

A REVIEW ON HEPATOPROTECTIVE HERBAL DRUGS

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ABSTRACT

Liver is a vital organ play a major role in metabolism and excretion of xenobiotics from the body. Liver cell injury caused by various toxic chemicals (certain anti-biotic, chemotherapeutic agents, carbon tetrachloride (CCl₄), thioacetamide (TAA) etc.), excessive alcohol consumption and microbes is well-studied. The available synthetic drugs to treat liver disorders in this condition also cause further damage to the liver. Hence, Herbal drugs have become increasingly popular and their use is wide-spread. Herbal medicines have been used in the treatment of liver diseases for a long time so the maintenance of a healthy liver is essential for the overall well being of an individual. Liver injury induced by toxins is more common nowadays. Herbal remedies are focused in the pharmaceutical industry to evolve a safe route for liver disorders. Therefore, hepatoprotective natural products such as *Andrographis paniculata*, *Chamomile capitula*, *Silybum marianum*, *Coccinia grandis*, *Flacourtia indica*, *Wedelia calendulacea*, *Annona squamosa*, *Prostechea michuacana*, *Ficus carica*, *Lepidium sativum*, *Sargassum polycystum*, *Solanum nigrum*, *swertia chirata*, *Phyllanthus emblica*, *Curcuma longa*, *Picrorhiza kurroa*, *Azadirachta indica*, *Aegle marmelos*, *Cassia roxburghii*, *Orthosiphon stamineus*, *Jatropha curcas*, *Foeniculum vulgare*, *Trigonella foenum graecum*, *Eclipta alba*, *Garcinia mangostana* Linn is reviewed. The present review is aimed at compiling data on promising Phytochemical from medicinal plants that have been tested in hepatotoxicity models using modern scientific system.

Keywords: hepatoprotection, hepatotoxicity, herbal drugs.

INTRODUCTION

Liver is considered to be one of the most vital organs that functions as a centre of metabolism of nutrients such as carbohydrates, proteins, lipids and excretion of waste metabolites. Additionally, it is also handling the metabolism and excretion of drugs and other xenobiotics from the body thereby providing protection against foreign substances by detoxifying and eliminating them. The bile secreted by the liver has, among other things, plays an important role in digestion.

Hepatic disease (Liver disease) is a term that

affects the cells, tissues, structures, or functions of the liver. Liver has a wide range of functions, including detoxification, protein synthesis, and production of biochemical necessary for digestion and synthesis as well as breakdown of small and complex molecules, many of which are necessary for normal vital functions. Herbal drugs are more widely used than allopathic drugs as hepatoprotective because of them are inexpensive, better cultural acceptability, better compatibility, with the human body and minimal side effects. These herbal drugs have shown the ability to maintain the normal functional statues

of the liver with or without fewer side effects. The liver plays an astonishing array of vital functions in the maintenance, performance and regulating homeostasis of the body. It is involved with almost all the biochemical pathways to growth, fight against disease, nutrient supply, energy provision and reproduction. Therefore, maintenance of a healthy liver is essential for the overall well being of an individual. Liver cell injury caused by various toxicants such as certain chemotherapeutic agents, carbon tetrachloride, thioacetamide etc., chronic alcohol consumption and microbes is well-studied. Since The Indian Traditional Medicine like Ayurveda, Siddha and Unani are predominantly based on the use of plant materials. Herbal drugs have gained importance and popularity in recent years because of their safety, efficacy and cost effectiveness. Several Indian medicinal plants have been extensively used in the Indian traditional system of medicine for the management of liver disorder. The use of natural remedies for the treatment of liver diseases has a long history and medicinal plants and their derivatives are still used all over the world in one form or the other for this purpose. Scientific evaluation of plants has often shown that active principles in these are responsible for therapeutic success. A large number of medicinal plants have been tested and found to contain active principles with curative properties against a variety of diseases. Liver protective plants contain a variety of chemical constituents like phenols, Coumarins, Lignans, essential oil, monoterpenes, carotinoids, glycosides, flavonoids, organic acids, lipids, alkaloids and xanthenes. Therefore a large number of plants and formulations have been claimed to have hepatoprotective activity so the development of plant based hepato protective 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 *Andrographis paniculata*, *Chamomile capitula*, *Silybum marianum*, *Coccinia grandis*, *Flacourtia indica*, *Wedelia calendulacea*, *Annona squamosa*, *Prostechea michuacana*, *Ficus carica*, *Lepidium sativum*, *Sargassum polycystum*, *Solanum nigrum*, *swertia chirata*, *Phyllanthus emblica*, *Curcuma longa*, *Picrorhiza kurroa*, *Azadirachta indica*, *Aegle marmelos*, *Cassia roxburghii*, *Orthosiphon stamineus*, *Jatropha curcas*, *Foeniculum vulgare*, *Trigonella foenum graecum*, *Eclipta alba*, *Garcinia*

