Lepidium sativum may be used to down-regulate pro-inflammatory cytokines such as TNF-α and IL-6, and up-regulate anti-inflammatory cytokines like IL-10. This can inhibit NF-κB activity, reduce oxidative stress markers such as MPO content, and alleviate MPO content. It also reduces TBARS levels, ALP, ALT, γ-GT, and bilirubin, while increasing SOD, GSH, and CAT levels. Moreover, Lepidium sativum can inhibit the expression of iNOS mRNA and induce the expression of bcl-2 and caspase-3, which can reduce AST, ALP, ALT, γ-GT, and bilirubin levels.
Advances in hepatoprotective medicinal plants research

Muhammad Imran Qadir and Zara Ahmad

Institute of Molecular Biology & Biotechnology, Bahauddin Zakariya University, Multan, Pakistan.

Abstract

Hepatic dysfunction is a major catastrophe that challenges the health concern researchers. Multiple factors such as biological, chemical and drug overdose are associated with liver disorders. Man-made pharmaceutical preparations, which are usually used for the treatment, further accelerate the toxification of the liver. In this situation, a great reliance has been evident on natural products which seem promising in dealing with liver diseases effectively. Plants are the basis of innate products, or dynamic constituents named as phytochemicals, which have been analyzed for their hepatoprotective potential and a review article on hepatoprotective plants was published in 2014 in Bangladesh Journal of Pharmacology. After that, a number of researches have been completed to identify new hepatoprotective medicinal plants. The purpose of this review was to update the information until now.

Introduction

Different medicinal plants are used for the protection and treatment of liver diseases and a review article on hepatoprotective plants was published in 2014 (Saleem and Naseer, 2014). After that, a number of researches have been completed to identify new hepatoprotective medicinal plants. The purpose of this review was to update the information regarding medicinal plants used in the protection and treatment of liver diseases, until now.

Liver Diseases

The liver is one of the most rudimentary organs that engage in the biotransformation of nutrients; provide protection to the body against foreign agents, detoxification as well as the excretion of drugs and xenobiotics from the body (Sagar et al., 2014). Thus, it is requisite to protract liver strength for overall body’s health and safety. Unluckily, environmental toxins, meager eating habits, alcohol and over-the-counter drug use are recurrent ill-treatments which can weaken the liver (Murugian et al., 2008). National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC) considered chronic liver disease and cirrhosis; as the 12th foremost basis of death which are asserting 30,000 lives in the United States per year (Gupta et al., 2015).

Liver diseases possibly classified as inflammatory liver diseases (acute/chronic hepatitis), non-inflammatory diseases (hepatosis) and liver fibrosis (also called cirrhosis) (Asadi-Samani et al., 2015). The main cause of pathogenesis of liver injury is the involvement of a deadly agent or the bio-activation of free radicals that elicits an immune response or protein dysfunction, lipid peroxidation, DNA damage, oxidative stress and depletion of reduced glutathione (Bedi et al., 2016). All liver cells including hepatocytes, kupffer and endothelial cells are involved in the pathogenesis of hepatic injury by programmed cell death, necrosis, ischemia and renewal, leading to tainted gene expression. Jaundice, hepatomegaly, hepatic encephalopathy, cirrhosis and obtrusive jaundice are well-known liver disorders (Saleem and Naseer, 2014). Liver damage can be caused by many factors such as biological, autoimmune diseases, some drugs e.g. high dosage of paracetamol, antitubercular drugs, lethal compounds (such as carbon...
Medicinal Plants to Treat Liver Disease

It is a challenge to find the ways of treatment for the common liver diseases. Although, there is best incompatibility among effectiveness of treatment such as colchicine, corticosteroid, interferon and penicillamine but the incidence of adverse effect is severe (Jain et al., 2013). For the management of hepatic diseases, there is a need to innovate alternative pharmaceuticals having more effectiveness and less toxicity. Chiefly, about 80% of the world’s population has employed plant material as traditional medication for health care. A variety of chemical compounds such as coumarins, essential oils, glycosides, carotenoids, organic acids, alkaloids, lignin’s, phenols, xanthenes, flavonoids and monoterpenes are present in the plant as well as fruits for liver protection (Madrigal-Santillan et al., 2014). Many fields such as botany, chemistry, biotechnology, pharmacognosy and pharmacology are doing a massive effort on herbal remedies using statistical methods to assess the reliability of claims (Roy et al., 2014). Although numerous herbal medicines have universal status significantly but there are some limiting factors behind their usage including inconsistency of the herbal drugs, lack of recognition of active constituents, randomized controlled tentative trials, and lack of toxicological review (Saleem et al., 2010). Besides all the above-mentioned restrictions, the researchers are probing some valuable treatments for the liver disorders. Plant-derived natural products and herbs have gained significant considerations in recent years due to their various pharmacological properties; anti-oxidant, anti-inflammatory, etc for hepatoprotective effect. Some examples of medicinal plants with hepatoprotective effect through different mechanisms are explained here briefly:

Berberis aristata, belongs to family the Berberidaceae has hepatoprotective activity against carbon tetrachloride-induced hepatic damage by inhibiting lipid peroxidation. Plant bark extract (at a dose of 100 and 300 mg/kg) inhibits the hepatic damage by decreasing the AST, ALT, ALP and bilirubin (total and direct) which increased after carbon tetrachloride administration (Rathi et al., 2015).

Boerhaavia diffusa (at a dose of 250 and 500 mg/kg) prevents the hepatic cells death and lipid peroxidation by free radical scavenging activity and has a stimulatory effect on hepatic regeneration against carbon tetrachloride-induced hepatotoxicity. It also decreases the serum levels of alanine transferases, aspartate transferases, alkaline phosphatase, total serum bilirubin and serum proteins which significantly increased after carbon tetrachloride administration (Beedimani and Jeevangi, 2015).

Canna indica is effective against hepatic necrosis and NAPl-mediated paracetamol-induced hepatic damage. The plant rhizome extract exerts an inhibitory effect on hepatocytes necrosis by hepatocytes regeneration, decreased serum alanine transaminase and shows anti-inflammatory activity against NAPQl mediated paracetamol poisoning (Longo et al., 2015).

