



Hepatoprotection Through Ayurvedic Herbs

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Medicinal plants are of great importance for healthy living of an individual. Liver diseases remain one of the serious health problems. Liver is the key organ for detoxification of toxic substance and disposition of endogenous substances. It is continuously and widely exposed to various toxins and chemotherapeutic agents that lead to impairment of its functions. All types of insults/injuries to the Liver (e.g. circulatory, traumatic, toxic or microbiological) lead to damage of hepatocytes which results in its mal-functioning. A number of Indian medicinal plants have been used for thousands of years in the traditional system of medicine, Ayurveda. A large number of medicinal plants have been tested and found to contain active principles with curative properties against a variety of diseases. A number of traditional remedies from plant origin are evaluated for their possible antioxidant and hepatoprotective effects against different chemical-induced liver damage in experimental animal's e.g. CCl₄-induced, paracetamol induced, alcohol-induced, antitubercular drug induced, nitrobenzene induced, bromobenzene induced, lead-induced etc. hepatotoxicity model. Therefore a large number of plants and formulations have been claimed to have hepatoprotective activity so the development of plant based hepatoprotective drugs has been given importance in the global market. This review article has been presented to enumerate some indigenous plants that have hepatoprotective properties.

KEYWORDS: Liver, Medicinal plants, hepatoprotective, traditional herbal medicine etc.

INTRODUCTION

Medicinal plants are of great importance for healthy living of an individual. Liver diseases remain one of the serious health problems. Liver is the key organ for detoxification of toxic substance and disposition of endogenous substances. It is continuously and widely exposed to toxins and chemotherapeutic agents that lead to impairment of its functions. All types of insults/injuries to the Liver (e.g. circulatory, traumatic, toxic or microbiological) lead to damage of hepatocytes which results in its mal-functioning. A number of Indian medicinal plants have been used for thousands of years in the traditional system of medicine, Ayurveda. These plants have been used for the management of hepatitis and liver damage. The liver supports almost every organ in the body and is vital for survival. Because of its strategic position and multidimensional functions, the liver is also prone to many diseases. The liver is the largest organ in the body, contributing about 2 per cent of the total body weight, or about 1.5 kg in the average adult human. The various functions of the liver are carried out by the liver cells or hepatocyte. Chronic hepatic diseases stand as one of the foremost health troubles worldwide, with liver cirrhosis and drug induced liver injury accounting ninth leading cause of death in western and developing countries. Liver has a wide range of functions, including manufacturing & excretion of bile, protein synthesis (e.g. albumin, prothrombin etc.), detoxification of toxic substance (e.g. alcohol, drugs etc.) and production of biochemical necessary for digestion and synthesis as well as metabolism of small and complex molecules. Additionally, the toxins absorbed from the intestinal tract go first to the liver resulting in a variety of liver ailments.

HEPATOPROTECTIVE AYURVEDIC HERBS

A large number of medicinal plants have been tested and found to contain active principles with curative properties against a variety of diseases. Plants contain a variety of chemical constituents like phenols, coumarins, lignans, essential oil, carotinoids, glycosides, flavanoids, organic acids, lipids, and alkaloids which showed hepatoprotective activity. A number of traditional remedies from plant origin are evaluated for their possible antioxidant and hepatoprotective effects against different chemical-induced liver damage in experimental animal's e.g. CCl₄-induced, paracetamol induced, alcohol-induced, antitubercular drug induced, nitrobenzene induced, bromobenzene induced, lead-induced etc hepatotoxicity model. Therefore damage to the liver inflicted by hepatotoxic substances is of grave consequences. Most of the hepatotoxic chemicals damage liver cells mainly by inducing lipid per oxidation and other oxidative damages. Therefore a large number of plants and formulations have been claimed to have hepatoprotective activity so the development of plant based hepatoprotective drugs has been given importance in the global market. This review article has been presented to enumerate some indigenous plants that have hepatoprotective properties such as:

