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TYPES OF HEPATITIS AND MEDICINAL PLANTS USED IN THEIR TREATMENT

M.G.Numonjonov[1],

1. Andijan state medical institute,assistant, department of Biochemistry,PhD researcher, Kokand State University.

E-mail: nomonjonovmuxiddin@gmail.com

ORCID: https://orcid.org/0009-0001-7281-5538

M.M.Xolmatova[2], D.A.Xasanova[2], M.F.Xoldarova[2], Z.M.Tursunaliyeva[2], Q.Q.Qayumov[2]

2) Andijan state medical institute. 3-year students,faculty of Fundamental medicine.

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Abstract: This article provides a detailed overview of the aetiology, developmental mechanisms, clinical-biochemical characteristics, and primary types of hepatitis. Specifically, the aetiology, pathogenesis, and systemic effects of viral hepatitis types A, B, C, D, and E, as well as toxic, alcoholic, autoimmune, and drug-induced hepatitis, are scientifically elucidated.

Keywords: Hepatitis, viral hepatitis, liver, hepatocytes, hepatoprotectors, phytotherapy, medicinal plants, milk thistle (Silybum marianum), turmeric (Curcuma longa), artichoke (Cynara scolymus), liquorice (Glycyrrhiza glabra), green tea (Camellia sinensis), black cumin (Nigella sativa), silymarin, curcumin, glycyrrhizin, antioxidants, biologically active substances, oxidative stress, lipid peroxidation, anti-inflammatory effect, biochemical changes, hepatoprotective properties.

Particular attention is paid to the vital metabolic functions of the liver within the organism, the biochemical processes occurring in hepatocytes, and the pathological alterations arising from disease progression. In particular, disruptions in protein, carbohydrate, and lipid metabolism, alterations in bilirubin metabolism, elevated activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) enzymes, oxidative stress, and lipid peroxidation processes are analysed.

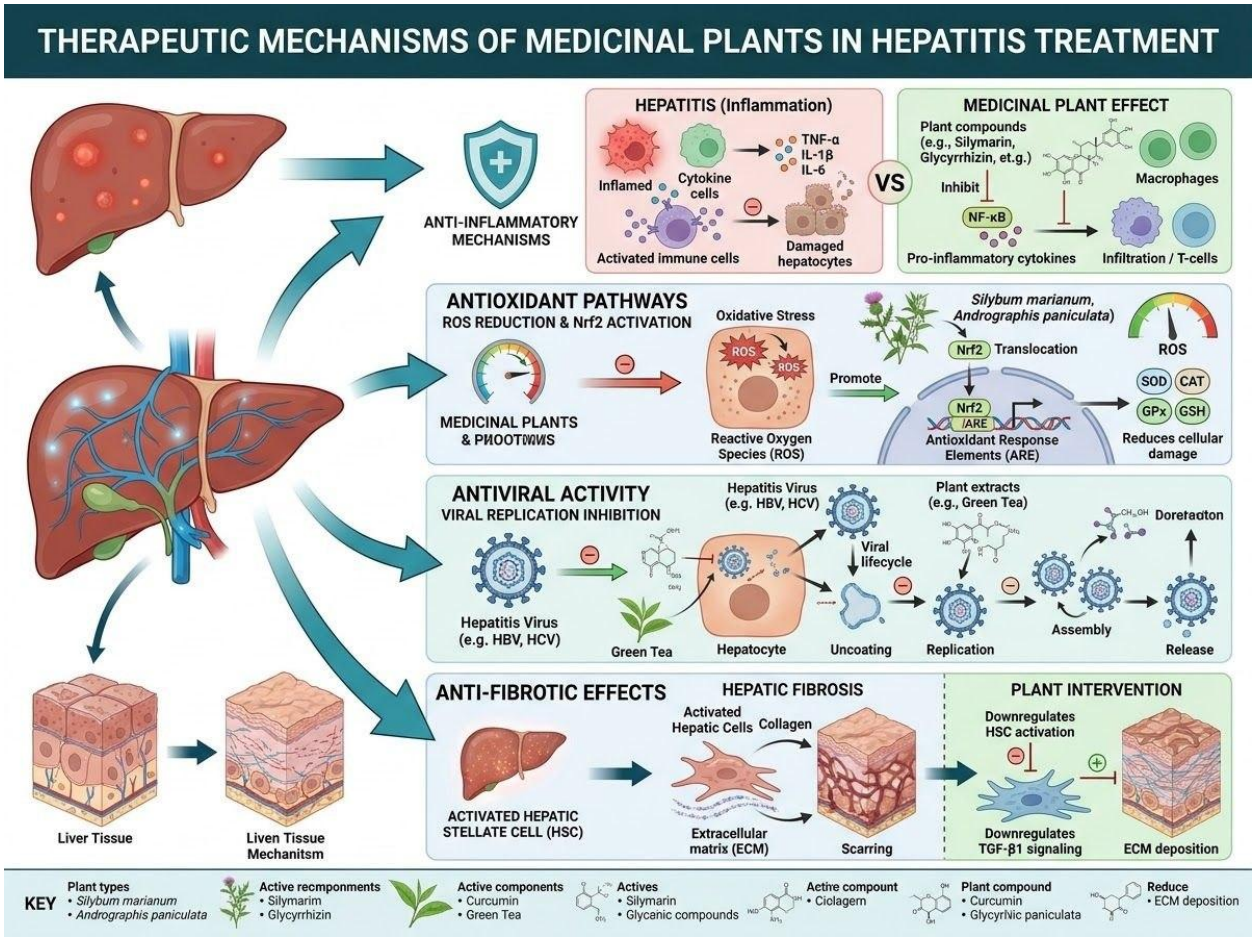
Furthermore, this paper comprehensively covers the chemical composition, biologically active substances, and pharmacological properties of medicinal plants studied for their application in treating hepatitis and supporting liver function. In particular, the antioxidant, anti-inflammatory, and cytoprotective properties of biologically active compounds such as silymarin, curcumin, cynarin, glycyrrhizin, catechins, and thymoquinone found in milk thistle (Silybum marianum), turmeric (Curcuma longa), artichoke (Cynara scolymus), liquorice (Glycyrrhiza glabra), green tea (Camellia sinensis), and black cumin (Nigella sativa) are reviewed from a scientific perspective.

