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Herbal Medicine in the Management of Liver Diseases

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Abstract

Liver diseases remain a global health challenge, with conventional drugs often limited in efficacy and sometimes caused hepatotoxicity. Herbal medicines offer promising alternatives due to their safety, potency and cost-effectiveness. Phytoconstituents such as flavonoids, polyphenols, glycosides and essential oils have demonstrated the hepatoprotective effects by reducing oxidative stress, enhancing antioxidant defenses and regulating liver enzyme activity. The major medicinal plants with reported hepatoprotective potential include C. sinensis, A. paniculata, S. marianum, Z. officinale, C. pepo, C. reticulata and P. crispum. The therapeutic efficacy of herbal formulations often arises from synergistic interactions among multiple constituents. Advanced techniques like high-performance liquid chromatography and microdialysis aid in characterizing these compounds, while understanding their pharmacokinetics is crucial for optimizing dosage and safety. Plant-based biomolecules thus represent a promising source for the development of effective hepatoprotective drugs.

Keywords: *Liver, herbal medicine, liver diseases, medicinal plants, hepatoprotective drugs.*

1. Introduction

Currently, phytochemicals from natural resources are being adopted as alternative treatment options to treat several acute to chronic diseases. Despite considerable advancements in modern medicine, a shortage of proper and potent hepatoprotective agents has remained a chronic concern (Hasan et al., 2018). Many conventional medications have been removed from the market due to reports of drug-induced liver injury, and serious cases of liver dysfunction can require liver transplantation or lead to death (Au et al., 2011). Modern drugs provide little relief for liver disorders are primarily treated using plant-based formulations. Herbal drugs have grown in importance and popularity in recent years due to their potency, purity and cost-effectiveness. Therefore, an attempt has been made to address herbal medicine for the treatment of liver diseases, which are widely used for the therapeutic purpose. A number of chemical constituents, such as phenols, organic acids, lignans, monoterpenes, alkaloids, flvonoids, glycosides, coumarins, lipids, and xanthenes, have been identified in hepatoprotective plants (Bhawna and Kumar, 2010). A wide range of plants are thought to have hepatoprotective efficacy, suggesting that the advancement of plant-based hepatoprotective drugs on the global market should be prioritized (Abu et al., 2017).

Across the world, liver disorders, such as jaundice, cirrhosis, fatty liver, hepatosis, drug-induced hepatitis, alcohol-induced hepatitis, non-alcoholic steatohepatitis and hepatocellular carcinoma, create conditions in which the functions and structure of the liver become impaired, and liver failure is the fifth most common cause of death globally, behind only heart failure, stroke, chest disease and cancer, making liver disease a public health issue (Azab and Albasha, 2018). The worldwide incidence of chronic liver disease is 18.5% and the prevalence of cirrhosis is 4.5%–9.5%, with 2 million people dying every year (Islam and

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Alam, 2019). According to the World Health Organization (WHO), deaths due to liver disease in India reached 268,580 in 2020, accounting for 3.17% of total deaths. Chronic liver diseases, including cirrhosis, were the eighth leading cause of death in 2022, a significant increase from previous years (Swaroop et al., 2024). Hepatic disorder is associated with the disruption of the liver structures, tissues and function, which may be caused by biological origins, including bacteria, viruses, parasites and autoimmune diseases, induced by various conventional drugs acetaminophen, nimesulide and hepatotoxins, which are primarily metabolized by the enzymes cytochrome P450 and glutathione S-acyltransferases mixed oxidases; and the excessive consumption of alcohol (Kumar et al., 2011; Madrigal-santill´an et al., 2014; Mishra et al., 2014). The present study discusses major medicinal plants with significant hepatoprotective properties and their contributions to the management of liver diseases.

2. Methodology

Different types of electronic bibliographic databases such as Web of Science Master Journal List, SpringerLink, ScienceDirect, Google Scholar, PubMed, Scopus, Wiley Online Library, Taylor & Francis, ResearchGate, and NISCAIR Online Periodicals Repository were extensively searched to obtain scientific information on “hepatoprotective traditional medicinal plants” by applying specific keywords. The keywords used included “plants against hepatoprotection,” “herbal medicine for liver problems,” “phytotherapy for liver disease,” and “plants and hepatoprotective effects.” The research articles were downloaded from various scientific journals and thoroughly examined for their relevance, authenticity, data quality and validity.