mangostana Linn is reviewed.

Eclipta alba

Eclipta alba (Bhringaraja), belonging to family Composite is a perennial shrub which grows widely in moist tropical countries. It is used as alterative, anthelmintic, expectorant, antipyretic, antiasthmatic, tonic, deobstruent in hepatic and spleen enlargement and significant anti-inflammatory activity. It has been reported to be useful in liver ailments & has been shown to possess hepatoprotective activity against carbon- tetrachloride induced liver cell damage in animals. The effect of *Eclipta alba* extract was studied on paracetamol induced hepatic damage in Mice. Treatment with ethanol extract of *E. alba* was found to protect the mice from hepatotoxic action of paracetamol as evidenced by significant reduction in the elevated serum transaminase levels.

Foeniculum vulgare

Fennel (*Foeniculum vulgare* Mill. family Umbelliferae) is an annual, biennial or perennial aromatic herb, depending on the variety, the leaves, stalks and seeds (fruits) of the plant are edible. *Foeniculum vulgare* is an aromatic herb whose fruits are oblong, ellipsoid or cylindrical, straight or slightly curved and greenish or yellowish brown in colour. Volatile components of fennel seed extracts by chromatographic analysis include trans-anethole, fenchone, methylchavicol, limonene, α -pinene, camphene, β -pinene, β -myrcene, α -phellandrene, 3-carene, camphor, and cis anethole. Hepatoprotective activity of *Foeniculum vulgare* essential oil was studied using a carbon tetrachloride-induced liver fibrosis model in rats. The hepatotoxicity produced by chronic carbon tetrachloride administration was found to be inhibited by *Foeniculum vulgare* essential oil with evidence of decreased levels of serum aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and bilirubin.

Trigonella foenum graecum

Fenugreek (*Trigonella foenum graecum*) is an annual herb that belongs to the family Leguminosae. The seeds of fenugreek are commonly used as a spice in food preparations due to the strong flavour and aroma. The seeds are reported to have restorative and nutritive properties. Fenugreek seeds have antioxidant activity and have been shown to produce beneficial effects such as neutralization of free

radicals and enhancement of antioxidant apparatus. The protective effect of a polyphenolic extract of fenugreek seeds against ethanol-induced toxicity was investigated in human Chang liver cells. Ethanolic treatment suppressed the growth of Chang liver cells and induced cytotoxicity, oxygen radical formation and mitochondrial dysfunction. Incubation of FPEt along with EtOH significantly increased cell viability in a dose-dependent manner, caused a reduction in lactate dehydrogenase leakage and normalized GSH/GSSG ratio. The findings suggest that the polyphenolic compounds of fenugreek seeds on the other gastric and lung cancer cell lines included in the screen. The investigators suggested that garcinone E may be potentially useful for the treatment of certain types of cancer.

***Garcinia mangostana* Linn**

Garcinia mangostana Linn. commonly known as "mangos teen", is a tropical evergreen tree and is an emerging category of novel functional foods sometimes called "super fruits" presumed to have a combination of appealing subjective characteristics, such as taste, fragrance and visual qualities, nutrient richness, antioxidant strength and potential impact for lowering risk of human diseases. The pericarps of *G. mangostana* have been widely used as a traditional medicine for the treatment of diarrhea, skin infection and chronic wounds in South East Asia for many years. These are the nature's most abundant sources of xanthenes, which are the natural chemical substances possessing numerous bioactive properties that help to maintain intestinal health, neutralize free radicals, help and support joints and cartilage functions and promotes immune systems. These are extracted from the rind of mangos teen containing 95% xanthenes also isoflavones, tannin and flavonoids. Treatment of hepatocellular carcinomas (liver cancer) with chemotherapy has generally been disappointing and it is most desirable to have more effective new drugs. The investigators extracted and purified 6 xanthone compounds from the rinds (peel) of the fruit of *Garcinia mangostana*, mangos teen fruit. The investigators tested this extract on 14 different human liver cancer cell lines. Several chemotherapeutic agents (drugs) were included in the study for comparison. The results showed that one of the xanthone derivatives which could be identified as garcinone E has potent cytotoxic effect (kill cells)

