# 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

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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 CCI4induced 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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| Name of plant                                    | Family         | Plant<br>part used        | Extract                                       | Animal<br>model                     | Hepatotoxic                | Remark   | Reference                                  |
|--|----------------|---------------------------|---|-------------------------------------|----------------------------|--|--|
| <i>Alpinia</i><br>galanga (L.)<br>Willd.         | Zingiberaceae. | Rhizome.                  | Aqueous<br>extract.                           | Male<br>Spargue-<br>Dawley<br>rats. | Paracetamol,<br>300 mg/kg. | Reversed the level of AST, ALT, MDA<br>and SOD to the normal.<br>Histopathological analysis showed<br>significant reduction in the number of<br>necrotic cells.  | Hemabarathy <i>et al.</i> , 2009.          |
| Achyranthes<br>aspera Linn.                      | Amaranthaceae  | Seeds.                    | Ethanolic<br>extract<br>100 mg/kg.            | Rats.                               | CCl <sub>4</sub>           | Pretreatment with extract inhibited the<br>increase in serum levels of total<br>bilirubin, total protein, serum ALT,<br>ASP and ALP reflecting the liver<br>protection by crude drug.  | Manjunatha <i>et</i><br><i>al.</i> , 2012. |
| Aegle<br>marmelos<br>(L.) Correa                 | Rutaceae       | Leaves.                   | Ethanolic<br>extract 500<br>mg/kg.            | Rats.                               | CCl <sub>4</sub> .         | Lowering of levels of enzymes like<br>serum glutamate pyruvate, trasaminase<br>serum glutamate oxaloacetate,<br>trasaminase, alkaline phosphatase,<br>bilirubin total cholesterol, triglycerides,<br>low density lipoprotein and very low<br>density lipoptotein but increase in the<br>level of high density lipoprotein.<br>Antioxidant enzymes were also<br>increased. These biochemical<br>observations were supported by<br>histopathological examination of liver. | Sumitha and<br>Thirunalasunda<br>ri, 2011. |
| Aerva lanata<br>(Linn.)Juss.                     | Amaranthaceae  | Whole<br>plant.           | Petroleum<br>ether extract.                   | Spargue<br>Dawley<br>rats.          | CCl <sub>4</sub> .         | Reduce SGOT, SGPT and ALP,<br>enhanced antioxidant enzyme activities,<br>reduced hepatic LPO and increased the<br>serum total protein and<br>albumin/globulin (A/G) ratio.   | Nevin and<br>Vijayamma,<br>2005.           |
| Aloe<br>barbadensis<br>Mill.                     | Liliaceae.     | Dried<br>aerial<br>parts. | Aqueous<br>extract.                           | Mice                                | CCl <sub>4</sub>           | Restoration of SGOT, SGPT, ALP,<br>bilirubin, TG, LPO, GSH, glucose 6<br>phosphatase and microsomal aniline<br>hydroxylase and amidopyrine N<br>demethylase towards normal.<br>Supportive histopathological findings.  | Chadan <i>et al.</i> ,<br>2007.            |
| Alternanthera<br>sessilis (L.)<br>DC.            | Amaranthaceae  | Aerial<br>parts           | Ethanolic<br>extract                          | Wistar<br>albino rats.              | Paracetamol                | Decrease in the activity of serum<br>enzymes, bilirubin, total cholesterol and<br>in vivo lipid peroxidation and<br>significant increase in the levels of<br>GSH, SOD, CAT and HDL cholesterol<br>suggests that EEAS could protect the<br>liver cells from paracetamol induced<br>liver damage by its antioxidative effect<br>on hepatocytes.  | Das <i>et al.,</i><br>2014.                |
| Amaranthus<br>spinosus<br>Linn.                  | Amaranthaceae  | Whole<br>plant.           | 50% ethanolic<br>extract.                     | Rats.                               | CCl <sub>4</sub> .         | SGOT, SGPT, ALP and TB. decreased<br>to near normal level. The presence of<br>flavonoids and phenolics compound<br>may be responsible for hepatoprotective<br>activity.  | Zeashan <i>et al.</i> ,<br>2008.           |
| Andrographis<br>paniculata<br>(Burm.f.)<br>Nees. | Acanthaceae.   | Aerial<br>parts.          | Aqueous<br>extract<br>50,100and 200<br>mg/kg. | Albino<br>wistar<br>Rats.           | Ethanol.                   | Reduction in the elevated serum<br>transaminase levels (SGOT, SGPT and<br>ALP), total and direct bilirubin.<br>Histopathplogical studies showed<br>marked reduction in fatty degeneration<br>and centrizonal necrosis.   | Sutha <i>et al.</i> ,<br>2010.             |
| Asteracantha<br>longifolia<br>Nees.              | Acanthaceae.   | Whole<br>plant.           | Hydro-<br>alcoholic.                          | Spargue<br>Dawley<br>rats (male).   | Isoniazid and<br>rifampcin | Significant reduction in marker<br>enzymes ALT, AST, ALP. And<br>bilirubin. The histopathological studies<br>shows regeneration of hepatocytes,<br>normalization of fatty changes and  | Shah <i>et al.</i> ,<br>2012               |

