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Liver Problems and Natural Cure

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Abstract: ***The liver is the largest and one of the most vital organs in the body of mammals. All of our blood flows through it. When the liver is damaged scar tissue forms and stops the flow of blood in healthy cells. Much liver damage is caused by drinking excessive alcohol. Alcohol is the common cause for the development of cirrhosis in liver and unfortunately is very often fatal. Functions of liver which are important for maintenance and performance of the body include- carbohydrate, protein and lipid metabolism, detoxification and secretion of bile. Unfortunately the liver is often abused by environmental toxins, poor eating habits, alcohol and some time due to over dose of the counter drug, which can damage and weaken the liver and eventually lead to hepatitis & cirrhosis. Conventional medicine is now persuing the use of natural products such as herbs to provide the support that the liver needs. Many herbs such as Eclipta alba, Boerhaavia diffusa, Andrographis paniculata Phyllanthus amarus, Terminalia arjuna and many more have a long history of traditional use in revitalizing the liver. The paper deals with documentation of plants which possess hepatoprotective properties.***

Keywords: Liver, Natural cure, Hepatoprotective, Conventional medicine

1. Introduction

The liver is largest glandular organ in the body. It is responsible for detoxifying the poisonous substances in the body by transforming and removing toxins and wastes. The liver serves a variety of functions. The most crucial is its role in the body's metabolism. There is no organ is more important to healthy metabolism than the liver in many ways (Robbins *et al*., 2003).

Some of the major functions include –

- Carbohydrates metabolism –Produces &stores glycogen (glycogenesis), produces liver glucose from liver glycogen & other molecules (gluconeogenesis) and release it in to the blood.
- Lipid metabolism-synthesizes cholesterols, phospholipids & bile salts.
- Protein metabolism.
- Formation & storage of vitamins & minerals.
- Detoxification of blood- bio-transform endogenous & exogenous compounds via phase -1 & phase-2 pathway of detoxification.

It is involved in the intermediary metabolism of proteins, fats, carbohydrates and foreign bodies and is responsible for the synthesis of a number of plasma proteins. It also plays an important role in the production of various enzymes and the formation and excretion of bile. It acts as a storehouse of proteins, glycogen, various vitamins and minerals. Hence, any injury to it or impairment of its function has grave influence on the health of the affected person.

Liver disease is a collective term for a whole group of problems that afflict the tissues, structures and cells of the human liver. The liver performs a multitude of important functions, so there's plenty of opportunity for something to go wrong. One of the most common causes of liver disease is inflammation, which often results from abuse of alcohol, poor diet or even malnutrition (Arias *et al*., 1989). In the absence of a reliable liver protective drug in modern medicine there are a number of medicinal preparations in Ayurveda recommended for the treatment of liver disorders. Due to severe undesirable side effects of synthetic drugs used in liver disorder (Guntupalli *et al.,* 2006), there is growing focus to follow systematic research methodology and to evaluate scientific basis for the traditional herbal medicines that are claimed to possess hepatoprotective activity. A single drug cannot be effective for all types of liver diseases. Therefore an effective formulation has to be developed using indigenous medicinal plants, with proper pharmacological experiments and clinical trials.

Hepatotoxicity inducing agents- Several chemicals have been known to induce hepatotoxicity. CCl_4 (carbon tetrachloride), Galactosamine, d- Galactosamine / lipopolysachharide (Gal N/ LPS), Thioacetamide, antitubercular drugs, paracetamol, arsenic etc. are used to induce experimental hepatotoxicity in laboratory animals. CCl_4 has been widely and successfully used by many investigators. During its metabolism in endoplasmic reticulum and mitochondria CCl_3O^-, a reactive oxidative free radical is formed which initiates lipid peroxidation.

Paracetamol, a widely used analgesic and antipyretic drug produces acute liver damage in high dose. Paracetamol administration causes necrosis of the centrilobular hepatocytes characterized by the nuclear pyknosis and eosinophilic cytoplasm followed by large excessive hepatic lesion.