on all liver cancer cell lines as well as.

Jatropha curcas

Jatropha curcas Linn (Family: Euphorbiaceae), is an evergreen shrub, indigenous to America, but cultivated in most parts of India. This evergreen plant is common in waste places throughout India, especially on the Coromandel Coast and in Travancore; in the southern parts it is cultivated chiefly for hedges in the Konkan, and also in Malay Peninsula. Leaves are regarded as antiphrostatic, applied to scabies; rubefacient for paralysis, rheumatism; also applied to hard tumours. Leaves also show antileukemic activity. Compounds that have been isolated from *Jatropha curcas* leaves include the flavonoids apigenin and its glycosides vitexin and isovitexin, the sterols stigmasterol, α -D-sitosterol and its α -D-glucoside. Methanolic fraction of leaves of *Jatropha curcas* (MFJC) was evaluated against hepatocellular carcinoma induced by Aflatoxin B1 (AFB1). Marked.

Silybum marianum

The protective effects of polyphenolic extracts of *Silybum marianum* and *Cichorium intybus* on thioacetamide-induced hepatotoxicity in rat was investigated (Madani et al., 2008). The extracts were injected to the rats, at a dose of 25 mg kg⁻¹ body weight together with thioacetamide at a dose of 50 mg kg body weight. Significant decrease in the activity of aminotransferase, alkaline phosphatase and bilirubin was observed in the groups treated with extracts and thioacetamide compared with the group that was treated only with thioacetamide. The level of Na⁺, K⁺ and liver weight between different groups was not significantly altered. This finding suggested the hepatoprotective effect of *Silybum marianum* and *Cichorium intybus* extracts on liver cells due to the presence of flavonoids and their antioxidant effects (Madani et al., 2008).

Chamomile capitula

The effect of ethanolic extract of *Chamomile recutita* capitula (400 mg kg⁻¹, P.O.) on blood and liver glutathione, Na⁺ K⁺ ATPase activity, serum marker enzymes, serum bilirubin, glycogen and thiobarbituric acid reactive substances against paracetamol-induced liver damage in rats have been studied to find out the possible mechanism of hepatoprotection. It was observed that extract of *Chamomile recutita* has

reversal effects on the levels of above-mentioned parameters in paracetamol hepatotoxicity (Gupta and Misra, 2006) suggesting its hepatoprotective and/or hepatostimulant activity.

Coccinia grandis

Alcoholic extract of the fruits of *Coccinia grandis* Linn (Curcubitaceae) was evaluated in CCl₄-induced hepato-toxicity in rats and levels of AST, ALT, ALP, total proteins, total and direct bilirubin were evaluated. At a dose level of 250 mg/kg, the alcoholic extract significantly ($p < 0.05$) decreased the activities of serum enzymes (AST, ALT and ALP) and bilirubin which were comparable to that of silymarin (Vadivu et al., 2008) revealing its hepato-protective effect.

Wedelia calendulacea

The hepatoprotective activity of ethanolic extract of *Wedelia calendulacea* L. (Family: Asteraceae) was studied against CCl₄-induced acute hepatotoxicity in rats. The treatment with ethanolic extract of *Wedelia calendulacea* showed a dose-dependent reduction in CCl₄-induced elevated serum enzyme activities with parallel increase in total proteins and bilirubin, indicating the extract could enhance the return of normal functional status of the liver comparable to normal rats. The weight of the organs such as liver, heart, lung, spleen and kidney in CCl₄-induced hepatic damaged animals that received ethanolic extract of *Wedelia calendulacea* showed an increase over CCl₄-treated control group (Murugaian et al., 2008).