1. *Abutilon indicum*: The aqueous extract of *Abutilon indicum* showed hepatoprotective activity against carbon tetrachloride- and paracetamol-induced hepatotoxicities in rat.¹
2. *Acacia catechu*: Ethyl acetate extract of *Acacia catechu*, "katha" inhibited carbon tetrachloride induced liver toxicity in albino rats at 250 mg/kg, b.w. as assessed by the biochemical and histopathological values which showed hepatoprotective activity.^{2, 3}
3. *Acorus calamus*: Methanolic extract of *Acorus calamus* investigated against alcohol-induced hepatotoxicity and oxidative stress showed hepatoprotective activity.⁴
4. *Aegle marmelos*: *Aegle marmelos* is widely used in the treatment of hepatitis in folk medicine. Alcohol induced liver injury in albino rat were treated with the fine crude plant leaves powder of *Aegle marmelos* for next 21 days and results indicate that the *Bael* leaves have excellent hepatoprotective effect.⁵ Similarly, extracts of *A. marmelos* showed the hepatoprotective activity when examined against CCl₄ induced liver damage in mice.^{6, 7}
5. *Aerva lanata*: The hydroalcoholic extract of *Aerva lanata* possesses hepatoprotective activity against paracetamol induced hepatotoxicity in rats.⁸
6. *Allium sativum*: The garlic and silymarin (given for 28 days periods) have shown the hepatoprotective effect against the antitubercular drug (isoniazid) induced hepatotoxicity in experimental animal model (Nasim Ilyas et al., 2011).⁹ Similarly during other study, garlic and vitamin C have some hepatoprotective and haematological effects when investigated on experimental rats that were exposed to lead (Pb) for one week (G. O. Ajayi et al., 2009).¹⁰
7. *Alstonia scholaris*: The methanolic stem bark extract of *Alstonia scholaris* (200 mg/kg) exhibited hepatoprotective activity against Swiss albino rats with liver damage induced by carbon tetrachloride which was also supported by histopathological studies of liver tissues.¹¹
8. *Amalkadi Ghrita*: Amalkadi Ghrita, a polyherbal formulation showed hepatoprotective activity against carbon tetrachloride (CCl₄) induced hepatic damage in rats.¹²
9. *Andrographis paniculata*: The diterpenes (andrographolide, andrographiside and neoandrographolide isolated from *A.paniculata* showed hepatoprotective activity on hepatotoxicity induced in mice by carbon tetrachloride due to their antioxidant activity.¹³ Similarly results in

another trail suggest that andrographolide is the major active antihepatotoxic principle present in *A. paniculata*.¹⁴