Arsenicles are wide spread in the environment as a result of natural or anthropogenic activities arsenic forms strong complexes with various sulf-hydryl groups and exerts its activity by generating reactive oxygen species (ROS), such as superoxide, hydroxyl and peroxyl radicals during its metabolism in cells. Arsenic exposure was shown to depress the antioxidant system leading to oxidative damage to cellular macromolecules including DNA, proteins and lipids in biological system by tissue damage, altering biochemical compounds and corroding cell membrane.

Medicinal herbs are significant source of pharmaceutical drugs. Latest trends have shown increasing demand of phyto drugs and some medicinal herbs have proven

hepatoprotective potential. Medicinal herbs and extracts prepared from them are widely used in the treatment of liver diseases like hepatitis, cirrhosis and loss of appetite (Nadkarni and Nadkarni, 1954). The table shows list of plants which are proven to be hepato-protective by their pharmacological studies on experimental animals.

2. Discussion

Not only the plants but even the results of herbal formulations which contain more than one herb also studied for their hepatoprotective activity. The pretreatment in low doses (2.6 ml/kg/day) with liquid formulations of Liv 52 and Livergen reversed the PCM induced liver toxicity. At higher doses (5.2 ml/ kg/day), all the six herbal formulations namely Liv 52, Livergen, Livokin, Octogen, Stimuliv and Tefroliv conclusively showed marked beneficial effects in the studied pharmacological, biochemical and histological parameters (Girish *et al.,* 2009).

The efficacy of any hepatoprotective drug is essentially dependent on its capability to either reduce harmful effects or to maintain the normal hepatic physiological mechanisms that have been unbalanced by the hepatotoxin (Sen *et al.,* 1993). The results of the present studies reveal that the different plant extract possesses significant hepatoprotective and antioxidant activities against CCI4, or other compound induced liver damage in rats. It has been observed that CCI4 is bio-transformed by the cytochrome P-450 system to the trichloromethyl free radical. This free radical may react again with oxygen to form a trichloromethyl peroxyl radical, which may attack lipids on the membrane of endoplasmic reticulum. The trichloromethyl peroxyl free radical leads to lipid peroxidation, the disruption of Ca++ homeostasis and finally, results in cell death (Clawson, 1989; Recknagel *et al.*, 1989). Therefore, leakage of large quantities of enzymes into the blood stream often associated with massive necrosis of the liver (Rees and Spector, 1961). Administration of CCI4 results in a rapid increase of serum GOT, GPT and ALP levels (Lin *et al.,* 1997). Serum GOT can be found in the liver, cardiac muscle, kidney, brain, pancreas, lungs, skeletal muscle, leukocytes and erythrocytes (in decreasing concentrations) (Rafatullah *et al.,* 1991), whereas the highest concentration of Serum GPT is found in the liver. In tissues, Serum GPT occurs in two locations, the cytosol and mitochondria (Rej, 1978). Serum GPT appears to be a more sensitive and specific test of acute hepatocellular damage than Serum GOT (Lin *et al.,* 1997). Therefore, the possible hepatoprotective mechanism of these plant extract on CCI4-induced liver injuries may be due to the following factors: (i) inhibition of cytochrome P-450 activity; (ii) prevention of lipid peroxidation; (iii) stabilization of the hepatocellular membrane and (iv) enhancement of protein synthesis (Al-Howiriny *et al.,* 2003).

Furthermore, alkaline phosphatase (ALP) is the prototype of these enzymes that reflects the pathological alteration in biliary flow (Plaa and Hewitt, 1981). CCI4-induced elevation of this enzymatic activity in serum is in line with the high level of serum bilirubin content (Al-Howiriny *et al.,* 2003). The extract-mediated suppression of the increased ALP activity with the concurrent depletion of raised bilirubin level suggests the possibilities of the extract being able to stabilize biliary dysfunction in the rat liver, thereby indicating its effectiveness in maintaining the normal functional status of the liver (Klassen, 1969). Different observations in the various studies also indicate that treatment with CCI4 caused a significant reduction in NP-SH concentration in the rat liver. Plant extracts however, offered a significant replenishing of the NP-SH level. Thus, sulfhydryl seems to have a role hepatoprotection through its antioxidant potential (Burk, 1983; Ahmed and Khater 2001). Phytochemical studies also showed that all plants possess different secondary metabolites including flavonoids, saponin, volatile oils, sterol and/or triterpenes. All of these constituents are known to exhibit antioxidant activity, offer protection against cell damage and possess free radical scavenging effects (Vogel, 1977; Kikuzaki *et al.,* 2000). In *Andrographis paniculata* the bioactive compounds are andrographolide and neoandrographolide, in *Bacopa monniera* bioactive compound is bacoside-A, in *Rubia cordifolia* bioactive compound is rubiadin, in *Terminalia catappa* bioactive are punicalagin and punicalin (Deshwal *et al.,* 2011), all these compounds show hepatoprotective activity in experimental models.