| Table: Medicinal Plants Having Hepatoprotectiv | ve Activity |
|--|-------------|
|--|-------------|

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|                |                |          |                 |              |                    | necrosis of the liver                     |                        |
|----------------|----------------|----------|-----------------|--------------|--------------------|---|------------------------|
| Racona         | Scrophulariace | Whole    | Ethanolic       | Male         | 0.5ml of 5%        | Significant reduction in serum marker     | Gudinati at            |
| monnieri (L.)  | ae             | plant    | extract         | Swiss        | CCL (orally)       | enzymes of henatic damage viz SGPT        | al 2012                |
| Pennel         | ac.            | Piant.   | CALLACT         | alhino       |                    | SGOT and bilirubin Bioactive              | u1.,2012               |
| i chilei.      |                |          |                 | mice         |                    | compound is Bacoside -A                   |                        |
| Reta vulgaris  | Chenonodiacea  | Root     | Ethanolic       | Rats         | CCL                | Significantly prevented serum markers     | Agrawal et al          |
| Linn           | e              | Root.    | extract         | ixats.       | 0.014              | viz cholesterol TG ALT and ALP            | 2006                   |
| Roerhaavia     | Nyctaginaceae  | Root and | 85%             | Wistar       | Drug               | Reduction in ALT AST ALP and              | Ialvavelu <i>et al</i> |
| diffusa Linn   | Tyetaginaceae. | aerial   | methanolic      | albino rats  | ibuprofen 50       | bilirubin and increase in antioxidant     | 2013                   |
| aijjusa Eiiii. |                | narts    | extract         | utomo tuts.  | 0mg/kg h wt        | enzymes SOD_CAT_GPx and GST               | 2015.                  |
|                |                | puits    | extract         |              | onig/kg o.wt.      | The henatic cell architecture restores    |                        |
|                |                |          |                 |              |                    | nearly normal structure and function.     |                        |
|                |                |          |                 |              |                    | Root of <i>B</i> diffusa possesses more   |                        |
|                |                |          |                 |              |                    | hepatoprotective efficiency than the      |                        |
|                |                |          |                 |              |                    | aerial parts.                             |                        |
| Bryophyllum    | Gentianaceae   | Aerial   | Aqueous and     | Rat          | n-                 | The level of cholesterol, triglyceride,   | Muhammad               |
| pinnatum       |                | part     | ethanolic       |              | diethylnitrosa     | HDL, LPO, SOD, CAT, SGPT, SGOT            | Afzal et               |
| Lam.           |                |          | extract 250,    |              | mine               | and ALP significantly reversed.           | al.,2013               |
|                |                |          | 500 mg/kg       |              | (DENA)             | Histopathological studies also            | -                      |
|                |                |          | 0.0             |              |                    | supported the protective action.          |                        |
| Cajanus        | Leguminosae.   | Aerial   | Hydroalcoholi   | Wistar       | CCl <sub>4</sub>   | 400 mg/kg plant extract shows             | Singh et al.,          |
| cajan          | -              | parts.   | c extract, 100, | albino rats. |                    | significant decrease in the level of      | 2011.                  |
| Linn.          |                | -        | 2 00 and 400    |              |                    | serum marker enzymes ALT, AST and         |                        |
|                |                |          | mg/kg.          |              |                    | increase in total protein to the near     |                        |
|                |                |          |                 |              |                    | normal value.                             |                        |
| Calotropis     | Asclepiadaceae | Flower.  | 70%             | Rats.        | Paracetamol.       | Reversed the enhanced SGOT, SGPT,         | Setty et al.,          |
| procera (Ait.) |                |          | hydroalcoholic  |              |                    | ALP, bilirubin and cholesterol levels;    | 2007.                  |