Annona squamosa

The extracts of *Annona squamosa* (300 & 350 mg/kg bw) were used to study the hepatoprotective effect in isoniazid + rifampicin-induced hepatotoxic model in albino Wistar rats. There was a significant decrease in total bilirubin accompanied by significant increase in the level of total protein and also significant decrease in ALP, AST, and ALT in treatment group as compared to the hepatotoxic group. In the histopathological study, the hepatotoxic group showed hepatocytic necrosis and inflammation in the centrilobular region with portal triaditis. The treatment group showed minimal inflammation with moderate portal triaditis and their lobular architecture was normal (Saleem et al., 2008). In another study, the protective effect was evaluated in diethyl nitrosamine induced

hepatotoxicity. This study revealed that the extracts of *Annona squamosa* exerted hepatoprotective effect and the plant extract could be an effective remedial for chemical-induced hepatic damage (Raj et al., 2009).

Flacourtia indica

The extracts of the aerial parts of *Flacourtia indica* (Burm. f.) Merr., were evaluated for hepato-protective properties. In paracetamol-induced hepatic necrosis in rat models, all extracts were found to reduce serum aspartate transaminase (AST), serum alanine transaminase (ALT) and serum alkaline phosphatase (ALP). The most significant reduction of the serum level of AST and ALT were exhibited by petroleum ether and ethyl acetate extracts at a single oral dose of 1.5g/kg of body weight with a reduction of 29.0% AST & 24.0% ALT level by petroleum ether extract, and 10.57% AST & 6.7% ALT level by ethyl acetate extract compared to paracetamol (3 g/kg of body weight) treated animals. Histopathological examination also showed good re-covey of paracetamol-induced necrosis by petroleum ether and ethyl acetate extracts. On the other hand, the methanol extract did not show any remarkable effect on paracetamol-induced hepatic necrosis. The hepatoprotective effects exhibited by petroleum ether and ethyl acetate extract might be mediated through the inhibition of microsomal drug metabolizing enzymes (Nazneen et al., 2008). But, in this study the dose they have used is too high and it is not successful or rationale for human dose.

Ficus carica

The Methanolic extract of the leaves of *Ficus carica* Linn. (Moraceae) was evaluated for hepatoprotective activity in CCl₄-induced liver damaged rats. The extract at an oral dose of 500 mg/kg exhibited a significant protective effect reflected by lowering the serum levels of AST, ALT, total serum bilirubin, and malondialdehyde equivalent, an index of lipid peroxidation of the liver (Krishna et al., 2007).

Lepidium sativum

The role hepato-protective of Methanolic extract of *Lepidium sativum* at a dose of 200 and 400 mg/kg was investigated in CCl₄-induced liver damage in rats. Significant reduction in all biochemical parameters were found in groups treated with *Lepidium sativum*. The severe fatty changes in the livers of rats caused by CCl₄

were insignificant in the *Lepidium sativum* treated groups (Afaf et al., 2008).

Sargassum polycystum

The protective effect of ethanol extract of *Sargassum polycystum* was evaluated in D-galactosamine-induced hepatitis in rats. Prior oral administration of *S. polycystum* extract [125mg/kg bodyweight/day for 15 days] significantly attenuated ($P < 0.05$) the D-galactosamine-induced increases in the levels of diagnostic marker enzymes (AST, ALT and ALP) in plasma of rats. It has also demonstrated antioxidant activity against D-galactosamine-induced hepatitis by inhibiting the activation of lipid peroxidation and by preserving the hepatic enzymatic and non-enzymatic antioxidant defense system at near normal. The antihepatotoxic potential of *S. polycystum* might possibly due to its antioxidant property and membrane stabilizing action (Meena et al., 2008).

Solanum nigrum

The effects of *Solanum nigrum* extract (SNE) was evaluated on thioacetamide (TAA)-induced liver fibrosis in mice. Mice in the three TAA groups were treated daily with distilled water and SNE (0.2 or 1.0 g/kg) via gastrogavage throughout the experimental period. SNE reduced the hepatic hydroxy proline and α - smooth muscle acting protein levels in TAA-treated mice. SNE inhibited TAA-induced collagen (α_1) (I), transforming growth factor- β 1 (TGF- β 1) and mRNA levels in the liver. Histological examination also confirmed that SNE reduced the degree of fibrosis caused by TAA treatment. Oral administration of SNE significantly reduces TAA-induced hepatic fibrosis in mice, probably through the reduction of TGF- β 1 secretion (Hsieh et al., 2008). In other study, the protective effects of aqueous extract of SN (ASNE) against liver damage were evaluated in CCl_4 - induced chronic hepatotoxicity in rats. The results showed that the treatment of ASNE significantly.