Mangifera indica (mango) belonging to family Anarcardiaceae and has hepatoprotective action by anti-oxidative and anti-lipoperoxidative mechanisms. Mangifera indica aqueous stem bark extract at dose of 150-500 mg/kg has hepatoprotective activity against carbon tetrachloride-induced hepatic necrosis via inhibiting increased level of serum aminotransferases, alkaline phosphatase, bilirubin (total and conjugated), fasting blood glucose and malondialdehyde and by increasing total protein, albumin, total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), superoxide dismutase, reduced glutathione (GSH) and catalase activity which might attributed to anti-oxidant and anti-lipoperoxidative potential (Adeneye et al., 2015).

The crude powder of Mimos pubis prevents liver cell necrosis and lysosomal latency by normalizing serum biochemical parameters against carbon tetrachloride-induced hepatotoxicity (Kumaresan et al., 2015).

Juice of Ananas comosus (family Bromeliaceae), commonly known as pineapple, has liver protective action (Mohamad et al., 2015) by controlling different protein expression, anti-oxidant levels and liver marker enzymes against paracetamol-induced toxicity. Fruit seeds of Cassia fistula (golden shower tree of family Fabaceae) have protective potential against hepatotoxins-induced liver damage and have non-significant effect on hematological parameters (Iqbal et
2016). Figure 1 has presented hepatoprotective action of *Lepidium sativum* (known as garden cress) belongs to family Crucifereae by up-regulating and down-regulating the enzymes, inflammatory genes expression, serum biochemical markers etc (Raish et al., 2016). Plant seeds extract mitigate hepatic injury and structural damage via inhibiting oxidative stress. Numerous plants have been reported against hepatic damage because of their role in hepatic gene regulation. For example, *Panax ginseng* belongs to family Araliaceae also named as ‘ginseng’. Roots of ginseng inhibit toxin-induced hepatic damage by decreasing vital genes expression which is essential for normal liver functions (Hafez et al., 2017) as shown in Figure 2.

In Table I, different medicinal plants, fruits, and herbs,

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**Figure 1:** D-GalN/LPS (D-galactosamine/lipopolysaccharides) decrease oxidative stress marker enzymes and albumin. *Lepidium sativum* ethanolic extract has shown hepatoprotective activity by decreasing AST (aspartate aminotransferase), ALP (alkaline phosphatase), ALT (alanine aminotransferase), γ-GT (gamma glutamyl transerase) and bilirubin, inhibiting NF-κB activity, alleviating MPO (myeloperoxidase) content, reducing TBARS (thiobarbituric acid reactive substance), down-regulating IL-6 (interleukin-6), TNF-α (tumor necrosis factor), caspase-3, INOS and HO-1, up-regulating IL-10 (interleukin-10) and bcl-2 expression.