3. Medicinal Plants for Hepatic Disorders

3.1 *Zingiber officinale*

Z. officinale (Zingiberaceae) is a widely used medicinal plant around the world, commonly incorporated into foods as a spice. Traditionally, it has been an important ingredient in Chinese, Ayurvedic, and Unani herbal medicines for the treatment of various ailments such as catarrh, rheumatism, nervous disorders, gingivitis, toothache, asthma, stroke, constipation, and diabetes (Awang, 1992; Tapsell et al., 2006; Wang and Wang, 2005). The pharmacological effects of ginger have been reported to include antiplatelet, antioxidant, antitumor, anti-rhinoviral, anti-hepatotoxic, anti-arthritic, and anti-inflammatory activities (Lantz et al., 2007; Patel et al., 2000). The antioxidant activity of gingerol and other constituents of ginger has also been confirmed (Aeschbach et al., 1994). It has been reported that different doses of ginger extract cause alterations in biochemical parameters, free radicals, and antioxidant enzymes induced by bromobenzene in a rat model, thereby improving bromobenzene-induced liver toxicity (El-Sharaky et al., 2009). Curcumin, another active component present in ginger, has been found to act as an antioxidant and anti-inflammatory agent, inducing haem-oxygenase-1 and protected endothelial cells against oxidative stress (Motterlini et al., 2000). Furthermore, ginger root extract has shown hepatoprotective effects against aspartame-induced hepatotoxicity by decreasing liver function biomarkers (ALT, AST, ALP, γ-GT), serum total protein, albumin, and total bilirubin levels, while increasing antioxidant enzyme levels and reducing malondialdehyde concentrations (Hozayen and Abou Seif, 2014).

3.2 *Cucurbita pepo* L.

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Pumpkin is frequently reported as a functional food or medicine (Caili et al., 2006). Pumpkin seeds are a rich source of unsaturated fatty acids, antioxidants, and fiber, and are known to have anti-atherogenic, hepatoprotective (Makni et al., 2008), and antidiabetic activities (Al-Zuhair et al., 2000). Phytochemical analyses have revealed that pumpkin is rich in unsaturated fatty acids particularly linoleic and oleic acids as well as tocopherols with very high oxidative stability (Stevenson et al., 2007), carotenoids, and gamma-aminobutyric acid (GABA) in the fruit (Liu et al., 2001; Gossell-Williams et al., 2008). Pumpkin seed oil contains nutrients such as essential fatty acids (omega-6 and omega-9), phytosterols, and antioxidants including carotenoids, vitamin A, and vitamin E (Murkovic et al., 1996). Moreover, pumpkin oil may play an important role in protecting against alcohol and Tramadol-induced hepatotoxicity and oxidative stress (Abou Seif, 2014a; Ekpono et al., 2024).

3.3 *Citrus reticulata*

C. reticulata, also known as mandarin, is a small citrus tree with fruits resembling other orange varieties. Chemically, the plant is rich in vitamin C, flavonoids, organic acids, volatile oils, and rutin (Wang et al., 2008; Luo et al., 2008). In humans, rutin exhibits more potent antioxidant properties compared to quercetin, acacetin, morin, hispidulin, hesperidin and naringin (Chow et al., 2005; Zhou et al., 2016), which are mostly isolated from citrus peel. Hesperidin is another flavanone glycoside found abundantly in citrus fruits that showed an antioxidant, anti-inflammatory, anticarcinogenic activities in vitro study (Farombi et al., 2008; Emim et al., 1994; Tanaka et al., 2000). Both hesperidin and rutin plays an important role in the protection against doxorubicin-induced hepatotoxicity, by alleviating the activities of liver enzymes (ALT, AST, and ALP and GGT) in addition to the amelioration in the levels of total bilirubin, albumin and sialic acid (Hozayen et al., 2014; Elhemiely et al., 2025).

3.4 *Petroselinum crispum* oil

The plant Parsley (Apiaceae) is a native herb of the central Mediterranean region (southern Italy, Algeria, and Tunisia) (Lopez et al., 1999). Various scientific studies have demonstrated its antibacterial and antioxidant activities (Wong and Kitts, 2006; Zhang et al., 2006; Kolarovic et al., 2010). Phytochemical analyses have shown that parsley contains several flavonoids, such as apiin and luteolin, while its essential oil is rich in apiol and myristicin (Alobaidi, 2024; Farzaei et al., 2013; Fusani et al., 2025). Parsley oil plays an important role in improving liver function by modulating enzyme activity, enhancing antioxidation and anti-lipid peroxidation, promoting detoxification, and protecting against glutathione depletion in cases of alcohol-induced hepatotoxicity and oxidative stress (Abou Seif, 2014b).