Cassia roxburghii

Seeds of *Cassia roxburghii* DC had been used in ethno medicine for various liver disorders for its hepato-protective activity. The methanolic extract of *Cassia roxburghii* reversed the toxicity produced by ethanol- CCl_4 combination in dose dependent manner in rats. The extract at the doses of 250 mg/kg and 500 mg/kg are

comparable to the effect produced by Liv-52, a well established plants-based hepato-protective formulation against hepatotoxins (Arulkumaran et al., 2009).

Aegle marmelos

Aegle marmelos leaves (*Bael*, family of Rutaceae) which is also called as *Bilva* in ancient Sanskrit, was used as herbal drug in the Indian System of medicine. The hepatoprotective effect of *Aegle marmelos* in alcohol-induced liver injury was evaluated rats using essential marker biochemical parameters. The results indicated that, the *Bael* leaves have excellent hepato-protective effect. Similar findings were also reported by other workers (Singanan et al., 2007).

Prosthechea michuacana

Methanol, hexane and chloroform extracts of *Prosthechea michuacana* (PM) were studied against CCl_4 -induced hepatic injury in albino rats. Pre-treatment with methanolic extract reduced biochemical markers of hepatic injury levels demonstrated dose-dependent reduction in the *in vivo* peroxidation induced by CCl_4 . Likewise, pretreatment with extracts of PM on paracetamol-induced hepatotoxicity and the possible mechanism involved in this protection were also investigated in rats after administering the extracts of PM at 200, 400 and 600mg/kg. The degree of protection was measured by monitoring the blood biochemical profiles. The methanolic extract of orchid produced significant hepatoprotective effect as reflected by reduction in the increased activity of serum enzymes, and bilirubin. These results suggested that methanolic extract of PM could protect paracetamol-induced lipid peroxidation thereby eliminating the deleterious effects of toxic metabolites of paracetamol. This hepatoprotective activity was comparable with silymarin. Hexane and chloroform extracts did not show any apparent effect. The findings indicated that the methanolic extract of PM can be a potential source of natural hepatoprotective agent (Rosa and Rosario, 2009).

Orthosiphon stamineus

The hepatoprotective activity of the methanol extract of *Orthosiphon stamineus* was assessed in paracetamol-induced hepatotoxicity rat model. Change in the levels of biochemical markers such as AST, ALT, ALP and lipid peroxides were assayed in both paracetamol treated and control

(untreated) groups. Treatment with the methanolic extract of *O. stamineus* leaves (200 mg/kg) has accelerated the return of the altered levels of biochemical markers to the near normal profile in the dose-dependent manner (Maheswari et al., 2008).

Andrographis Paniculata

Studies proved that *Andrographis paniculata* (Kalmegh) antihepatotoxic activity of the *Andrographis paniculata* (acanthaceae) methanolic extract (equivalent to 100 mg/kg of andrographolide) and 761.33 mg/kg ip, of the andrographolide-free methanolic extract (equivalent to 861.33 mg/kg of the methanolic extract) of the plant, using CCl₄-intoxicated rats. Biochemical parameters like serum transaminase, SGOT and SGPT, serum alkaline phosphatase, serum bilirubin and hepatic triglycerides were estimated to assess the liver function. The results suggest that andrographolide is the major active antihepatotoxic principle present in *A. paniculata*. Other species of *Andrographis* i.e. *Andrographis lineata* nees had also proved hepatoprotective effect of *Andrographis lineata* (Acanthaceae) extracts in CCl₄-induced liver injury in rats. Male Wistar rats with chronic liver damage, induced by subcutaneous injection of 50% v/v CCl₄ in liquid paraffin at a dose of 3 mL/kg on alternate days for a period of 4 weeks, were treated with methanol and aqueous extracts of *A. lineata* orally at a dose of 845 mg/kg/day. The biochemical parameters such as serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, serum bilirubin and alkaline phosphatase were estimated to assess the liver function. Histopathological examinations of liver tissue corroborated well with the biochemical changes. The activities of extracts were comparable to a standard drug. Andrographolide, the major antihepatotoxic component of the plant, exerted a pronounced protective effect in rats against hepatotoxicity induced by CCl₄, Dgalactosamine, paracetamol and ethanol. Andrographolide inhibited the CCl₄-induced increase in the activity of serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, alkaline phosphatase, bilirubin and hepatic triglycerides. Oxidative damage through free radical generation involved in the hepatotoxic effect of carbon tetrachloride (CCl₄) and paracetamol (PC). An anti-oxidant property of Andrographolide is claimed to be one