3. Conclusion

This review demonstrates that a large number of plants have significant hepatoprotective and antioxidant properties. Some of them are part of Ayurvedic medicines also. Further studies are necessary to isolate the active chemical component(s) and to elucidate its exact mechanism(s) of action.

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Table: Medicinal Plants Having Hepatoprotective Activity

Name of plant	*Family*	*Plant part used*	*Extract*	*Animal model*	*Hepatotoxic agent used*	*Remark*	*Reference*
Alpinia galanga (L.) Willd.	Zingiberaceae.	Rhizome.	Aqueous extract.	Male Spargue-Dawley rats.	Paracetamol , 300 mg/kg.	Reversed the level of AST, ALT, MDA and SOD to the normal. Histopathological analysis showed significant reduction in the number of necrotic cells.	Hemabarathy *et al*., 2009.
Achyranthes aspera Linn.	Amaranthaceae.	Seeds.	Ethanolic extract 100 mg/kg.	Rats.	CCl_4	Pretreatment with extract inhibited the increase in serum levels of total bilirubin, total protein, serum ALT, ASP and ALP reflecting the liver protection by crude drug.	Manjunatha *et al*., 2012.
Aegle marmelos (L.) Correa	Rutaceae	Leaves.	Ethanolic extract 500 mg/kg.	Rats.	CCl_4.	Lowering of levels of enzymes like serum glutamate pyruvate, trasaminase serum glutamate oxaloacetate, trasaminase, alkaline phosphatase, bilirubin total cholesterol, triglycerides, low density lipoprotein and very low density lipoptotein but increase in the level of high density lipoprotein. Antioxidant enzymes were also increased. These biochemical observations were supported by histopathological examination of liver.	Sumitha and Thirunalasundari, 2011.
*Aerva lanata (*Linn.)Juss.	Amaranthaceae.	Whole plant.	Petroleum ether extract.	Spargue Dawley rats.	CCl_4.	Reduce SGOT, SGPT and ALP, enhanced antioxidant enzyme activities, reduced hepatic LPO and increased the serum total protein and albumin/globulin (A/G) ratio.	Nevin and Vijayamma, 2005.
Aloe barbadensis Mill.	Liliaceae.	Dried aerial parts.	Aqueous extract.	Mice	CCl_4	Restoration of SGOT, SGPT, ALP, bilirubin, TG, LPO, GSH, glucose 6 phosphatase and microsomal aniline hydroxylase and amidopyrine N demethylase towards normal. Supportive histopathological findings.	Chadan *et al*., 2007.
*Alternanthera sessilis (*L.) DC.	Amaranthaceae.	Aerial parts	Ethanolic extract	Wistar albino rats.	Paracetamol	Decrease in the activity of serum enzymes, bilirubin, total cholesterol and in vivo lipid peroxidation and significant increase in the levels of GSH, SOD, CAT and HDL cholesterol suggests that EEAS could protect the liver cells from paracetamol induced liver damage by its antioxidative effect on hepatocytes.	Das *et al.,* 2014.
Amaranthus spinosus Linn.	Amaranthaceae.	Whole plant.	50% ethanolic extract.	Rats.	CCl_4.	SGOT, SGPT, ALP and TB. decreased to near normal level. The presence of flavonoids and phenolics compound may be responsible for hepatoprotective activity.	Zeashan *et al*., 2008.
Andrographis paniculata (Burm.f.) Nees.	Acanthaceae.	Aerial parts.	Aqueous extract 50,100and 200 mg/kg.	Albino wistar Rats.	Ethanol.	Reduction in the elevated serum transaminase levels (SGOT, SGPT and ALP), total and direct bilirubin. Histopathplogical studies showed marked reduction in fatty degeneration and centrizonal necrosis.	Sutha *et al*., 2010.
Asteracantha longifolia Nees.	Acanthaceae.	Whole plant.	Hydro-alcoholic.	Spargue Dawley rats (male).	Isoniazid and rifampcin	Significant reduction in marker enzymes ALT, AST, ALP. And bilirubin. The histopathological studies shows regeneration of hepatocytes, normalization of fatty changes and	Shah *et al*., 2012