10. *Asparagus racemosus*: The extract of *Asparagus racemosus* revealed hepatoprotective effect against carbontetrachloride-induced¹⁵ and isoniazid-induced hepatotoxicity in male albino rats.¹⁶
11. *Azadirachta indica*: *Azadirachta indica* showed hepatoprotective activity against paracetamol induced hepatic damage in rats by presence of quercetin and rutin compounds.¹⁷ Similarly hepatoprotective activity of *A. indica* against paracetamol induced-,¹⁸ and carbon tetrachloride¹⁹ treated animals were found.
12. *Bacopa monniera* : Significant hepatoprotective effect of *Bacopa monniera* alcohol extract in morphine induced liver toxicit^{y20} and were noted acute experimental liver injury induced by Nitrobenzene in rats.²¹
13. *Benincasa hispida*: *Benincasa hispida* was found to possess significant hepatoprotective effect against diclofenac sodium-,²² and nimesulide-induced hepatotoxicity model in rats.²³
14. *Berberis aristata*: The aqueous-methanol extract of *Berberis aristata* fruits exhibits hepatoprotective action partly through microsomal drug metabolizing enzymes inhibitory action against paracetamol- and CCl₄-induced hepatic.²⁴ Similar results found against dimethylnitrosamine induced liver cirrhosis in rat's model noticed by evaluating ethanolic and aqueous extract of whole plant of *Berberis aristata*.²⁵
15. *Boerhaavia diffusa*: Extracts from *B. diffusa* possess hepatoprotective property against acetaminophen-induced liver damage²⁶ and thioacetamide intoxicated rats.²⁷
16. *Boswellia serrata*: The hexane extract of oleo-gum-resin of *Boswellia serrata* possess hepatoprotective property against liver injury induced by chemical.²⁸
17. *Bramhi ghrita*: *Bramhi ghrita* (a polyhedral formulation) was administered at doses 100 mg/kg and 300 mg/kg/day significantly reduces levels of various serum marker enzymes elevated due to carbon tetrachloride-induced hepatotoxicity to rats (G Achliya et al., 2004).²⁹
18. *Calotropis sp.*: Ethanolic extract (50%) of stems of *Calotropis gigantea* at doses of 250 and 500 mg kg⁻¹ showed hepatoprotective activity in male Wistar rats with liver damage induced using carbon tetrachloride (Gaurav Lodhi et al., 2009).³⁰ Treatment with hydroethanolic extract of *C. procera* flowers (200 mg/kg and 400 mg/kg) against paracetamol-induced hepatitis in rats showed hepatoprotective activity (S. Ramachandra Setty et al., 2007)³¹ and similar root extract against CCl₄ induced hepato-oxidative stress in albino rats showed hepatoprotective activity (Patil Prakash et al., 2011).³²
19. *Capparis sepiaria*: The alcohol extract of *Capparis sepiaria* stem while using against carbon tetrachloride-induced toxicity in albino rats results in significant (p<0.01) reduction in the elevated levels of aspartate transaminase, alanine transaminase, total bilirubin and rise of decreased total protein level when compared with the toxic control (T. Satyanarayana et al., 2009).³³
20. *Cassia fistula*: Extract of *Cassia fistula* leaves at a dose of 400 mg/kg showed significant hepatoprotective activity which was comparable to that of a standard hepatoprotective agent when trailed in rats (T. Bhakta et al., 1999).³⁴
21. *Cassia occidentalis*: Aqueous-ethanolic extract (50%, v/v) of leaves of *Cassia occidentalis* was studied on rat liver damage induced by paracetamol and ethyl alcohol and result showed hepatoprotective effect (M. A Jafri et al., 1999).³⁵
22. *Centella asiatica*: *C. asiatica* extract exhibited hepatoprotective action against carbon tetrachloride-induced liver injury in rats.^{36,37}
23. *Citrus limon*: The ethanol extract of *Citrus limon* fruits was evaluated for its effects on experimental liver damage induced by carbon tetrachloride. The ethanol extract normalized the levels of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and total and direct bilirubin, which were altered due to carbon tetrachloride intoxication in rats (Shefalee K. Bhavsar et al., 2007).³⁸