| R.Br.          |                |          | extract.        |              |                    | reduced the serum level of HDL and        |                        |
|                |                |          |                 |              |                    | tissue level of GSH.                      |                        |
| Celosia        | Amaranthaceae  | Seeds.   | 70% ethanolic   | Wistar       | CCl <sub>4</sub>   | Significant lowering of serum marker      | Jain, 2005.            |
| argentea       |                |          | extract 200     | strain male  |                    | parameters like AST, ALT, ALP, total      |                        |
| Linn.          |                |          | and 400mg/kg.   | rats.        |                    | 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.                        |                        |
| Centella       | Apiaceae.      | Whole    | Aqueous slurry  | Wistar       | CCl <sub>4</sub> . | Significant reduction in the marker       | Pingale, 2008.         |
| asiatica (L.)  | (Umballiferae) | plant.   | 0./gm/kg        | albino rats. |                    | enzymes ALT, AST levels, reduction in     |                        |
| Urban.         |                |          |                 |              |                    | cholesterol, triglycerides, and bilirubin |                        |
|                |                |          |                 |              |                    | all these blood blo chemical assays       |                        |
|                |                |          |                 |              |                    | snowed that the plant through free        |                        |
|                |                |          |                 |              |                    | important role in regeneration of liver   |                        |
|                |                |          |                 |              |                    | aniportant fore in regeneration of fiver  |                        |
| Cuscuta        | Convolvulacea  | Whole    | Chl             | Male         | CC1.               | Reduction in the serum trasaminase        | Chatteriee at          |
| reflexa Roxh   | e              | nlant    | Chloroform      | wistar       | 0014.              | ALP ACP and bilirubin. The total          | al = 2010              |
| Гергели Коло.  | C              | piant    | and ethanol     | albino rats  |                    | triglyceride and cholesterol levels       | <i>ui.</i> , 2010.     |
|                |                |          | extract 200     |              |                    | VLDL, LDL HDL, ALPO4 and LDH              |                        |
|                |                |          | and 400         |              |                    | were also reduced Histopathological       |                        |
|                |                |          | mø/kø           |              |                    | studies also provide supportive           |                        |
|                |                |          | ing ng.         |              |                    | evidence necrosis and fatty changes       |                        |
|                |                |          |                 |              |                    | were prevented.                           |                        |
| Daucus         | Apiaceae.      | Root.    | Carrot extract  | Rats.        | Lindane.           | Decreasing the level of serum enzymes     | Balasubramania         |
| carota         | 1              |          | 25              |              |                    | (AST, ALT/ALP, TBARS, cholesterol,        | m et al., 1998         |
| Linn,          |                |          | ml/kg           |              |                    | TG and LDL-cholesterol.                   | et et al., 1998        |
| ,              |                |          | C               |              |                    | Carrot extract also restored the          | ,                      |
|                |                |          |                 |              |                    | depressed antioxidants and HDL-           |                        |
|                |                |          |                 |              |                    | cholesterol levels to near normal.        |                        |
| Eclipta alba   | Asteraceae.    |          | 50% ethanolic   | Albino       | Paracetamol.       | Significant reduction in the elevated     | Tabassum and           |
| (Linn.)        |                | Whole    | extract 100     | mice.        |                    | serum ALT levels.                         | Agrawal, 2004          |
| Hassk          |                | plant.   | and             |              |                    | Histopathological studies showed          |                        |