**Figure 2:** *Panax ginseng* has shown anti-fibrosis effect via TGF-β1 signaling pathway in CCl4 induced liver fibrosis model. The administration of ginseng in combination with CCl4 significantly decreased the expression of TGF-β1, its receptors, Smad2, Smad3, Smad4, MMP2, MMP9, TIMP1, Col1α2, Col3α1, IL-10, IL-8, expression.
| Plants with common name                          | Parts used    | Extract     | Hepatotoxic agent | Model         | Results                                                                 | References                      |
|-------------------------------------------------|---------------|-------------|-------------------|---------------|-------------------------------------------------------------------------|---------------------------------|
| Acantholimon gilliati                           | Aerial part   | Methanol    | Formaldehyde      | Mouse         | ↓AST, ALT, ALP                                                           | Lashgari et al., 2017           |
| Acrocarpus fraxinifolius (Shingle tree)         | Leaf          | n-Hexane    | Paracetamol       | Rat           | ↓AST, ALT, ALP, lipid, bilirubin, LPO                                     | Abd El-Ghffar et al., 2017      |
| Acalypha indica and Centella asiatica (Centella) | Leaf, whole plant | Methanol    | Hypoxia           | Rat           | ↓MDA, prevention from hypoxia                                           | Dwijayanti et al., 2015         |
| Adansonia digitata (Baobab tree)                | Fruit pulp    | Methanol    | Paracetamol       | Rat           | ↓AST, ALT, ALP, MDA                                                      | Hanafy et al., 2016             |
| Aloe vera (Ghee gangwar)                        | Stem          | Ethanol     | Paracetamol       | Rat           | ↓AST, ALT, SALP, bilirubin                                               | Hena et al., 2016               |
| Ananas comosus (Pineapple)                      | Fruit         | No extract  | Paracetamol       | Male mouse    | ↓AST, ALT, ALP, TG, restored SOD, SH, LPO, FRAP, INF, NO, INOS and liver p450 protein expression | Mohamad et al., 2015            |
| Andrographis alata (Justicia alata)             | Leaf          | Aqueous     | Carbon tetrachloride | Rat           | ↓AST, ALT Prevents histopathological changes                             | Nagaraja and Krishna, 2016      |
| Annona muricata (Soursop)                       | Leaf          | Ethanol     | No                 | Rat           | ↓body wt, ↓AST, ALT, ALP                                               | Okoye et al., 2016              |
| Aquilaria agallocha (Agarwood)                  | Leaf          | Ethanol     | Paracetamol       | Rat           | ↓AST, ALT, ALP, LDH, CHL, bilirubin, relative liver wt, ↑final body wt, SP | Alam et al., 2017               |
| Artemisia absinthium (Sweet wormwood)           | Aerial part   | Alcohol     | No                 | Rat           | ↓AST, ALT, TTG Non-significant ↓ in TAP                                  | Mohammadian et al., 2016        |
| Artemisia capillaries (Yin Chen Hao)            | Oil           | No extract  | Carbon tetrachloride | Mouse         | ↓AST, ALT, MDA Prevent decrease in SOD, GSH, GSH-Px                       | Gao et al., 2016                |
| Artemisia dracunculus (Tarragon)                | Leaf          | Ethanol     | Carbon tetrachloride | Rat           | ↓AST, ALT, ALP, bilirubin                                                | Sultana and Ahmed, 2017         |
| Azadirachta indica (Neem)                       | Leaf          | Aqueous     | Paracetamol       | Rat           | ↓AST, ALT, ALP +Vitamin C & E in liver homogenate                         | Nwobodo et al., 2016            |
| Bauhinia purpurea (Purple bauhinia)             | Leaf          | Methanol    | Paracetamol       | Rat           | ↓AST, ALT, LDH, ↓liver/body wt ratio                                      | Zakaria et al., 2016            |
| Berberis aristata (Chithra)                     | Stem bark     | Ethanol     | Carbon tetrachloride | Rat           | ↓AST, ALT, ALP, bilirubin                                                | Rath et al., 2015               |
| Bidens pilosa (Blackjack)                       | Aerial part   | Methanol    | Carbon tetrachloride D-galactosamine | Mouse         | ↓ALT, AST, ALP, ↑SP, GSH                                                   | Abdel-Chany et al., 2016        |
| Boerhaavia diffusa (Punarnava)                  | Root          | Aqueous     | Carbon tetrachloride | Rat           | ↓GGTP, ALT, bilirubin                                                    | Beedimani and Jeevangi, 2015    |
| Brassica oleracea var. capitate f. alba (White cabbage) | Aerial part (oil) | No extract  | Carbon tetrachloride | Rat           | Prevents glycogen depletion                                              | Morales-López et al., 2017      |
| Plants with common name       | Parts used | Extract     | Hepatotoxic agent | Model | Results                                                                 | References          |
|-------------------------------|------------|-------------|-------------------|-------|-------------------------------------------------------------------------|---------------------|
| *Butea monosperma* (Parrot tree) | Bark       | Ethyl acetate | Thioacetamide     | Rat   | Stabilized AST, ALT, ALB, ALP, SOD, CAT, GSH, GR Restored collagen and hydroxyproline levels ↓ expression of p-P13K, p-Akt, p-mTOR | Kaur et al., 2017   |
| *Caesalpinia bonduc* (Grey nicker) | Leaf       | Ethanol     | Carbon tetrachloride | Rat   | ↓AST, ALT, ALP, bilirubin, MDA ↑TP, CAT, GSH-Px                      | Ubhenin et al., 2016|
| *Caesalpinia gilliesii* (Yellow bird of paradise) | Flower     | Dichloromethane | Carbon tetrachloride | Rat   | ↓AST, ALT ↑GSH                                                       | Osman et al., 2016  |
| *Canna indica* (Achira)  | Rhi-zome  | Aqueous      | Paracetamol       | Rat   | Normalized rat behavior, ↓relative liver wt and ALT                      | Longo et al., 2015  |
| *Cansecora decussate* (Shankkpushpi) | Whole plant | Methanol    | Paracetamol       | Rabbit | ↑AST, ALT, ALP, bilirubin                                                | Akhtar et al., 2015 |
| *Carica papaya* (Papaya/pawpaw) | Leaf, Unripe fruit | Aqueous | Carbon tetrachloride Paracetamol | Rat   | ↓AST, ALT, ALP, bilirubin, UA, MDA ↑GSH, SOD, CAT                       | Awodele et al., 2016 |
| *Cassia fistula* (Golden shower tree) | Fruit seed | Methanol | No | Chick | ↓AST, ALT, ALP, urea, CRE ↑plasma protein                               | Iqbal et al., 2016  |
| *Cassia tora* (Coffee cassia) | Leaf       | Methanol    | Carbon tetrachloride | Rat   | ↑TP, ALB, GSH ↓AST, ALT, ACP, ALT, AST, MDA                               | Saravanan and Malarvannan, 2016 |
| *Centratherum anthelminticum* (Banjira) | Seed       | Ethanol     | Carbon tetrachloride | Rat   | ↓AST, ALP ALT, IBR, bilirubin, UA ↑TP, ALB ↓in %inhibition of SOD, CAT, GSH | Qureshi et al., 2016 |
| *Ceriops decandra* (Mangrove plant) | Leaf, Bark, Collar, Hypocotyl, Flower | Petroleum ether, ethanol | Carbon tetrachloride | Rat   | ↓AST, ALP, BR, CHL, LDH ↓TPN, ALB                                       | Gnanadesigan et al., 2016 |
| *Citrus macroptera* (Satkara/wild orange) | Fruit       | Ethanol    | Paracetamol       | Rat   | ↓ALT, GGT, LDH, AST, ALP, TB, TG, TC Improved serum CRE, urea, UA, Na+, K+, Cl- ↑MDA | Paul et al., 2016  |
| *Coreopsis tinctoria* (Golden tickseed) | Flowers   | Ethanol    | Carbon tetrachloride | Rat   | ↓ALT, AST, MDA, NO, TNF-α, IL-6, IL-1β ↑Grd, SOD, GSH-Px              | Tsai et al., 2017   |
| *Coriandrum sativum* (Coriander) | Fruit       | No extract | Ibuprofen        | Rat   | ↓ALT, AST                                                              | Baghdadi et al., 2016 |
| *Crocus sativus* (Saffron) | Dried red stigmas | Ethanol | Amiodarone        | Male rabbit | ↓ALT, ALP, AST, LDH, BR, UA, Na+ ↑ALB synthesis                  | Saleem et al., 2016  |
| Plants with common name | Parts used | Extract | Hepatotoxic agent | Model | Results | References |
|------------------------|-----------|---------|-------------------|-------|---------|------------|
| Cucumis sativus (Cucumber) | Juice | No extract | Lead | Rat | Pb detoxification, positive effect on RBCs count and food intake | Bajpai et al., 2017 |
| Cymbopogon citratus (Lemon grass) | Whole plant | Aqueous | Paracetamol | Rat | ↓AST, ALT, MDA, BUN, CRE↑GSH (liver) | Saenthaweesuk et al., 2017 |
| Eclipta alba (Bhangra) | Leaf | Aqueous | Carbon tetrachloride | Rat | ↓ALT, AST, ALP, SB↑SP | Beedimani and Shetkar, 2015 |
| Elettaria cardamomum (True cardamom) | Seed | Aqueous | Gentamicin | Rat | ↓AST, ALT, BR, CHL, TG, LDL-C↑SB, HDL-C | Aboubakr and Abdelazem, 2016 |
| Eriocaulon quinquangulare (Eriocaulon sp Australia Red) | Whole plant | Aqueous | Ethanol | Porcine liver slices | ↓ALT, AST, LDH↑Lipid peroxidation | Fernando and Soysa, 2016 |
| Ferulago angulata (Chavir) | Flower | Methanol | N-nitroso-dimethylamine | Rat | ↓SOD, CAT, GSH-Px↑Liver hyperemic | Kiziltas et al., 2017 |
| Ficus religiosa (Peepal tree) | Latex | Methanol, petroleum ether | Cisplatin | Rat | ↓ALT, AST, ALP | Yadav, 2015 |
| Fragaria ananassa (Garden strawberry) | Juice | No extract | Carbon tetrachloride | Rat | ↓AST, ALT, TBARS, nitrate, ↑GSH, SOD, CAT, GPx expression↑anti-apoptotic protein Bcl2↓pro apoptotic proteins bax, caspase-3 | Hamed et al., 2016 |
| Gentianella turkestanerum | Whole plant | GPE, GEA, GBA, GW | Carbon tetrachloride | Male mouse | ↓ALT, AST, ALP, TB, GSH, CAT, SOD, MDA↑TP | Yang et al., 2017 |
| Helicantlius elastica (Mango Mistletoe) | Whole plant | Ethanol | Paracetamol | Mouse | ↓AST, ALT↑ALPase activity↑Serum TB↑Serum TP | Kumar et al., 2016 |
| Grapefruit Lemon Orange (Hesperidin) | No | No extract | Carbon tetrachloride | Rat | ↑GSH, CAT, SOD↑TBARS synthesis, Reduced caspase-3 activation | Çetin et al., 2016 |
| Holostemma ada-kodien (Holostemma creeper) | Whole plant | Alcohol | Paracetamol | Rat | ↓ALT, ASP, ALP, SB, MDA↑GSH | Sunil et al., 2015 |
| Homalium leteului (Makoli) | Stem | Ethanol | Paracetamol | Rat | ↓ALT, AST, ALP, bilirubin↑CAT, SOD, GPx, GSH, TP, ALB, hematological parameters | Okokon et al., 2017 |
| Indocalamus latifolius | Whole plant | Ethanol | Carbon tetrachloride | Rat | ↓ALT, AST, ALP | Tan et al, 2015 |
| Plants with common name                      | Parts used | Extract   | Hepatotoxic agent | Model | Results | References       |
|---------------------------------------------|------------|-----------|-------------------|-------|---------|------------------|
| Juniperus communis (Juniper)                | Leaf       | Ethanol   | Paracetamol       | Rat   | ↓ALT, AST, ALP, bilirubin | Ved et al., 2017 |
| Lagerstroemia speciosa (Queen’s flower)    | Flower     | Ethanol   | Carbon tetrachloride | Mouse | ↓ACP, ALT, AST, ALP, MDA ↑ in %inhibition of LPO, CAT, GSH | Tiwary et al., 2017 |
| Lepidium sativum (Garden cress)            | Seed       | Ethanol   | D-galactosamine/Lipo polysaccharides | Rat | Down regulate TNF-α, IL-6, HO-1, iNOS, m-RNA expression Up-regulate IL-10, mitigate MPO, NF-kB | Raish et al., 2016 |
| Lawsonia inermis (Henna)                   | Leaf       | Methanol  | Carbon tetrachloride | Rat   | ↑AST, ALT, ALP, bilirubin Hepatocytes regeneration | Mohamed et al., 2016 |
| Mammea africana (African mammee apple)     | Stem bark  | Ethanol   | Paracetamol       | Rat   | ↑TP, ALB, SOD, CAT, GPx, GSH | Okokon et al., 2016 |
| Mangifera indica (Mango)                   | Stem bark  | Aqueous   | Carbon tetrachloride | Rat   | ↑ALT, AST, ALP, FBG, TB, CB, LDL-C, MDA ↑TC, TG, HDL-C, TP, ALB ↑SOD, CAT, GSH (liver) | Adeneye et al., 2015 |
| Melothria perpusilla (Lamthabi)            | Aerial parts | Aqueous | Carbon tetrachloride | Rat   | ↑ALT, AST, ALP, bilirubin | Yengkhom et al., 2017 |
| Mimosa pudica (Touch-me-not)               | Whole plant | Crude extract | Carbon tetrachloride plus paraffin | Rat | ↑AST, ALT, SB, MDA (serum and tissue), γ-GT, ALP, ACP | Kumaresan et al., 2015 |
| Monotheca buxifolia                       | Fruit      | Ethanol   | Isoniazid plusrifampicin | Rat | Restored ALT, AST, ALP, SP, bilirubin | Ullah et al., 2016 |
| Moringa peregrina (Ben tree)               | Leaf       | Ethanol   | Paracetamol       | Rat   | Suppress MDA Normalize G-Px ↑GSH, CAT, SOD ↑DNA fragmentation | Azim et al., 2017 |
| Moringa oleifera (Sohanja)                 | Leaf       | Gum acasia plus alcohol | Cadmium | Rat | ↑AST, ALT, ALP, LPO ↑SOD | Toppo et al., 2015 |
| Morus indica (Mulberry)                    | Leaf       | Aqueous and dechlorophyllised | Carbon tetrachloride | Rat | ↑AST, ALT, ALP, TG, LPO ↑SP, GSH | Reddy and Urooj, 2017 |
| Murraya koenigii (Curry tree)              | Leaf       | Ethanol   | Carbon tetrachloride and paracetamol | Rat | ↑AST, ALP, ALT, LPO ↑SOD, CAT, GSH | Sangale and Patil, 2017 |
| Nymphaea lotus (White water lily)          | Whole plant | Methanol   | Carbon tetrachloride | Rat | ↑AST, ALT, bilirubin, TBARS (liver) ↑GSH, GSH-Px | Oyeyemi et al., 2017 |
| Opuntia monacantha (Chnutarhar)            | Whole plant | Methanol, chloroform | Paracetamol | Rabbit | ↑AST, ALT, ALP, bilirubin | Saleem et al., 2015 |
| Plants with common name                        | Parts used  | Extract  | Hepatotoxic agent | Model    | Results                                                                 | References                                      |
|-----------------------------------------------|-------------|----------|-------------------|----------|-------------------------------------------------------------------------|-----------------------------------------------|
| *Opuntia robusta* (Wheel cactus) and *Opuntia streptacantha* (Prickly pear cactus) | Fruits (juice) | No extract | Paracetamol       | Rat      | ↓AST, ALT, ALP, LDH leakage and cell necrosis, Prevent GSH (liver) depletion | González-Ponce et al., 2016                   |
| *Otostegia persica* (Goldar)                  | Aerial parts | Ethanol  | Carbon tetrachloride | Rat      | ↓AST, ALT, ALP, bilirubin, MDA ↑SP                                      | Toori et al., 2015                            |
| *Oudemansiella radicata* (Mushroom/ Rooting shank fungus) | Dried fruiting bodies | Ethanol  | Carbon tetrachloride | Mouse    | ↓AST, ALT MDA (liver) suppression, ↑SOD, GSH-Px Prevent ↑ in liver wt, ↓Lipid droplet accumulation | Liu et al., 2017                              |
| *Oxalis stricta* (Pickle plant)               | Whole plant | Ethanol  | Paracetamol       | Rat      | Prevent GSH depletion ↓lipid peroxidation, AST, ALT, ALP, bilirubin     | Patel et al., 2016                            |
| *Panax ginseng* (Ginseng)                     | Root        | Aqueous  | Carbon tetrachloride | Rat      | ↓Hepatic fat, reticular fiber deposition, ↓AST, ALT, LDL, TGF-β, Smad2, Smad3, Smad4, MMP2, MMP9, TIMP-1, Col1α2, Col3α1, Restored IL-8, IL-10 | Hafez et al., 2017                            |
| *Pandanus odoratissimus* (Umbrella tree)      | Root        | Ethanol  | Paracetamol       | Rat      | ↓AST, ALT, ALP, bilirubin, TG                                           | Mishra et al., 2015                            |
| *Picralima nitida* (Abeere)                   | Seed        | Methanol | Carbon tetrachloride | Rat      | ↑CAT, GSH ↓ALT, AST, ALP, bilirubin                                     | MacDonald et al., 2016                        |
| *Piper triosicum*                             | Aerial part | Ethanol  | Carbon tetrachloride | Rat      | ↓AST, ALT, bilirubin, MDA ↑TP, SOD, CAT, GPx                            | Lakshmi et al., 2016                          |
| *Phyllanthus emblica* (Amla)                  | Bark        | Alcohol  | Ethanol           | Rat      | Restored ALT, AST, ALP, SP                                              | Chaphalkar et al., 2017                       |
| *Prunus armeniaca* (Apricot)                  | Leaf        | Methanol | Paracetamol       | Rat      | ↓AST, ALT, SALP, TBARS, GGT, LDH, SP, SB, ALB                            | Raj et al., 2016                               |
| *Pongamia pinnata* (Indian beech tree)        | Leaf        | Ethanol  | Paracetamol       | Rat      | ↓ALT, AST, ALP, GT, SP, bilirubin ↑SOD, CAT, GPx                         | Rajeshkumar and Kalyavizhi, 2015              |
| *Pterospermum acerifolium* (Karnikara tree)   | Leaf        | Petroleum ether, alcohol | Paracetamol | Rat      | ↑ALT, AST, ALP, LPO ↑GSH, SOD, CAT                                       | George et al., 2016                           |
| *Randia dumerorum* (Emetic nut)               | Leaf        | Methanol | Carbon tetrachloride | Rat      | ↓AST, ALT, ALP, LDH, ALB, TB, DB, TBARS, TNF-α, IL-1β ↑TP, SOD, CAT, GSH | Kandimalla et al., 2016                       |
| *Rosa canina* (Dog-rose)                      | Fruit       | Ethanol  | Carbon tetrachloride | Rat      | ↓AST, ALT, ALP, MDA ↑SP                                                  | Sadeghi et al., 2016                          |
| *Salix subserrata* (Flute willow)             | Flower      | Ethanol  | Carbon tetrachloride | Rat      | ↓AST, ALT, ALP, LDH, S-chol, TG, MDA, bilirubin, expression of TNF-α, NF-κβ ↑SP, GSH | Wahid et al., 2016                            |
| *Sapium sebiferum*                            | Leaf        | Methanol | Paracetamol       | Mouse    | ↓AST, ALT, ALP, bilirubin                                                | Hussain et al., 2015                          |
### Table I
Medicinal plants having hepatoprotective potential (Cont.)