24. *Citrullus colocynthis*: The ethanolic extract of *Citrullus colocynthis* L. possesses good hepatoprotective activity against polluted water induced hepatotoxicity in albino rats (Arshed Iqbal Dar et al., 2012).³⁹
25. *Cleome viscosa*: The ethanolic extract of *Cleome viscosa* showed hepatoprotective activity against carbon tetrachloride induced hepatotoxicity in experimental animal models (Nishant Kumar Gupta, Vinod Kumar Dixit, 2009).⁴⁰ Similarly, the ethanolic extract of *Cleome viscosa* seeds showed hepatoprotective activity when studied on paracetamol treated albino rats (Ashok Kumar Mubiya, 2010).⁴¹
26. *Curcuma longa*: Aqueous extract of turmeric reduced the level of SGOT, SGPT and bilirubin in CCl₄ intoxicated mice.⁴² Similarly *Curcuma longa* and three other herbs showed hepatoprotective activity in liver injury and immunosuppression induced by Isoniazid, Rifampicin and Pyrazinamide.⁴³
27. *Curculigo orchoides*: The methanolic extract of *Curculigo orchoides* rhizomes in rats treated with carbon tetrachloride showed hepatoprotective potential.⁴⁴
28. *Cyathea gigantea*: Methanolic leaf extract of *C. gigantea* showed hepatoprotective potential used in paracetamol induced hepatotoxicity in rats (P Madhu Kiran et al., 2012).⁴⁵
29. *Daucus carota*: Carbon tetrachloride (CCl₄) induced acute liver damage significantly lowered due to pretreatment with the extract of carrot extract (Anupam Bishayee et al., 1995).⁴⁶
30. *Eclipta alba*: Hepatoprotective activity of *Eclipta alba* is evident by regulating the levels of hepatic microsomal drug metabolising enzymes.⁴⁷ Similarly hepatic lesions caused by CCl₄ were improved by treatment with both ethanolic extracts of *Eclipta alba*.⁴⁸
31. *Ficus carica*: During trial, treatment with petroleum ether extract of *Ficus carica* showed improvement in biochemical, histological and functional changes induced by rifampicin treatment in rats (N. Y. Gond, S. S. Khadabadi, 2008).⁴⁹ Similarly, the ethanolic extract of *Ficus carica* (50 mg/kg, 100 mg/kg, 200 mg/kg) exhibited significant hepatoprotection in carbontetrachloride intoxicated rats in a dose dependant manner (Mohd Mujeeb et al., 2011).⁵⁰
32. *Ficus glomerata*: The methanol extract of the bark of *F. glomerata* showed potent hepatoprotective and antioxidant nature against CCl₄ treated control rats.⁵¹
33. *Ficus hispida*: The methanol extract of the leaves of *Ficus hispida* revealed hepatoprotective activity against liver damage by paracetamol (750 mg/kg, p.o.) as indicated by lowering the serum levels of transaminase, bilirubin and alkaline phosphatase.⁵²
34. *Ficus religiosa*: Extracts of *Ficus religiosa* against Paracetamol (2g/kg) induced hepatotoxicity in rats and showed significant hepatoprotection potential.⁵³
35. *Glycyrrhiza glabra*: *Glycyrrhiza glabra* is a potential antioxidant and attenuates the hepatotoxic effect of carbontetrachloride⁵⁴ and paracetamol.⁵⁵
36. *Hemidesmus indicus*: The methanolic extract of *H. indicus* roots possesses a potential antihepatotoxic activity in paracetamol and CCl₄ produced liver damage in rats (Baheti J R et al., 2006).⁵⁶ Similarly use of this plant resulted in improvement in various parameters in ethanol induced liver damage⁵⁷ and against the bromobenzene induced oxidative stress.⁵⁸
37. *Leptadenia reticulata*: The extracts of stems of *L. reticulata* showed significant hepatoprotective activity in CCl₄ induced liver injury model in rats (Amit Kumar Neema et al., 2011).⁵⁹
38. *Melia azedarach*: The flower extract of *Melia azedarach* showed hepatoprotective activity against Paracetamol induced hepatocellular injury due to its antioxidant property.⁶⁰
39. *Mimosa pudica*: The methanolic extract of leaves of *Mimosa pudica* revealed hepatoprotective effect against carbontetrachloride induced liver damage in wistar albino rats.⁶¹
40. *Momordica charantia*: *M. charantia* leaves administered for seven days against carbon tetrachloride induced hepatotoxicity in albino wistar rats noticed significant hepatoprotective activity.⁶²
41. *Myristica fragrans*: Myristicin was found to possess hepatoprotective activity during a trial.⁶³
42. *Nigella sativa*: Significant hepatoprotective effects of *N. sativa* in carbon tetrachloride-,⁶⁴ D-Galactosamine-,⁶⁵ and turpentine oil- induced liver damage⁶⁶ were noted.
43. *Nyctanthes arbor-tristis*: The alcoholic and aqueous extracts showed significant hepatoprotective activity at a dose of 500 mg/kg body weight against carbontetrachloride-induced liver damage in rats.⁶⁷