|                |                |          | 250mg/100gm     |              |                    | marked reduction in fatty degeneration    |                        |
|                |                |          |                 |              |                    | and centrizonal necrosis.                 |                        |
| Emblica        | Euphorbiaceae. | Fruits.  | 50% hydro-      | Rats.        | Rifampicin,        | Reversal of serum enzyme activity         | Tasduq <i>et al.</i> , |
| officinalis    |                |          | alco            |              | isoniazid, and     | 1.e.(AST, ALT, ALP, bilirubin and LPO     | 2005.                  |
| Gaertn.t.      |                |          | -holic extract. |              | pyrazınamıde       | and recovery of GSH content, CAT and      |                        |
| 1              | 1              |          | 1               | 1            | •                  | GSH activities were restored,             |                        |

|  |                       |                 |  |                                  |  | histopathological examination provided<br>favourable results.   |   |
|--|-----------------------|-----------------|--|----------------------------------|--|---|---|
| Euphorbia<br>hirta Linn.                     | Euphorbiaceae.        | Whole<br>plant. | Alcoholic<br>extract<br>100&200<br>mg/kg. b.wt.                            | Albino<br>rats.                  | CCl <sub>4</sub><br>intraperitonia<br>l injection  | Biochemical and histopathological<br>parameters shows the protective<br>activity of 200mg/kg p. o. dose, there<br>was significant reduction in serum<br>pyruvate transaminase, serum oxalate<br>trasaminase and serum bilirubin.<br>Histopathological results were also<br>favourable                                     | Kumarappan <i>et al.</i> , 2011.            |
| Fumaria<br>Indica<br>(Hausskn)<br>Pugsley    | Fumariaceae.          | Whole<br>plant. | Petroleum<br>ether, aqueous<br>and<br>methanolic<br>extract.               | Albino rats                      | CCl <sub>4,</sub> PA<br>and<br>rifampicin.   | Reductions in the elevated levels of<br>some of the serum biochemical<br>parameters.  | Rao and<br>Mishra,<br>1997.                 |
| Glorgloriosa<br>superba L.                   | Liliaceae.            | Tubers.         | Aqueous<br>500mg/kg.   | Female<br>wistar<br>albino rats. | Paracetamol.   | Decrease in lipid peroxidation, increase<br>in glutathione and vitamin –C, catalase<br>and glutathione peroxidase were also<br>increased. The plant contains alkaloids,<br>carbohydrates proteins and thiols. Thus<br>results shows that antioxidant activity is<br>responsible for recovery of<br>hepatotoxicity damage. | Indhumathi and<br>Erattarakkal,<br>2011     |
| Jatropha<br>curcas Linn.                     | Euphorbiaceae.        | Leaves.         | Methanolic<br>extract,   | Rats.                            | Aflatoxin B <sub>1</sub> .   | Increase in lipid peroxide level and<br>decrease in antioxidant enzyme level is<br>reversed to near normal. liver<br>histopathology showed that plant<br>extract reduced the incidence of liver<br>lesions lymphatic infilteration and<br>hepatic necrosis induced by AFB <sub>1</sub> .                                  | Balaji <i>et al.</i> ,<br>2009.             |
| Lawsonia<br>inermis Linn.                    | Lytheraceae.          | Seeds.          | Aqueous.   | Rats                             | Paracetamol.   | Significant reduction in serum enzymes<br>alkaline amino transferase(ALT),<br>aspartate amino transferase (AST),<br>alkaline phosphatase (ALP),acid<br>phosphatase (ACP), protein and<br>bilirubin. The phytochemicals present<br>are tannins, saponins, steroids,<br>flavonoids, terpenoids and phloba-<br>tannins.      | Selvanayaki<br>and Ananthi,<br>2012.        |
| <i>Mimosa</i><br>pudica Linn.                | Mimosaceae.           | Leaves.         | Methanolic<br>extract<br>200mg/kg.   | Wistar<br>albino rats.           | CCl <sub>4</sub><br>1.25ml/kg<br>i.p.  | Significant reduction in SGOT,<br>SGPT, ALP TBL,CHL. and<br>increase in TPTN and ALB.   | Rajendran <i>et</i><br><i>al.</i> , 2009.   |
| Moringa<br>oleifera<br>Lamk.                 | Moringaceae.          | Fruit.          | Aqueous and<br>alcoholic<br>extract.                                       | Rats.                            | CCl <sub>4</sub>   | SGOT, SGPT level decreases significantly.   | Patel <i>et al.</i> ,<br>2008.              |
| Phyllanthus<br>amarus<br>Schumach &<br>Than. | Euphorbiaceae.        | Whole<br>plant. | Ethanolic<br>200mg/kg.   | Male<br>Wistar<br>albino rats.   | Alcohol.   | Great change in the biochemical<br>parameters in the ethanol intoxicated<br>rats and maintained well to the normal<br>level.  | Arun and<br>Balasubramania<br>n, 2011.      |