Additionally, the potential applications of medicinal plants, scientific approaches to evaluating their efficacy, possible side effects, and their role in modern hepatology are discussed. The primary objective of the article is to biochemically investigate various forms of hepatitis, analyse the

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mechanisms of action of medicinal plants on liver function, and provide a scientific basis for the possibilities of integrating them into modern medicine.

GRAPHICAL ABSTRACT: Mechanism of Action of Medicinal Plants in the Treatment of Hepatitis



Introduction. The liver is one of the vital organs of the human body, serving as the central regulatory hub for metabolic, detoxification, synthetic, immunological, and homeostatic processes. Protein, lipid, and carbohydrate metabolism, blood plasma protein synthesis, bile formation, bilirubin metabolism, and the biotransformation of endogenous and exogenous substances all occur within the liver. Disruptions to these processes adversely affect not only the morphofunctional state of the liver but also the metabolic equilibrium of the entire organism.Among liver diseases, hepatitis holds distinct clinical and biochemical significance. Hepatitis is a pathological process characterised by the inflammation and injury of the liver parenchyma, particularly hepatocytes. Viral infections, toxic substances, alcohol, certain medications, autoimmune reactions, and metabolic disorders represent key aetiological factors in its development. The disease can present in acute or chronic forms. Prolonged inflammation can lead to hepatocyte necrosis, apoptosis, liver fibrosis, and, in some cases, the development of cirrhosis. Viral hepatitis is classified into types A, B, C, D, and E based on the aetiological agent. Their transmission mechanisms, pathogenesis, clinical course, and propensity for

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chronicity vary from one another. Furthermore, toxic, alcoholic, autoimmune, and drug-induced forms of hepatitis constitute other important manifestations of liver pathology.

One of the primary molecular mechanisms in the pathogenesis of hepatitis is oxidative stress. Oxidative stress occurs when the balance between the generation of reactive oxygen species (ROS) and the antioxidant defence system of the cell is disrupted. Consequently, lipid peroxidation in cell membranes, mitochondrial damage, intracellular calcium dysregulation, and DNA damage are observed. These processes diminish the functional capacity of hepatocytes, leading to cell death via necrosis or apoptosis.

