potential in protecting and supporting liver health. These plants contain a variety of phytochemical constituents such as flavonoids, phenolic compounds, alkaloids, and glycosides, which are widely recognized for their antioxidant and anti-inflammatory activities. These bioactive

compounds help reduce oxidative stress, prevent lipid peroxidation, and protect hepatocytes from damage caused by toxins, drugs, and other harmful agents. Several experimental and in-vitro studies, including those conducted on HepG2 cell lines, have reported that extracts of these plants can help normalize altered liver enzyme levels and improve overall liver function. Moreover, their long-standing use in traditional herbal medicine further



highlights their therapeutic value. Based on the available scientific evidence, *Boerhavia diffusa* and *Bauhinia variegata* may serve as promising natural sources for the development of safer hepatoprotective therapies. Nevertheless, further detailed pharmacological studies and well-designed clinical trials are necessary to fully establish their safety, efficacy, and potential role in the prevention and treatment of liver diseases.

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