| Picrorhiza<br>kurroa Royle<br>ex.            | Scrophulariace<br>ae. | Whole<br>plant. | Ethyl acetate,<br>ethanol and<br>aqueous 30,<br>100 and 300<br>mg/kg b.wt. | Swiss<br>albino<br>mice.         | Galactosamin<br>e (Gal-<br>N.).400<br>mg/kg b. wt.<br>along with<br>lipopolysacch<br>aride (LPS)<br>(0.5µg/kg)<br>b.wt. i.p. | Pre treatment with<br>ethylacetate100mg/kg b.wt. and<br>aqueous extract 30 and 100mg/kg. b.wt.<br>shows significant reduction in SGOT,<br>SGPT, total bilirubin, cholesterol and<br>triglycerides.  | Karthikumar <i>et</i><br><i>al.</i> , 2009. |
| Ricinus<br>communis<br>Linn.                 | Euphorbiaceae.        | Leaves          | Ethanolic<br>extract<br>100mg/kg b.w.                                      | Mice                             | Ketoconazole   | Total protein and albumin/globulin<br>ratio was increased, and reduction in<br>AST, ALT, ALP and total bilirubin.   | Padmapriya <i>et al.</i> , 2012.            |
| <i>Scoparia</i><br><i>dulcis</i> L<br>Linn.  | Scrophulariace<br>ae. | Whole<br>plant. | Aqueous<br>extract<br>500mg/kg.  | Wistar<br>albino rats            | DEN (N-<br>nitrosodiethyl<br>amine).   | An oral dose of 500 mg/kg exhibited<br>significant decrease in marker enzymes<br>level ALT, AST, ALP, ACP was<br>observed, a significant increase in the<br>level of superoxide dismutase,<br>catalase, glutathione peroxidise,   | Langeswaran <i>et</i><br><i>al.</i> , 2012. |

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|                      |               |           |                                | 1                     |                     |  |                         |
|----------------------|---------------|-----------|--------------------------------|-----------------------|---------------------|--|-------------------------|
|                      |               |           |                                |                       |                     | ascorbic acid and S-tocopherol was<br>observed in the <i>Scoparia dulcis</i> treated<br>animals. |                         |
| Nigella sativa<br>L. | Ranunculaceae | Seeds     | Ethanolic<br>extract           | wistar<br>albino rats | D-<br>Galactosamine | The <i>Nigella sativa</i> alcoholic extract (NSE) used in the study showed                       | Gani and John,<br>2013. |
|                      |               |           |                                |                       | (GalN)/             | significant protection and maintained  |                         |
|                      |               |           |                                |                       | Lipo-               | the levels of AST, ALT and ALP near  |                         |
| Swertia              | Gentianaceae  | Stem      | Ethanolic                      | Albino rats           | Paracetamol         | Significantly altered serum marker   |                         |
| Chirata              |               |           | extract                        |                       |                     | enzymes(aspartate amino transferase  | Cheedella et al.,       |
| Roxb.                |               |           | 100, 200 and                   |                       |                     | (AST), alanine amino   | 2014.                   |
|                      |               |           | 400 mg/kg                      |                       |                     | transferase (ALT), alkaline phosphatase  |                         |
|                      |               |           |                                |                       |                     | (ALP), total bilirubin) levels to near   |                         |
|                      |               |           |                                |                       |                     | The activity of the extract at dose of   |                         |
|                      |               |           |                                |                       |                     | 400 mg/kg was approximately  | 2014                    |
|                      |               |           |                                |                       |                     | comparable to the standard drug,   | Cheedella               |
|                      |               |           |                                |                       |                     | silymarin (25 mg/kg, p.o.).  | Cheedella,              |
|                      |               |           |                                |                       |                     | the findings Flavo   |                         |
| Sida acuta           | Malvaceae.    | Whole     | Methanolic                     | Wistar                | Paracetamol         | Decrease in serum levels of glutamate  | Sreedevi et al.,        |
| Burm. f.             |               | plant and | extract                        | rats.                 |                     | pyruvate transaminase, glutamate   | 2009.                   |