| Plants with common name | Parts used | Extract        | Hepatotoxic agent | Model | Results                                      | References           |
|-------------------------|------------|----------------|-------------------|-------|----------------------------------------------|----------------------|
| Simarouba glauca (Paradise tree) | Leaf       | Ethanol and chloroform | Paracetamol       | Rat   | ↓AST, ALT, ALP                               | John et al., 2016    |
| Solanum melongena (Eggplant) | Ripe fruit | Methanol        | Carbon tetrachloride | Rat   | ↓AST, ALT, ALP, MDA, SOD, CAT                | Hamzah et al., 2016  |
| Solanum nigrum (Black nightshade) | Aerial parts | Aqueous        | Carbon tetrachloride | Rat   | ↓ALT, ALP, bilirubin                        | Goyal and Sharma, 2016 |
| Sonchus asper            | Whole plant |               | Paracetamol       | Rabbit | ↓ALT, ALP, bilirubin, necrosis              | Aftab-Ullah et al., 2015 |
| Sphaeranthus anarrathi (Sivakaranthai and Oldenlandia umbellate (Chay root)) | Whole plant | Methanol        | Carbon tetrachloride | Rat   | ↓AST, ALT, ALP, bilirubin, necrosis         | De et al., 2017      |
| Syzygium cumini (Jamun)  | Seed       | Methanol        | Carbon tetrachloride | Rat   | ↓AST, ALT, Bit, ALP, SP                     | Islam et al., 2015   |
| Terminalia catappa (Sea almond tree) | Bark | Alcohol | Isoniazid | Rat   | ↓AST, ALT, ALP, bilirubin, SP               | Vahab and Harindran, 2016 |
| Tinospora cordifolia (Heart-leaved moonseed) | Aerial part | Aqueous        | Carbon tetrachloride | Rat   | ↓AST, ALT, ALP, bilirubin                   | Goyal and Kumar, 2016 |
| Valeriana wallichii (Mushkabala) | Root       | Aqueous        | Carbon tetrachloride | Rat   | ↓AST, ALT, ALP, GGT, Improved TG, MDA, necrosis | Syed et al., 2017   |
| Vernonia amygdalina (African bitter leaf) | Leaf | Ethanol       | Dimethyl nitrosamine | Rat   | ↓AST, ALT, ALP, GGT, SP                     | Usunobun et al. 2015 |
| Veronica ciliata (Dongdongsul) | Whole plant | Ethanol, petroleum ether | Paracetamol | Mouse | ↓SOD, GSH, ↓AST, ALT, MDA, TNF-α, NF-kβ | Tan et al., 2017     |
| Viola canescens (Banafsha) | Whole plant | Methanol, Ethyl acetate | Carbon tetrachloride | Mouse | ↓ALT, ALP, bilirubin, MDA, SP, CAT, SOD | Khan et al., 2017    |
| Zizyphus jujube cv. Huanghetaizao (Red date) | Whole plant | Ethanol | Carbon tetrachloride | Mouse | ↓AST, ALT, LDH, MDA, SOD, GSH-Px | Liu et al., 2015     |