of the mechanisms of hepatoprotective effect. Adjuvant to hepatoprotective action drug is commonly have Antibacterial, Anti-inflammatory, Immunostimulatory, Antidiarrhoeal, Anti-human immunodeficiency virus (HIV), Antipyretic, Antimalarial & Antivenom activity, and used in urinary infections.

Swertia Chirata

Due to effect of hepatotoxicant (like ethanol, drugs, chemicals and others) serum aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT), and alkaline phosphatase (ALP) activities and bilirubin level are increased, but liver glycogen and serum cholesterol levels are decreased. Histologically it produced hepatocytic necrosis especially in the centrilobular region. Simultaneous treatments with *Swertia chirata* caused improvement at both biochemical and histopathological parameters. Drug also possesses digestive, hepatic (conditions pertaining to the liver), tonic, astringent and appetizer properties and used in cough, dropsy and skin diseases. *Swertia Chirata* (Chirayata) Simultaneous treatments with *S. Chirata* (Gentianeae). (in different doses, viz. 20, 50, and 100 mg/kg body wt daily) and (CCl₄) caused improvement at both biochemical and histopathological parameters compared to that of (CCl₄) treatment alone but it was most effective when *S. chirata* was administered in a moderate dose (50 mg/kg body wt).

Phyllanthus amarus (Bhuimala)

Ethanol extract of *Phyllanthus amarus* (Euphorbiaceae), at (0.3g kg (-1) BW 0.2 ml (-1) day (-1) was given to all groups except control groups (gp. I and gp. V), after 30 min of aflatoxin administration. The entire study was carried out for 3 months and animals were sacrificed after an interval of 30 days till the completion of study. *Phyllanthus amarus* extract was found to show hepatoprotective effect by lowering down the content of thiobarbituric acid reactive substances (TBARS) and enhancing the reduced glutathione level and the activities of antioxidant enzymes, glutathione peroxidase (GPx), glutathione-S transferase (GST), superoxide dismutase (SOD) and catalase (CAT).

Morinda citrifolia L. (Noni)

The hepatoprotective effects of Noni juice (TNJ) (Rubiaceae) against CCl₄-induced chronic liver

damage in female Sprague Dawley (SD) rats. Histopathological examination revealed that liver sections from the TNJ + CCl₄ appeared similar to controls, whereas typical hepatic steatosis was observed in the placebo + CCl₄ group. Serum alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine transaminase (ALT), total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) levels were increased in the placebo group compared with the TNJ group. In contrast, high-density lipoprotein (HDL) was increased in the TNJ group and decreased in the placebo group. Thus, TNJ juice appears to protect the liver from chronic exogenous CCl₄ exposures.

***Fumaria indica* (Hauskn)**

Fumaria indica (Fumariceae) were studied for their hepatoprotective activity against carbon tetrachloride, paracetamol and rifampicin-induced hepatotoxicities in albino rats. The petroleum ether extract against carbon tetrachloride, total aqueous extract against paracetamol and methanolic extract against rifampicin-induced hepatotoxicities showed similar reductions in the elevated levels of some of the serum biochemical parameters in a manner similar that of silymarin indicating its potential as a hepatoprotective agent.

***Cassia fistula* (Amaltas)**

Hepatoprotective activity of the n-heptanes extract of *Cassia fistula* (Fabaceae) leaves was investigated by inducing hepatotoxicity with paracetamol in rats. The extract at a dose of 400 mg/kg body wt. exhibited orally, significant protective effect by lowering the serum levels of transaminase (SGOT and SGPT), bilirubin and alkaline phosphatase (ALP). The effects produced were comparable to that of a standard hepatoprotective agent.