44. *Oxalis corniculata*: Aqueous and ethanolic leaves extracts of *Oxalis corniculata* showed significant hepatoprotective activity against thioacetamide-induced hepatotoxicity in rats.⁶⁸
45. Panchagavya ghrita: Trail of Panchagavya ghrita in albino rats significantly reduced the CCl₄ induced hepatotoxicity (G.S. Achliya et al., 2003).⁶⁹
46. *Phyllanthus emblica*: *Phyllanthus emblica* showed hepatoprotective activity on various trails.^{70,71,72}
47. *Phyllanthus sp.*: Bhyumyamalki (*Phyllanthus fraternus*) and Phaltrikadi decoction (an Ayurvedic herbal composition) when studied showed hepatoprotective activity (H Singh, 2008).⁷³ *Phyllanthus niruri* also used from old times as hepatoprotective and also showed similar results in recent studies.^{74, 75}
48. *Picrorrhiza kurroa*: *Picrorrhiza kurroa* and *Eclipta alba* showed restoration of Na⁺K⁺ATPase activity during trail which showed hepatoprotective activity against toxic hepatic injuries by various hepatotoxic agents used in the experimental study (Mogre Kala et al., 1981).⁷⁶ Similarly trailed proved hepatoprotective potential of *Picrorrhiza kurroa*.^{77, 78, 79}
49. *Pinus roxburghii*: Wood oil of *Pinus roxburghii* at doses of 200, 300 and 400 mg/kg body weight were studied on rat liver damage induced by CCl₄ and ethanol and showed hepatoprotective activity (Imran Khan et al., 2012).⁸⁰
50. *Plumbago zeylanica*: Methanolic extract of aerial parts of *Plumbago zeylanica* showed hepatoprotection against CCl₄-induced hepatotoxicity in wistar rats (Rajesh Kumar et al., 2009).⁸¹
51. *Punica granatum*: *Punica granatum* noticed hepatoprotection against isoniazid and rifampicin induced hepatotoxicity (Surinder Kumar Yogeeta et al., 2007).⁸² and against trichloroacetic acid-exposed in rats (Ismail Celik et al., 2009).⁸³
52. *Sesamum indicum*: Ethanolic extract of *Sesamum indicum* Linn. seeds against Paracetamol-induced liver damage in rats (Kumar Munish et al., 2011).⁸⁴
53. *Rohitaka ghrita*: During a trail, treatment with Rohitaka ghrita (3.6 and 7.2 g kg⁻¹) and silymarin (25 mg kg⁻¹) result in improvement against paracetamol induced hepatocellular damage in rats.⁸⁵
54. *Sida cordifolia*: Ethanolic extract of the roots of *S. cordifolia* Linn. has a potent hepatoprotective action against alcohol-induced toxicity (S. Rejitha et al., 2012).⁸⁶
55. *Solanum nigrum*: The hepatoprotective effects extract of *Solanum nigrum* shown against CCl₄-induced chronic hepatotoxicity in rats.^{87, 88}
56. *Solanum xanthocarpum*: Ethanolic fruit extract of *S. xanthocarpum* (100, 200 or 400 mg/kg body weight) was administered daily for 14 days in experimental rats and results showed its hepatoprotective potential (Ramesh K Gupta et al., 2011).⁸⁹ Similar hepatoprotective potential of *Solanum xanthocarpum* fruit extract noticed against antitubercular drugs induced hepatopathy in experimental rodents (Talib Hussain et al., 2012).⁹⁰ Hepatoprotective and antioxidant effects of extracts and steroidal saponins of *S. xanthocarpum* and *Solanum nigrum* on paracetamol induced hepatotoxicity were found during a trail (Amartya K. Gupta et al., 2009).⁹¹
57. *Strychnos nux-vomica*: During a trail, detoxified seeds of *nux-vomica* noticed improvement in various serum parameter which were affected by use of CCl₄ induced hepatic injury in albino rats (Gopalkrishna S.V et al., 2010).⁹²
58. *Tephrosia purpurea*: The aerial parts of *Tephrosia purpurea* and stem bark of *Tecomella undulata* showed hepatoprotective activity against thioacetamide-induced hepatotoxicity (Amit Khatri et al., 2004).⁹³ Similarly *Tephrosia purpurea* offered a protective action in both acute (D-galactosamine) and chronic (CCl₄) models during a trail (Ramamurthy M Sree, 1993).⁹⁴
59. *Terminalia arjuna*: the aqueous extract of the bark of *Terminalia arjuna* noticed protection of the liver and kidney tissues against CCl₄-induced oxidative stress (Prasenjit Manna et al., 2006).⁹⁵
60. *Terminalia belerica*: The fruits of *Terminalia belerica* while trailed in experimental liver injury induced by carbon tetrachloride (CCl₄) were studied showed restorative effect in liver damage (K.K.Anand et al., 1994).⁹⁶ Gallic acid (*Terminalia belerica* active principle) was found effective against carbon tetrachloride induced liver and kidney damage (S A Tasduq et al., 2006).⁹⁷
61. *Terminalia chebula*: During a study, using isolated rat hepatocyte experiment, the treatment of hepatocytes with chebulic acid significantly reduced induced cell cytotoxicity, intracellular reactive oxygen species level which proves its hepatoprotective potential (Hyun Sun Lee et al., 2007).⁹⁸