Abbreviations: AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, ALP: Alkaline phosphatase, GSH: Reduced glutathione, GSH-Px: Glutathione peroxidase, CAT: Catalase, SOD: Superoxide dismutase, ROS: Reactive oxygen species, STP: Total protein, TB: Total bilirubin, CB: Conjugate bilirubin, SB: Serum bilirubin, DB: Direct bilirubin, TC: Triglyceride, MDA: Malondialdehyde, LDH: Lactate dehydrogenase, CCl₄: Tetra chloromethane/carbon tetrachloride, GGT: Gamma glutamyl transferase, LPO: Lipid peroxide, TC: Total cholesterol, TP: Total protein, ALB: Albumin, FBS: Fasting blood sugar, BUN: Blood urea nitrogen, UA: Uric acid, TBARS: Thiothriobarbituric acid reactive substance, LDL-c: Low density lipoprotein cholesterol, HDL-c: High density lipoprotein cholesterol, MPO: Myeloperoxidase, TPN: Total protein, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, TLC: Total leukocyte count, DLC: Differential leukocyte count, TAP: Total antioxidant power, TGF: Transforming growth factor beta, TIMP: Tissue inhibitor matrix metalloproteinase, CoIα2: Collagen Iα2, CoIα3: Collagen Iα3, Smad2: Mothers against decapentaplegic homologue 2, B.wt: Body weight, SP: Serum protein, HAC: Hepatic anti-oxidant capacity.
etc are compiled which have been reported for their hepatoprotective activity against various hepatotoxins.