During the inflammatory process, the activation of the NF-κB signalling pathway and the production of pro-inflammatory cytokines such as TNF-α, IL-1β, and IL-6 play a crucial role. Chronic inflammation results in the activation of hepatic stellate (Ito) cells and enhanced collagen synthesis, leading to extracellular matrix accumulation and the development of hepatic fibrosis.Biochemical laboratory parameters hold a prominent place in the diagnosis and assessment of the progression of hepatitis. Elevated activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) enzymes serves as a critical indicator of hepatocyte injury. Total and direct bilirubin levels are utilised to evaluate bilirubin metabolism and the excretory function of the liver. Alkaline phosphatase (ALP) and gamma-glutamyltransferase (GGT) are of great importance in identifying cholestatic processes. Albumin levels and prothrombin time provide insights into the protein-synthetic function of the liver. Therefore, a comprehensive evaluation of clinical signs, biochemical analyses, and instrumental examinations is essential for the assessment of hepatitis.In recent years, there has been growing scientific interest in exploring the pharmacological potential of natural bioactive compounds for the treatment of liver diseases and the mitigation of their complications. Polyphenols, flavonoids, terpenoids, and other secondary metabolites found within medicinal plants are distinguished by their antioxidant, anti-inflammatory, and cytoprotective properties.Specifically, silymarin, found in the plant Silybum marianum (milk thistle), is a complex of flavonolignans. Its primary components comprise silybin, silydianin, and silychristin. Silymarin has been investigated in scientific studies for its antioxidant properties, ability to limit lipid peroxidation, and capacity to protect hepatocyte membranes.

Curcumin, found in Curcuma longa (turmeric), is a bioactive polyphenol possessing antioxidant and anti-inflammatory properties. It can modulate intracellular signalling pathways such as NF-κB and Nrf2. The Nrf2 system plays a vital role in regulating glutathione synthesis and the activity of antioxidant enzymes, including superoxide dismutase, catalase, and glutathione peroxidase.

Cynara scolymus (artichoke) contains cynarin, chlorogenic acid, and other phenolic compounds. These substances are characterised by their antioxidant activity and their effects on bile Glycyrrhizin, found in the root of Glycyrrhiza glabra (liquorice), belongs to the formation and lipid metabolism. It and its metabolite, glycyrrhetinic acid, possess the ability to modulate inflammatory mediators. These compounds have been evaluated in studies related to certain viral and inflammatory liver diseases.

Epigallocatechin gallate (EGCG) and other catechins in Camellia sinensis (green tea) exhibit potent antioxidant properties. They can participate in neutralising free radicals, reducing lipid peroxidation, and modulating inflammatory processes.The seeds of Nigella sativa (black cumin) contain

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thymoquinone and other bioactive compounds. Thymoquinone has garnered particular attention in scientific research due to its antioxidant and anti-inflammatory properties, as well as its potential impact on the Nrf2/ARE antioxidant defence system.

The bioactive substances within the aforementioned medicinal plants can exert their effects through diverse mechanisms. Their primary research directions are associated with reducing oxidative stress, modulating inflammatory responses, preserving the structural integrity of hepatocytes, and regulating metabolic processes.

Concurrently, the chemical composition, bioavailability, pharmacokinetic properties, and safety profiles of plant extracts vary considerably. A hepatoprotective effect identified under experimental conditions does not always translate to clinical efficacy in humans. Therefore, medicinal plants should be evaluated not as substitutes for standard therapeutic modalities, but as bioactive sources requiring further scientific investigation.

The objective of this article is to analyse, based on scientific literature, the primary aetiological and pathogenetic forms of hepatitis, the biochemical alterations occurring within liver cells, and the potential hepatoprotective, antioxidant, and anti-inflammatory mechanisms of action of the bioactive substances found in medicinal plants. Furthermore, it aims to comparatively evaluate the effects of the active components in milk thistle, turmeric, artichoke, liquorice, green tea, and black cumin on liver function, and to scientifically elucidate the prospects of integrating them into modern medicine.

MATERIALS AND METHODS

In the preparation of this article, scientific literature concerning the aetiology, pathogenesis, biochemical mechanisms of hepatitis, and the hepatoprotective properties of medicinal plants was analysed. Scientific data regarding the bioactive substances within Silybum marianum, Curcuma longa, Cynara scolymus, Glycyrrhiza glabra, Camellia sinensis, and Nigella sativa plants served as the research materials.

During the research process, methods of scientific literature analysis, comparison, systematisation, and synthesis were employed. Additionally, the antioxidant, anti-inflammatory, and hepatoprotective mechanisms of action of the active compounds within the plants were investigated from a biochemical perspective.

Silybum marianum (Milk Thistle) The silymarin flavonolignan complex found within this plant possesses antioxidant properties. Scientific studies have investigated its potential effects in protecting liver cells against oxidative stress and stabilising cell membranes. However, its efficacy in the treatment of hepatitis C has not been reliably confirmed in clinical trials.