						necrosis of the liver.	
Bacopa monnieri (L.) Pennel.	Scrophulariaceae.	Whole plant.	Ethanolic extract	Male Swiss albino mice	0.5ml of 5% CCl_4 (orally).	Significant reduction in serum marker enzymes of hepatic damage viz. SGPT SGOT and bilirubin. Bioactive compound is Bacoside –A.	Gudipati *et al.*,2012
Beta vulgaris Linn.	Chenopodiaceae.	Root.	Ethanolic extract.	Rats.	CCl_4	Significantly prevented serum markers viz. cholesterol, TG, ALT and ALP.	Agrawal *et al.*, 2006.
Boerhaavia diffusa Linn.	Nyctaginaceae.	Root and aerial parts	85% methanolic extract	Wistar albino rats.	Drug ibuprofen.500mg/kg b.wt.	Reduction in ALT, AST, ALP and bilirubin and increase in antioxidant enzymes SOD, CAT, GPx and GST. The hepatic cell architecture restores nearly normal structure and function. Root of *B. diffusa* possesses more hepatoprotective efficiency than the aerial parts.	Jalyavelu *et al.*, 2013.
Bryophyllum pinnatum Lam.	Gentianaceae	Aerial part	Aqueous and ethanolic extract 250, 500 mg/kg	Rat	n-diethylnitrosamine (DENA)	The level of cholesterol, triglyceride, HDL, LPO, SOD, CAT, SGPT, SGOT and ALP significantly reversed. Histopathological studies also supported the protective action.	Muhammad Afzal *et al.,*2013
Cajanus cajan Linn.	Leguminosae.	Aerial parts.	Hydroalcoholic extract, 100, 2 00 and 400 mg/kg.	Wistar albino rats.	CCl_4	400 mg/kg plant extract shows significant decrease in the level of serum marker enzymes ALT, AST and increase in total protein to the near normal value.	Singh *et al.*, 2011.
Calotropis procera (Ait.) R.Br.	Asclepiadaceae	Flower.	70% hydroalcoholic extract.	Rats.	Paracetamol.	Reversed the enhanced SGOT, SGPT, ALP, bilirubin and cholesterol levels; reduced the serum level of HDL and tissue level of GSH.	Setty *et al.*, 2007.
Celosia argentea Linn.	Amaranthaceae.	Seeds.	70% ethanolic extract 200 and 400mg/kg.	Wistar strain male rats.	CCl_4	Significant lowering of serum marker parameters like AST, ALT, ALP, total bilirubin and increase in serum total proteins and albumin. Furthermore the extract causes a significant reduction of lipid peroxidation and an elevation in antioxidant defense glutathione (GSH), ascorbic acid content and catalase activity in liver.	Jain, 2005.
Centella asiatica (L.) Urban.	Apiaceae. (Umballiferae)	Whole plant.	Aqueous slurry 0.7gm/kg	Wistar albino rats.	CCl_4.	Significant reduction in the marker enzymes ALT, AST levels, reduction in cholesterol ,triglycerides, and bilirubin all these blood bio chemical assays showed that the plant through free radicals scavenging activity play important role in regeneration of liver cells.	Pingale, 2008.
Cuscuta reflexa Roxb.	Convolvulaceae	Whole plant	Chl Chloroform and ethanol extract 200 and 400 mg/kg.	Male wistar albino rats.	CCl_4.	Reduction in the serum trasaminase ALP, ACP and bilirubin. The total triglyceride and cholesterol levels VLDL, LDL HDL, ALPO4 and LDH were also reduced. Histopathological studies also provide supportive evidence necrosis and fatty changes were prevented.	Chatterjee *et al.*, 2010.
Daucus carota Linn,	Apiaceae.	Root.	Carrot extract 25 ml/kg	Rats.	Lindane.	Decreasing the level of serum enzymes (AST, ALT/ALP, TBARS, cholesterol, TG and LDL-cholesterol. Carrot extract also restored the depressed antioxidants and HDL-cholesterol levels to near normal.	Balasubramaniam *et al.*, 1998 *et et al.*, 1998
Eclipta alba (Linn.) Hassk	Asteraceae.	Whole plant.	50% ethanolic extract 100 and 250mg/100gm.	Albino mice.	Paracetamol.	Significant reduction in the elevated serum ALT levels. Histopathological studies showed marked reduction in fatty degeneration and centrizonal necrosis.	Tabassum and Agrawal, 2004
Emblica officinalis Gaertn.f.	Euphorbiaceae.	Fruits.	50% hydro-alco -holic extract.	Rats.	Rifampicin, isoniazid, and pyrazinamide.	Reversal of serum enzyme activity i.e.(AST, ALT,ALP, bilirubin and LPO and recovery of GSH content, CAT and GSH activities were restored,	Tasduq *et al.*, 2005.