Amiodarone causes hepatotoxicity with a characteristic prototype of enzyme turbulence. One study was reported on amiodarone-induced liver toxicity in rabbits. Gentamicin, an aminoglycoside antibiotic is used for treatment of bacterial infections. One of the side effects of gentamicin usage is its potential to induce hepatotoxicity. One study was performed on rat to examine the ameliorative effect of plant extract on gentamicin-mediated hepatotoxicity.

Among the entire listed plants, only a few severe toxicity studies were carried out. For example, _Acrocarpus fraxinifolius_ did not show any sign of toxicity up to oral dose of 250 and 500 mg/kg in rats (Abd El-Ghiffar et al., 2017) and ethanolic extract of _Pandanus odoratissimus_ at a particular dose, LD50 was found to be 3,000 mg/kg when injected in rats (Mishra et al., 2015).

Botanical plants have been used for anticipation and management of hepatic disorders due to the charisma of chemical constituents. For instance, polyphenolic compounds have an imperative function in alleviating lipid oxidation as well as anti-oxidant activity. Sigmassterol, β-sterol and flavonoids from _Acalypha indica_, phenol and triterpenoids from _Centella asiatica_ have provided defensive consequence in rat liver against hypoxia by means of lipid peroxidation (Dwijayanti et al., 2015). 70% Ethanolic extract of _Oxalis stricta_ has shown a higher concentration of polyphenolic components that was beneficial for therapy of liver disease by anti-lipoperoxidative activity (Patel et al., 2016). Phytochemical investigation of _Melothria perpusilla_ extract revealed the presence of flavonoids, tannins and steroids that has a role in ameliorating hepatic damage by anti-oxidant mechanisms (Yengkhom et al., 2017). Citrus species containing flavonoids also play a crucial role in plant defense scheme. Hesperidin, a bioflavonoid present in citrus fruits, has pharmacological properties and control hepatic cholesterol production via inhibiting the 3-hydroxy-3-methyl-glutaryl-CoA (HMG-CoA) reductase activity (Çetin et al., 2016). Fungal species have gained importance in the prevention of liver diseases.

Fruiting bodies of _Oudemansiella radicata_, an edible mushroom and belong to the family Physalacriaseae has hepatoprotective activity by anti-oxidant mechanisms attributed to heteropolysaccharides (mannose, glucose and galactose) prepared from the mushroom (Liu et al., 2017).

Heteropolysaccharides (arabinose and galactose) from _Zizyphus jujube_, commonly known as red date belongs to the family Rhamnaceae has been involved in liver protective activity via alleviating liver marker enzymes (Liu et al., 2015). Plants containing volatile or essential oils also are main pharmacological active compounds and confers positive effect from the medicinal point of view.

Essential oils of _Artemisia capillaries_ has been investigated against carbon tetrachloride-induced hepatotoxicity and has approved protective potential on liver histology, hepatic profile and serum profile (Gao et al., 2016). Anti-oxidant compounds play the significant role in liver protection.

_Phyllanthus emblica_, due to its anti-oxidant compounds like ellagic acid and gallic acid, has approved hepatoprotective activity in alcohol induce toxicity model (Chaphalkar et al., 2017). Liver protection is also associated with control of protein and gene expression.