Curcuma longa (Turmeric)The primary bioactive compound of turmeric is curcumin, which is distinguished by its antioxidant and anti-inflammatory properties. In scientific literature, the effects of curcumin on oxidative stress and inflammatory processes have been investigated. However, its clinical efficacy in the treatment of hepatitis has not been sufficiently established.

Cynara scolymus (Artichoke) Artichoke contains chlorogenic acid and other phenolic compounds, which exhibit potent antioxidant properties. In scientific research, the effects of artichoke extract on

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liver enzymes and metabolic processes have been evaluated. Nevertheless, clinical evidence regarding its efficacy in treating viral hepatitis remains limited.

Glycyrrhiza glabra (Liquorice) One of the principal bioactive compounds in liquorice root is glycyrrhizin, which possesses anti-inflammatory and immunomodulatory properties. Although glycyrrhizin has been investigated in certain hepatitis studies, further clinical trials are required to fully establish its efficacy and safety profile.

Camellia sinensis (Green Tea) Green tea contains catechins, including epigallocatechin gallate (EGCG). These compounds exhibit antioxidant activity and may participate in mechanisms that mitigate oxidative stress. However, high doses of green tea extracts have been reported to induce liver injury in certain cases.

Nigella sativa (Black Cumin) Thymoquinone is one of the primary bioactive compounds found within black cumin, characterised by its antioxidant and anti-inflammatory properties. While some studies have investigated its impact on liver enzymes, its efficacy in the treatment of viral hepatitis has not been confirmed by sufficient clinical evidence.

During the course of this study, the bioactive compounds, antioxidant, and anti-inflammatory properties of the aforementioned medicinal plants were comparatively analysed. The synthesis of scientific data indicates their potential capacity to protect the liver. Concurrently, high-quality clinical trials are essential to determine the clinical efficacy and safety of these plants in the treatment of viral hepatitis.

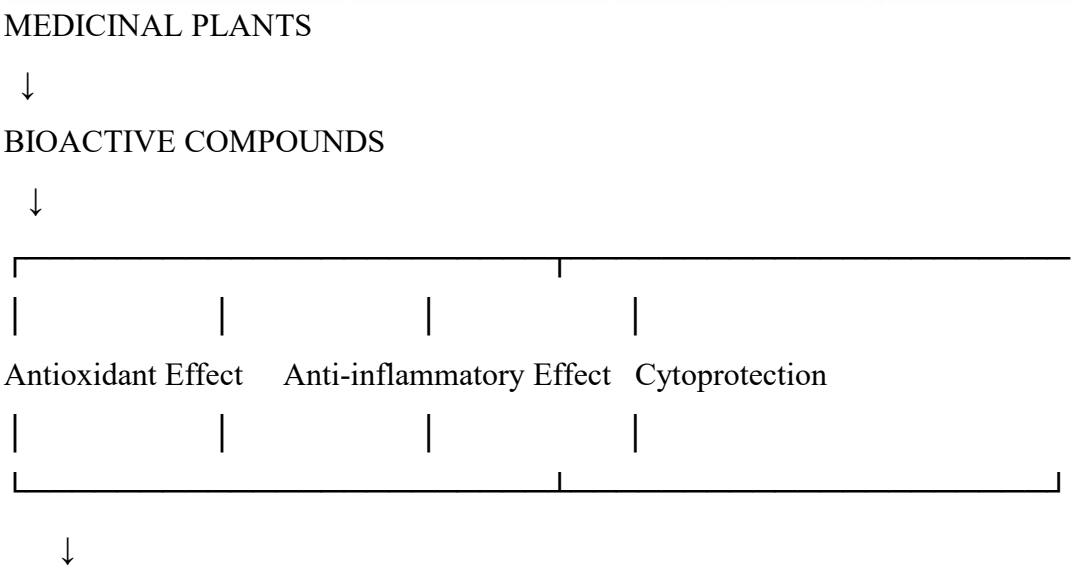
RESULTS AND DISCUSSION

The analysed scientific literature demonstrates the potential significance of bioactive compounds found within medicinal plants in protecting liver cells against injury associated with oxidative stress and inflammation.Within the scope of this study, scientific evidence regarding the active substances within Silybum marianum, Curcuma longa, Cynara scolymus, Glycyrrhiza glabra, Camellia sinensis, and Nigella sativa, their mechanisms of action, and their applications in hepatitis diseases was comprehensively analysed.The biological activity of these plants was evaluated based on their antioxidant, anti-inflammatory, immunomodulatory, and potential hepatoprotective properties. Concurrently, discrepancies between laboratory (in vitro/in vivo) findings and clinical trial outcomes were taken into consideration. Table 1. Bioactive compounds and chemical groups of the investigated medicinal plants.