|                      |               | Root      |                                |                       |                     | alkaline oxaloacetate transaminase,  |                         |
|                      |               |           |                                |                       |                     | alkaline phoaphatase and bilirubin.  |                         |
|                      |               |           |                                |                       |                     | extract shortened the <i>acuta</i> extract   |                         |
|                      |               |           |                                |                       |                     | shortened the duration of necrosis in  |                         |
|                      |               |           |                                |                       |                     | mice indicating itshepatoprotective  |                         |
|                      |               |           |                                |                       |                     | potential. Phenolic compound ferulic   |                         |
| Solanum              | Solanaceae    | Fruits    | Hydroalcoholi                  | Wistar                | CCL                 | Mark reduction in serum  | Subash <i>et al</i>     |
| nigrum Linn.         | Boluliaceae   | Tuno      | c extract.                     | albino rats.          | 0.014               | ALT, AST and bilirubin and increase in   | 2011.                   |
| _                    |               |           |                                |                       |                     | antioxidant activity enzymes SOD,  |                         |
|                      |               |           |                                |                       |                     | GSH were increased.  |                         |
|                      |               |           |                                |                       |                     | provides favourable result.  |                         |
| Solanum              | Solanaceae    | Fruits.   | Ethanolic                      | Spargue               | CCl <sub>4</sub>    | Significant reduction in biochemical   | Gupta <i>et al.</i> ,   |
| xanthocarpu          |               |           | extract 100,                   | Dawley                |                     | parameters AST, ALT, ALP, total  | 2011.                   |
| <i>m</i> Schrad and  |               |           | 200 and 400                    | rats.                 |                     | bilirubin. Antioxidant enzyme markers  |                         |
| Wendl.               |               |           | mg/kg b. wt.                   |                       |                     | increased GSH, SOD, CAT etc.   |                         |
|                      |               |           |                                |                       |                     | favourable results.  |                         |
| Tephrosia            | Fabaceae.     | Aerial    | Aqueous,                       | Albino rats           | Thioacetamid        | Oral administration of Tephrosia   | Khatri et al.,          |
| prupurea             |               | parts.    | ethanolic                      |                       | e.                  | purpurea at 500mg/kg dose resulted in  | 2009                    |
| Lin <i>n</i> .       |               |           | extract 100, $300 \& 500 mg/k$ |                       |                     | a significant reduction in serum   |                         |
|                      |               |           | g.                             |                       |                     | amino trasaminase, gamma glutamyl  |                         |
|                      |               |           | 0                              |                       |                     | trasnpeptidase alkaline phosphatase,   |                         |
|                      |               |           |                                |                       |                     | total bilirubin and liver MDA levels   |                         |
|                      |               |           |                                |                       |                     | and significant improvement in liver   |                         |
|                      |               |           |                                |                       |                     | section of the animal treated with   |                         |
|                      |               |           |                                |                       |                     | extracts also showed dose dependent  |                         |
|                      | -             |           |                                |                       |                     | reduction of necrosis.   |                         |