_Fragaria ananassa_ (commonly called strawberry, family: Rosaceae) has anti-oxidant, anti-apoptotic and anti-fibrotic properties by gene expression regulation (Hamed et al., 2016)

**Conclusion**

This study signified the probable hepatoprotective effects of therapeutic plants. It can be concluded that plants have verified hepatoprotective potential which can be utilized in outlook to prepare valuable hepatoprotective drugs. There is still necessitating scrutinizing the hepatoprotective potential of plants on molecular stage so that authentic method of phytochemical action can be explored.

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Authors declare no conflict of interest

**References**

Abd El-Ghiffar EA, El-Nashar HA, Eldahshan OA, Singal ANB. GC-MS analysis and hepatoprotective activity of the n-hexane extract of _Acrocarpus fraxinifolius_ leaves against paracetamol-induced hepatotoxicity in male albino rats. Pharma Biol. 2017; 55: 441-49.

Abdel-Ghani RH, Barakat WM, Shabat AA, Abd-Allah WE-S, Ali EA. _In vitro_ and _in vivo_ hepatoprotective activity of extracts of aerial parts of _Bidens pilosa_ L. (Asteraceae). Trop J Pharma Res. 2016; 15: 2371-81.

Aboubakr M, Abdelazem AM. Hepatoprotective effect of aqueous extract cardamom against gentamicin-induced hepatic damage in rats. Int J Basic Appl Sci. 2016; 5: 1-4.

Aderene AA, Awodele O, Aiyela SA, Benebo AS. Modulatory potentials of the aqueous stem bark extract of _Mangifera_
indicata on tetrachloride-induced hepatotoxicity in rats. J Tradit Complement Med. 2015; 5: 106-15.

Aftab-Ullah, Ahmad M, Ahmad T, Naseer FN. Hepatoprotective activity of Sonchus asper in paracetamol-induced hepatic damage in rabbits. Bangladesh J Pharmacol. 2015; 10: 115.

Akhtar MS, Quyyum MI, Irshad N, Yaseen M, Hussain A, Altaf H, Saif-ur-Rehman, Suleman N. Hepatoprotective properties of methanolic extract of Canscori decusata (Schult) against paracetamol induced liver toxicity in rabbits. IJIAS. 2015; 10: 701-06.

Alam J, Mujahid M, Jahan Y, Bagga P, Rahman MA. Hepatoprotective potential of ethanolic extract of Aquilaria agallocha leaves against paracetamol induced hepatotoxicity in SD rats. J Tradit Complement Med. 2017; 7: 9-13.

Asadi-Samani M, Kafash-Farkhad N, Azimi N, Fasih A, Alinia -Ahandani E, Rafieian-Kopaei M. Medicinal plants with hepatoprotective activity in Iranian folk medicine. Asian Pac J Trop Biomed. 2015; 5: 146-57.

Awodele O, Yemitan O, Ise PU, Ikumawoyi VO. Modulatory potentials of aqueous leaf and unripe fruit extracts of Carica papaya Linn. (Caricaceae) against carbon tetrachloride and acetaminophen-induced hepatotoxicity in rats. J Intercult Ethnopharmacol. 2015; 5: 27-35.

Azim SAA, Abdelrahem MT, Said MM, Khattab A. Protective effect of Moringa peregrina leaves extract on acetaminophen-induced liver toxicity in albino rats. African J Tradit Complement Med. 2017; 14: 206-16.

Baghdadi HH, El-Demerdash FM, Radwan EH, Hussein S. The protective effect of Coriandrum sativum L. oil against liver toxicity induced by ibuprofen in rats. J Biosci Appl Res. 2016; 2: 197-202.

Bajpai VK, Kim J-E, Kang SC. Protective effect of heat-treated cucumber (Cucumis sativus L.) juice against lead-induced detoxification in rat model. Indian J Pharma Edu Res. 2017; 51: 59-69.

Bedi O, Bijjem KRV, Kumar P, Gauttam V. Herbal induced hepatoprotection and hepatotoxicity: A critical review. Indian J Physiol Pharmacol. 2016; 60: 6-21.

Beedimani RS, Jeevangi SK. Evaluation of hepatoprotective activity of Boerhaavia diffusa against carbon tetrachloride induced liver toxicity in albino rats. Int J Basic Clin Pharmacol. 2015; 4: 153-58.

Beedimani RS, Shethkar S. Hepatoprotective activity of Eclipta alba against carbon tetrachloride-induced liver toxicity in albino rats. Int J Basic Clin Pharmacol. 2015; 4: 404-09.

Çetin A, Çiftçi O, Otlu A. Protective effect of hesperidin on oxidative and histological liver damage following carbon tetrachloride administration in Wistar rats. Arch Med Sci. 2016; 12: 486-93.

Chaphalkar R, Apte KG, Talekar Y, Ojha SK, Nandave M. Anti-oxidants of Phyllanthus emblica L. bark extract provide hepatoprotection against ethanol-induced hepatic damage: A comparison with silymarin. Oxid Med Cell Longev. 2017; 2017.

Chaudhari NB, Chittam K, Patil V. Hepatoprotective activity of Cassia fistula seeds against paracetamol-induced hepatic injury in rats. Arch Pharm Sci Res. 2009; 1: 219-21.

De S, Suresh R, Babu AMSS, Aneela S. In-vitro hepatoprotective activity of methanolic extracts of Sphaeranthus indicus and Oldenlandia umbellate. Phcog. J. 2017; 9: 98-101.

Dwijiyaniti A, Fretherney A, Hardiandy NS, Purwaningsih EH. Hepatoprotective effects of Acalypha indica and Centella asiatica in rat's liver against hypoxia. Procedia Chem. 2015; 14: 11-14.

Fernando CD, Soysa P. Evaluation of hepatoprotective activity of Eriocaulon quinquangulare in vitro using porcine liver slices against ethanol induced liver toxicity and free radical scavenging capacity. BMC Complement Altern Med. 2016; 16: 74.

Gao Q, Zhao X, Yin L, Zhang Y, Wang B, Wu X, Zhang X, Fu X, Sun W. The essential oil of Artemisia capillaris protects against CCl4-induced liver injury in vivo. Rev Bras Farmacog. 2016; 26: 369-74.