Careya arborea

The methanol extract of *Careya arborea* bark, (Myrtaceae) was tested for antioxidant and hepatoprotective activity in Ehrlich ascites carcinoma (EAC) tumor-bearing mice. Tumor control animals inoculated with EAC showed a significant alteration in the levels of antioxidant and hepatoprotective parameters. The extract treatment at 50, 100 and 200 mg/kg body weight doses given orally caused a significant reversal of these biochemical changes towards the normal in serum. Liver and kidney when

compared to tumor control animals indicating the potent antioxidant and hepatoprotective nature of the standardized extract.

***Azadirachta indica* (Neem)**

Effect of *A. indica* leaf (*Meliaceae*) extract on serum enzyme levels (glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, acid phosphatase and alkaline phosphatase) elevated by paracetamol in rats was studied with a view to observe any possible hepatoprotective effect of this plant. It is stipulated that the extract treated group was protected from hepatic cell damage caused by paracetamol induction. The findings were further confirmed by histopathological study of liver. The antihepatotoxic action of picroliv seems likely due to an alteration in the biotransformation of the toxic substances resulting in decreased formation of reactive metabolites.

***Picrorhiza kurroa* (Kutki)**

Administration of picroliv, a standardized fraction of alcoholic extract of *Picrorhiza kurroa* (Scrophulariaceae) (3-12 mg/kg/day for two weeks) simultaneously with *P. berghei* infection showed significant protection against hepatic damage in *Mastomys natalensis*. The increased levels of serum glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT), alkaline phosphatase, lipoprotein-X (LP-X) and bilirubin in the infected animals were markedly reduced by different doses of picroliv. In the liver, picroliv decreased the levels of lipid peroxides and hydroperoxides and facilitated the recovery of superoxide dismutase and glycogen.

Phyllanthus emblica

Ethanol extract of *Phyllanthus emblica* Linn. (Euphorbiaceae) (PE) induced rat hepatic injury. PE (0.5 and 1 mg/ml) increased cell viability of rat primary cultured hepatocytes being treated with ethanol (96 μ l/ml) by increasing % MTT and decreasing the release of transaminase. Pretreatment of rats with PE at oral dose of 25, 50 and 75 mg/kg or SL (silymarin, a reference hepatoprotective agent) at 5 mg/kg, 4 h before ethanol lowered the ethanol induced levels of AST, ALT and IL-1 β . The 75 mg/kg PE dose gave the best result similar to SL. Treatment of rats with PE (75 mg/kg/day) or SL (5 mg/kg/day) for 7 days after 21 days with ethanol (4 g/kg/day, p.o.)

enhanced liver cell recovery by bringing the levels of AST, ALT, IL-1 β back to normal.

Curcuma longa

Curcuma longa or turmeric is a member of Zingiberaceae family which is a perennial herb with short and thick rhizomes. Turmeric has been used extensively in traditional Chinese medicine and Ayurvedic medical system. *Curcuma longa* contains approximately 2% volatile oil, composed mainly of α - and β -turmerone, monoterpenes (Leung and Foster 1996), 5% curcuminoids, mainly curcumin¹², minerals, carotene and vitamin C¹¹. The active constituent of *Curcuma longa* is Curcumin, which is the yellow pigment of turmeric. The hepatoprotective activity of the ethanol extract of *Curcuma longa* was investigated against paracetamol-induced liver damage in rats. At the dose of 600 mg/kg, paracetamol induced liver damage in rats as manifested by statistically significant increase in serum alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) and alkaline phosphatase (ALP). Pretreatment of rats with the ethanolic extract of *Curcuma longa* (100 mg/kg) prior to paracetamol dosing at 600 mg/kg statistically lowered the three serum liver enzyme activities. Moreover, treatment of rats with only the ethanolic extract of *Curcuma longa* (100 mg/kg) had no effects on the liver enzymes. This current result suggests that ethanolic extract of *Curcuma longa* has potent hepatoprotective effect against paracetamol-induced liver damage in rats.

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