Similarly hepatoprotective activity against anti-tuberculosis (anti-TB) drug-induced toxicity were noticed during a study (Anjana Jadon et al., 2007).⁹⁹

62. *Tinospora cordifolia*: *T. cordifolia* extract reported significant protective results in the adverse effect of CCl₄ in liver function as well as immune functions (Bishayi B et al., 2002)¹⁰⁰ and similar protective role against lead-induced hepatotoxicity (V. Sharma, 2010).¹⁰¹
63. *Trigonella foenum-graecum*: *T. foenum graecum* trial results showed that it had considerable anti-inflammatory and hepatoprotective activities (Ahmet Cihat Oner et al., 2008),¹⁰² and its seeds lower the incidence of cholesterol gallstones (Raghunatha R. L et al., 2011).¹⁰³
64. *Trichosanthes dioica*: Ethanolic and Aqueous extracts of *T. dioica* showed significant (p<0.01) reduction in serum marker as well as profound histopathological protection to liver cells which was evident from histopathological studies (Ghaisas MM et al., 2008).¹⁰⁴
65. *Vitex negundo*: The extract of *Vitex negundo* showed hepatoprotective action against carbon tetrachloride-induced liver damage (Y. Avadhoot et al., 1991).¹⁰⁵
66. *Withania somnifera*: Glycowithanolides (isolated from the roots of *Withania somnifera*) showed hepatoprotection against heavy metals and other environmental toxins, may be due the antioxidant action (A. Bhattacharya et al., 2000).¹⁰⁶
67. *Woodfordia fruticosa*: The aqueous extract of *Woodfordia fruticosa* significantly restores physiological integrity of hepatocytes¹⁰⁷ as well as flowers possesses protective effect against acetaminophen-induced hepatotoxicity.¹⁰⁸
68. *Zanthoxylum armatum*: *Zanthoxylum armatum* showed significant protective effect against hepatotoxicity induced by CCl₄.¹⁰⁹
69. *Zingiber officinale*: The aqueous ethanol extract of *Z. officinale* reported hepatoprotective effect against acetaminophen-induced acute toxicity.^{110,111}
70. *Zizyphus jujube*: The fruit of *Zizyphus jujube* showed hepatoprotection against carbon tetrachloride-induced hepatic injury in mice by anti-oxidative activities.¹¹²

CONCLUSION

Chronic hepatic diseases, liver cirrhosis and drug induced liver injury etc. are the foremost health troubles worldwide, with accounting leading cause of death in developed and developing countries. In Ayurveda texts, these herbal medicines indicated in liver disorders. As from above description, it is clear that herbal medicine in recent times evaluated by different extracts in experimental animals to notify their hepatoprotective efficacy and their observations also shows their potential. So, in recent times more efforts should be directed towards the practical scientific valuation for their safety and efficacy by subjecting to strong preclinical studies. In this review article, an attempt has been made to assemble the reported hepatoprotective plants in the field of Ayurveda.

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