3.5 *Andrographis paniculata*

A. paniculata (Acanthaceae) is one of the most commonly used plants in the traditional systems of Unani and Ayurvedic medicine, and it is widely known as the king of bitters (Jarukamjorn and Nemoto, 2008). *A. paniculata* has been reported to possess antibacterial (Mishra et al., 2013), antimalarial (Dua et al., 2004), antiviral (Wiart et al., 2005), cardioprotective, antioxidant, anti-inflammatory (Sheeja et al., 2006), antidiabetic, and antitumor activities (Zhao et al., 2008). Treatment with whole-plant extracts of *A. paniculata* has been shown to reduce lipid peroxidation levels and enhance antioxidant enzyme activity, likely due to the presence of various flavonoids, phenols, and glycosides in the plant (Subramaniam et al., 2015).

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3.6 *Silybum marianum*

Silymarin, derived from the seeds of *S. marianum*, is a member of the sunflower family and is commonly called milk thistle. The plant has been used for centuries as a natural remedy for liver and biliary tract diseases (Abou Seif, 2016). The active biomolecules of milk thistle are flavonolignans, including silybin, silydianin, and silychristin, collectively known as silymarin (Shaarawy et al., 2009). The pharmacological activity of silymarin has been reported to protect liver cells from a wide variety of toxins, including acetaminophen, ethanol, CCl_4 and D-galactosamine (Rasool et al., 2014). Its hepatoprotective efficacy is attributed to several mechanisms, including antioxidation, anti-lipid peroxidation, enhanced detoxification, and protection against glutathione depletion (Pradhan and Girish, 2006). Silybum seeds also contain betaine and essential fatty acids, which may contribute to silymarins' anti-inflammatory effect (Saller et al., 2001).

3.7 *Camellia sinensis*

Green tea leaves produce organic compounds that may be involved in the defense of plants against invading pathogens, and these metabolites are known as polyphenols (Friedman, 2007), which include catechin, epicatechin, epigallocatechin, tannins and caffeine (Wang and Goodman, 1999). Green tea displays antioxidants and free radical scavenger properties (Crespy and Williamson, 2004). The green tea extract and its main catechin polyphenols have medicinal value for the prevention of and therapeutics in several diseases (Ostrowska and Skrzydlewska, 2006). The green tea exerts improvement in liver function by preventing the production of reactive oxygen species (ROS) and enhancing the antioxidant defense system capacity. Thus, green tea extract has protective effects against ethanol toxicity (Bharali and Chetry, 2013; Lodhi et al., 2014).

4. Discussion and Conclusion

Although the number of patients with liver diseases has been increasing rapidly, treatment outcomes are still considered unsatisfactory. Herbal medicine has become a major contributor to the management of liver problems. The growing number of preclinical and traditional studies on various herbal medicines indicates a promising future for drug development from herbal-based products. The success of treating liver diseases with herbal medicines depends on understanding each chemical constituent and their interactions. Currently, a handful of herbal drugs, such as silymarin, rutin, epicatechin, and epigallocatechin, have been extensively studied. These plant-based biomolecules, along with other constituents mentioned in this study, have demonstrated their significance and potential as major treatment modalities for liver diseases.

Unlike conventional drugs, which are composed of known chemical constituents that can be accurately quantified, herbal drugs consist of complex mixtures of ingredients. Due to this complexity, studies face major challenges, with the greatest difficulty being the purification of herbal medicines and the identification and quantification of their individual components. Currently, advanced techniques such as high-performance liquid chromatography, protein precipitation, and microdialysis are being used to separate these chemical constituents.

However, studying the clinical effects of individual chemical constituents in isolation is of limited use for several reasons such as the neutralization of harmful chemicals in a mixture by other compounds, as well as the synergistic or inhibitory interactions among constituents that together create an effective in vitro therapeutic combination. Relying solely on

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information about the pharmacodynamics of herbal medicines in liver diseases provides insufficient detail for developing drugs with similar effects. Factors such as metabolism, absorption, distribution, and the intrinsic concentration of the drug must be accurately understood to determine the appropriate dosage, duration of treatment, and safety margin.

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Conflict of interests:

The authors declare that there are no conflicts of interest related to this article.

Data availability statement:

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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