						histopathological examination provided favourable results.	
Euphorbia hirta Linn.	Euphorbiaceae.	Whole plant.	Alcoholic extract 100&200 mg/kg. b.wt.	Albino rats.	CCl_4 intraperitonial injection	Biochemical and histopathological parameters shows the protective activity of 200mg/kg p. o. dose, there was significant reduction in serum pyruvate transaminase, serum oxalate trasaminase and serum bilirubin. Histopathological results were also favourable.	Kumarappan *et al*., 2011.
Fumaria Indica (Hausskn) Pugsley	Fumariaceae.	Whole plant.	Petroleum ether, aqueous and methanolic extract.	Albino rats	CCl_4, PA and rifampicin.	Reductions in the elevated levels of some of the serum biochemical parameters.	Rao and Mishra, 1997.
Glorgloriosa superba L.	Liliaceae.	Tubers.	Aqueous 500mg/kg.	Female wistar albino rats.	Paracetamol.	Decrease in lipid peroxidation, increase in glutathione and vitamin –C, catalase and glutathione peroxidase were also increased. The plant contains alkaloids, carbohydrates proteins and thiols. Thus results shows that antioxidant activity is responsible for recovery of hepatotoxicity damage.	Indhumathi and Erattarakkal, 2011
Jatropha curcas Linn.	Euphorbiaceae.	Leaves.	Methanolic extract,	Rats.	Aflatoxin B_1.	Increase in lipid peroxide level and decrease in antioxidant enzyme level is reversed to near normal. liver histopathology showed that plant extract reduced the incidence of liver lesions lymphatic infilteration and hepatic necrosis induced by AFB_1.	Balaji *et al*., 2009.
Lawsonia inermis Linn.	Lytheraceae.	Seeds.	Aqueous.	Rats	Paracetamol.	Significant reduction in serum enzymes alkaline amino transferase(ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP),acid phosphatase (ACP), protein and bilirubin. The phytochemicals present are tannins, saponins, steroids, flavonoids, terpenoids and phloba-tannins.	Selvanayaki and Ananthi, 2012.
Mimosa pudica Linn.	Mimosaceae.	Leaves.	Methanolic extract 200mg/kg.	Wistar albino rats.	CCl_4 1.25ml/kg i.p.	Significant reduction in SGOT, SGPT, ALP TBL,CHL. and increase in TPTN and ALB.	Rajendran *et al*., 2009.
Moringa oleifera Lamk.	Moringaceae.	Fruit.	Aqueous and alcoholic extract.	Rats.	CCl_4	SGOT, SGPT level decreases significantly.	Patel *et al*., 2008.
Phyllanthus amarus Schumach & Than.	Euphorbiaceae.	Whole plant.	Ethanolic 200mg/kg.	Male Wistar albino rats.	Alcohol.	Great change in the biochemical parameters in the ethanol intoxicated rats and maintained well to the normal level.	Arun and Balasubramanian, 2011.
Picrorhiza kurroa Royle ex.	Scrophulariaceae.	Whole plant.	Ethyl acetate, ethanol and aqueous 30, 100 and 300 mg/kg b.wt.	Swiss albino mice.	Galactosamine (Gal-N.).400 mg/kg b. wt. along with lipopolysaccharide (LPS) (0.5µg/kg) b.wt. i.p.	Pre treatment with ethylacetate100mg/kg b.wt. and aqueous extract 30 and 100mg/kg. b.wt. shows significant reduction in SGOT, SGPT, total bilirubin, cholesterol and triglycerides.	Karthikumar *et al*., 2009.
Ricinus communis Linn.	Euphorbiaceae.	Leaves	Ethanolic extract 100mg/kg b.w.	Mice	Ketoconazole.	Total protein and albumin/globulin ratio was increased, and reduction in AST, ALT, ALP and total bilirubin.	Padmapriya *et al*., 2012.
Scoparia dulcis L Linn.	Scrophulariaceae.	Whole plant.	Aqueous extract 500mg/kg.	Wistar albino rats	DEN (N-nitrosodiethylamine).	An oral dose of 500 mg/kg exhibited significant decrease in marker enzymes level ALT, AST, ALP, ACP was observed, a significant increase in the level of superoxide dismutase, catalase, glutathione peroxidise,	Langeswaran *et al*., 2012.