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Table 1. List of Pharmaceutical and Biological Terms

Medicinal Plants	Biological Terms	Chemical Compounds
Milk thistle	Silimarin	Flavonoids
Long rhizome (turmeric)	Curcumin	Polyphenols
Scutellaria baicalensis	Xyloragenic acid	Phenolic glycosides
Licorice (Glycyrrhiza glabra)	Glycyrrhizin	Triterpene saponins
Camellia sinensis	EGCG	Catechins
Nigella sativa	Thymoquinone	Xenon



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HEPATOPROTECTIVE POTENTIAL

Table 2. Medicinal Plants, Their Chemical Constituents and Pharmacological Effects

Plant name	Active compound(s)	Potential effect(s)	Mechanism of action
Milk thistle *Silybum marianum*	Silymarin	Antioxidant	Inhibits HCV viral replication
Turmeric *Curcuma longa*	Curcumin	Anti-inflammatory	Inhibits the synthesis of pro-inflammatory mediators
Scutellaria *Scutellaria baicalensis*	Baicalein	Antioxidant	Regulates the expression of viral proteins
Licorice *Glycyrrhiza glabra*	Glycyrrhizin	Anti-inflammatory	Inhibits the release of glycoproteins
Camellia sinensis *Camellia sinensis*	EGCG	Antioxidant	Concentrates the activity of hepatotoxins
Nigella sativa *Nigella sativa*	Thymoquinone	Antioxidant	Reduces free radicals in cells

Summarising the Scientific Evidence of Medicinal Plants

The results of the analysis indicate that the potential hepatoprotective effects of medicinal plants are primarily associated with antioxidant and anti-inflammatory mechanisms.However, the biological activity, clinical efficacy, and antiviral impact of these plants represent distinct concepts. Antioxidant activity demonstrated under laboratory conditions does not implicitly equate to efficacy in treating viral hepatitis in humans.

According to the NCCIH (National Center for Complementary and Integrative Health), no dietary supplement has been reliably proven effective in the treatment of hepatitis C. Furthermore, clinical trials on silymarin have failed to demonstrate any significant superiority when compared to placebos.Consequently, the role of medicinal plants in hepatitis should not be viewed as an adjunct or alternative to contemporary antiviral therapy, but rather as a promising avenue for prospective scientific research.

Discussion of Results

On the whole, the bioactive compounds within medicinal plants can influence the molecular mechanisms of liver cell injury associated with oxidative stress and inflammation.The analysed literature highlights the hepatoprotective potential of silymarin, curcumin, glycyrrhizin, catechins, and thymoquinone. Nevertheless, current clinical evidence does not substantiate their use as standalone therapeutic agents for viral hepatitis.

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In the treatment of hepatitis B and C, modern antiviral drugs remain the cornerstone of therapy. Medicinal plants must not serve as substitutes for these standard therapeutic modalities.In future investigations, it is of paramount importance to explore the standardised composition, bioavailability, safe dosages, and interactions of these plant extracts with antiviral medications.

CONCLUSION

This comprehensive review of the scientific literature demonstrates that bioactive compounds within medicinal plants possess potential hepatoprotective significance in hepatitis diseases. Compounds such as silymarin, curcumin, chlorogenic acid, glycyrrhizin, catechins, and thymoquinone found in *Silybum marianum*, *Curcuma longa*, *Cynara scolymus*, *Glycyrrhiza glabra*, *Camellia sinensis*, and *Nigella sativa* are distinguished by their potent antioxidant and anti-inflammatory properties. In the analysed studies, these bioactive substances were investigated regarding their impact on oxidative stress, inflammatory mediators, and mechanisms of hepatocyte injury. However, outcomes observed in laboratory and experimental models do not constitute definitive proof of clinical efficacy in humans.Notably, clinical evidence regarding the direct efficacy of medicinal plants in treating viral hepatitis remains constrained. A reduction in liver enzyme levels does not imply viral clearance from the organism or complete remission of the disease. Furthermore, it is critical to consider the safety profiles, bioavailability, standardised compositions, and drug-drug interactions of these herbal preparations. Products of natural origin may still carry risks of adverse effects and hepatotoxicity.

In conclusion, medicinal plants represent a promising scientific direction in the study of liver diseases. Large-scale, randomised, controlled trials are warranted to establish their clinical significance in the management of hepatitis. At present, medicinal plants must not supersede standard antiviral treatment protocols.

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