| Terminalia           | Combretaceae. | Bark.     | Aqueous                        | Female                | Isoniazid 100       | Significant reduction in serum elevated  | Doorika and             |
| (Roxb.)              |               |           | mg/kg b.wt.                    | aiomo rais.           | mg∕kg b.wt.         | SGOT, SGPT and increased level of  | Ananuni, 2012.          |
| Wight & Arn.         |               |           |                                |                       |                     | SOD and GSH. The hepatoprotective  |                         |
| _                    |               |           |                                |                       |                     | activity of aqueous extract may be due   |                         |
|                      |               |           |                                |                       |                     | to antioxidant principles in it.   |                         |
|                      |               |           |                                |                       |                     | tanning, phenolics compound quinone  |                         |
|                      |               |           |                                |                       |                     | terpinoids, sugar, alkaloids and   |                         |
|                      |               |           |                                |                       |                     | flavonoids. alkaloids and flavonoids   |                         |
|                      |               |           |                                |                       |                     | phenolics, quinine, terpenoids sugar,  |                         |
| Ternminalia          | Combretaceac  | Leaver    | 1%mm                           | Male                  | Paracetemol         | alkaloids and flavonoids.  | Vidva at al             |
| chebula Retz.        | Comoretaceae. | Leaves.   | accacia                        | wistar rats.          | 1 aracetainoi       | elevated biochemical parameters  | 2011.                   |
|                      |               |           | suspension of                  |                       |                     | SGOT, SGPT, ALP, bilirubin (total and  |                         |
|                      |               |           | leaves                         |                       |                     | direct) cholesterol, triglycerides and   |                         |

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|  |                     |                  | 300mg/kg.p.o.   |                          |                    | lipid peroxidation and increase in GSH.<br>Histopathplogical findings were also<br>supportive.   |                                   |
|--|---------------------|------------------|---|--------------------------|--------------------|--|-----------------------------------|
| <i>Tinospora</i><br><i>cordifolia</i><br>Willed.)Miers<br>ex. Hk. f &<br>Th. | Manispermacea<br>e. | Aerial<br>parts. | Aqueous<br>extract 1-<br>2ml/100g.                                | Wistar<br>albino<br>rats | CCl <sub>4</sub> . | Biochemical parameters ALT, ALP and<br>total bilirubin are decreased to near<br>normal level in experimental rats.   | Kumar <i>et al.</i> ,<br>2013.    |
| Tridex<br>procumbens<br>Linn.  | Asteraceae.         | Aerial<br>parts. | Chloroform<br>insoluble<br>fraction from<br>ethanolic<br>extract. | Rats.                    | d-Gal-N<br>/LPS.   | Pretreatment altered increase in the<br>activities of marker enzymes AST,<br>ALT, ALP, LDH and gamma glutamyl<br>tranferase and bilirubin level in serum<br>and lipid.           | Vilwanathan <i>et al.</i> , 2005. |
| Vitex<br>negundo<br>Linn.  | Verbenaceae         | Leaves.          | Ethanolic<br>extract<br>300mg/kg.                                 | Rats.                    | Paracetamol.       | Significant reduction in serum enzymes<br>ALT, AST, ALP. The histopathological<br>result also shows protective action.   | Ladda <i>et al.</i> ,<br>2011.    |
| Withania<br>frutescents<br>Linn.   | Solanaceae.         | Leaves.          | Ethanolic<br>extract.   | Rat or<br>mice.          | CCl <sub>4</sub>   | Alteration in the modification of<br>Nembutal-induced sleep, bile flow,<br>serum trasaminase and hepatic fatty<br>acids levels and histopathological<br>studies.                 | Montilla <i>et al.</i> ,<br>1990. |
| Zingiber<br>officinale<br>Rosc.  | Zingiberaceac.      | Rhizome.         | Ethanolic<br>extract<br>of essential oil.                         | Rats.                    | CCl <sub>4</sub>   | Lowered the elevation of ALT, ALP,<br>AST, LDH, SDH and GDH/direct<br>bilirubin level in dose dependent<br>manner. Histopathological studies also<br>provide favourable results. | Yemitan and<br>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).