						ascorbic acid and S-tocopherol was observed in the *Scoparia dulcis* treated animals.	
Nigella sativa L.	Ranunculaceae	Seeds	Ethanolic extract	wistar albino rats	D-Galactosamine (GalN)/ Lipo-polysahharide	The *Nigella sativa* alcoholic extract (NSE) used in the study showed significant protection and maintained the levels of AST, ALT and ALP near to normal level.	Gani and John, 2013.
Swertia Chirata Roxb.	Gentianaceae	Stem	Ethanolic extract 100, 200 and 400 mg/kg	Albino rats	Paracetamol	Significantly altered serum marker enzymes(aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), total bilirubin) levels to near normal against paracetamol treated rats. The activity of the extract at dose of 400 mg/kg was approximately comparable to the standard drug, silymarin (25 mg/kg, p.o.). Histopathological studies supplemented the findings. Flavo	Cheedella et al., 2014. 2014 Cheedella Cheedella,
Sida acuta Burm. f.	Malvaceae.	Whole plant and Root	Methanolic extract	Wistar rats.	Paracetamol	Decrease in serum levels of glutamate pyruvate transaminase, glutamate alkaline oxaloacetate transaminase, alkaline phoaphatase and bilirubin. Pretreatment with *Sida acutaaacuta* extract shortened the *acuta* extract shortened the duration of necrosis in mice indicating itshepatoprotective potential. Phenolic compound ferulic acid is present in the roots.	Sreedevi *et al*., 2009.
Solanum nigrum Linn.	Solanaceae	Fruits	Hydroalcoholic extract.	Wistar albino rats.	CCl_4	Mark reduction in serum ALT, AST and bilirubin and increase in antioxidant activity enzymes SOD, GSH were increased. Histopathological analysis also provides favourable result.	Subash *et al*., 2011.
Solanum xanthocarpum Schrad and Wendl.	Solanaceae	Fruits.	Ethanolic extract 100, 200 and 400 mg/kg b. wt.	Spargue Dawley rats.	CCl_4	Significant reduction in biochemical parameters AST, ALT, ALP, total bilirubin. Antioxidant enzyme markers increased GSH, SOD, CAT etc. Histopathological studies also show favourable results.	Gupta *et al*., 2011.
Tephrosia prupurea Lin*n.*	Fabaceae.	Aerial parts.	Aqueous, ethanolic extract 100, 300&500mg/kg.	Albino rats	Thioacetamide.	Oral administration of *Tephrosia purpurea* at 500mg/kg dose resulted in a significant reduction in serum aspartate amino trasaminase, alanine amino trasaminase, gamma glutamyl trasnpeptidase alkaline phosphatase, total bilirubin and liver MDA levels and significant improvement in liver glutathione. Histology of the liver section of the animal treated with extracts also showed dose dependent reduction of necrosis.	Khatri *et al*., 2009
Terminalia arjuna (Roxb.) Wight & Arn.	Combretaceae.	Bark.	Aqueous extract 200 mg/kg b.wt.	Female albino rats.	Isoniazid 100 mg/kg b.wt.	Significant reduction in serum elevated biochemical markers ALP, ACP, SGOT, SGPT and increased level of SOD and GSH. The hepatoprotective activity of aqueous extract may be due to antioxidant principles in it. Phytochemical present are steroids, tannins, phenolics compound, quinone, terpinoids, sugar, alkaloids and flavonoids. alkaloids and flavonoids phenolics, quinine, terpenoids sugar, alkaloids and flavonoids.	Doorika and Ananthi, 2012.
Ternminalia chebula Retz.	Combretaceae.	Leaves.	1%gum accacia suspension of leaves	Male wistar rats.	Paracetamol	Significant decrease was observed in elevated biochemical parameters SGOT, SGPT, ALP, bilirubin (total and direct) cholesterol, triglycerides and	Vidya *et al*., 2011.

			300mg/kg.p.o.			lipid peroxidation and increase in GSH. Histopathplogical findings were also supportive.	
Tinospora cordifolia Willed.)Miers ex. Hk. f & Th.	Manispermaceae.	Aerial parts.	Aqueous extract 1-2ml/100g.	Wistar albino rats	CCl_4.	Biochemical parameters ALT, ALP and total bilirubin are decreased to near normal level in experimental rats.	Kumar *et al*., 2013.
Tridex procumbens Linn.	Asteraceae.	Aerial parts.	Chloroform insoluble fraction from ethanolic extract.	Rats.	d-Gal-N /LPS.	Pretreatment altered increase in the activities of marker enzymes AST, ALT, ALP, LDH and gamma glutamyl tranferase and bilirubin level in serum and lipid.	Vilwanathan *et al*., 2005.
Vitex negundo Linn.	Verbenaceae	Leaves.	Ethanolic extract 300mg/kg.	Rats.	Paracetamol.	Significant reduction in serum enzymes ALT, AST, ALP. The histopathological result also shows protective action.	Ladda *et al*., 2011.
Withania frutescents Linn.	Solanaceae.	Leaves.	Ethanolic extract.	Rat or mice.	CCl_4	Alteration in the modification of Nembutal-induced sleep, bile flow, serum trasaminase and hepatic fatty acids levels and histopathological studies.	Montilla *et al*., 1990.
Zingiber officinale Rosc.	Zingiberaceac.	Rhizome.	Ethanolic extract of essential oil.	Rats.	CCl_4	Lowered the elevation of ALT, ALP, AST, LDH, SDH and GDH/direct bilirubin level in dose dependent manner. Histopathological studies also provide favourable results.	Yemitan and Izegbu, 2006.

Note – ACP (Acid Phosphatase), ALB (Albumin), ALP (Alkaline Phosphatase), ALT (Alanine Amino Trasferase), AST (Aspartate Transaminase),
CAT (Catalase), CHL (Cholesterol), GDH (Glutamate Dehydrogenase), GSH (Glutathione), GPx (Glutathione Peroxidase), HDL (High-Density Lipoprotein), LDH (Lactate Dehydrogenase), LDL (Low-Density Lipoprotein), SDH (Sorbitol Dehydrogenase),
SGOT (Serum Glutamic Oxalocetic Transaminase), SGPT (Serum Glutamic-Pyruvic Transaminase), SOD (Superoxide Dismutase),
TBARS (Thiobarbituric Acid Reactive Substances), TBL (Total Bilirubin), TPTN (Total Protein), (VLDL (Very Low-Density Lipoprotein).