George M, Joseph L, Deshwal N, Joseph J. Hepatoprotective activity of different extracts of Pterospermum acerifolium against paracetamol induced hepatotoxicity in albino rats. Pharm Innov J. 2016; 5: 32-6.

Gnanesigian M, Ravikumar S, Anand M. Hepatoprotective activity of Ceriops decandra (Griff.) Ding Hou mangrove plant against CCl4 induced liver damage. J Taibah Univ Sci. 2016.

González-Ponce HA, Martínez-Saldaña MC, Rincón-Sánchez AR, Sumaya-Martínez MT, Buist-Homan M, Faber KN, Moshage H, Jaramillo-Juárez F. Hepatoprotective effect of Opuntia robusta and Opuntia streptacantha fruits against acetaminophen-induced acute liver damage. Nutrients 2016; 8: 607.

Goyal YK, Kumar V. Exploration and comparison of hepatoprotective activity of aqueous extract of Tinospora cordifolia: An experimental study. IJSR. 2016; 5.

Goyal YK, Sharma A. Exploration of hepatoprotective activity of aqueous extract of Solanum nigrum. IJSR. 2016; 5.

Gupta R, Gupta A, Singh RL. Hepatoprotective activities of Triphala and its constituents. Int J Pharma Res Rev. 2015; 4: 34-55.

Hafez MM, Hamed SS, El-Khadragy MF, Hassan ZK, Al Rejaie SS, Sayed-Ahmed MM. Effect of ginseng extract on the TGF-β1 signaling pathway in CCl4-induced liver fibrosis in rats. BMC Complement Altern Med. 2017; 17: 45.

Hamed SS, Al-Yhaya NA, El-Khadragy MF, Al-Olayan EM, Alajmi RA, Hassan ZK. The protective properties of the strawberry (Fragaria xanassa) against carbon tetrachloride-induced hepatotoxicity in rats mediated by anti-apoptotic and up-regulation of anti-oxidant genes expression effects. Front Physiol. 2016; 7.

Hamzah R, Agboola A, Busari M, Omogu E, Umar M, Abubakar A. Evaluation of hepatoprotective effect of methanol extract of Solanum melongena on carbon tetrachloride induced hepatotoxic rats. European J Med Plants. 2016; 13: 1-12.

Hanafy A, Aldawsari HM, Badr JM, Ibrahim AK, Abdel-Hady SE-S. Evaluation of hepatoprotective activity of Adansonia
Hena PT, Srivastava M, Ghoshal S. Hepatoprotective and histopathological activity of ethanol and aqueous extracts of stem of Aloe vera Linn. (Ghee gangwar) against paracetamol-induced liver damage in rats. Int J Pharm Bio Sci. 2016; 1: 1-7.

Hussain L, Akash MS, Tahir M, Rehman K. Hepatoprotective effects of Sapium sebiferum in paracetamol-induced liver injury. Bangladesh J Pharmcol. 2015; 10: 393-98.

Iqbal I, Afzal M, Aftab MN, Manzoor F, Kaleem A, Kaleem A. Hepatotoxicity of Cassia fistula extracts in experimental chicks and assessment of clinical parameters. Kuwait J Sci. 2016; 43: 135-41.

Islam M, Hussain K, Latif A, Hashmi F, Saeed H, Bukhari N, SS Hassan, TZ Danish, B Ahmad. Evaluation of extracts of seeds of Syzygium cumini L. for hepatoprotective activity using CCl4-induced stressed rats. Pakistan Vet J. 2015; 35: 197-200.

Jain SK, Rajvaidy S, Desai P, Singh GK, Nagori BP. Herbal extract as hepatoprotective: A review. J Pharmacog Phytochem. 2013; 2.

John PP, Jose N, Carla Sr B. Preliminary pharmacological screening of Sinorourba glauca DC leaf extracts for hepatoprotective activity. World J Pharmaceut Sci. 2016; 5: 1714-205.

Kandimalla R, Kalita S, Saikia B, Choudhury B, Singh YP, Kalita K, Dash S, Kotoky J. Anti-oxidant and hepatoprotective potentiality of Randia duneetorum Lam. leaf and bark via inhibition of oxidative stress and inflammatory cytokines. Front Pharmacol. 2016; 7: 205.

Kaur V, Kumar M, Kaur P, Kaur S, Singh AP, Kaur S. Hepatoprotective activity of Butea monosperma bark against thioacetamide-induced liver injury in rats. Biomed Pharmacother. 2017; 89: 332-41.

Khan MA, Ahmad W, Ahmmed M, Nisar M. Hepatoprotective effect of the solvent extract of Viola bonopernna Wall. ex. Roxb. against CCl4 induced toxicity through anti-oxidant and membrane stabilizing activity. BMC Complement Altern Med. 2017; 17: 10.

Khan MZ, Jogeza N, Tareen JK, Shabbir MI, Malik MA, Khan AUR. Compilation on medicinal plants with hepatoprotective activity. Isra Med J. 2016; 8: 196-202.

Kiziltas H, Ekin S, Bayramoglu M, Akbas E, Oto G, Yildirim S, et al. Anti-oxidant properties of Ferulago angulata and its hepatoprotective effect against N-nitrosodimethylamine-induced oxidative stress in rats. Pharm Biol. 2017; 55: 888-97.

Kumar KS, Rajakrishnan R, Thomas J, Reddy GA. Hepatoprotective effect of Helicanthus elasta. Bangladesh J Pharmcol. 2016; 11: 525-30.

Kumaresan R, Veerakumar S, Elango V. A study on hepatoprotective activity of Mimosa pudica in albino rats. Int J Pharm Phytochem Res. 2015; 7: 337-39.

Lakshmi AI, Gobinath M, Bhattacharya J, Priyanka P. Hepato-

World J Pharmaceut Sci. 2016, 6: 949-61.

Lashgari AP, Gazor R, Asgari M, Mohammadghasemi F, Nasiri E, Rouhan ZA. Hepatoprotective effect of Acantholimon gilliati Turril, kew. Bull. on formaldehyde induced liver injury in adult male mice. Iranian J Pharma Res. 2017; 16: 5135-41.

Liu G, Liu X, Zhang Y, Zhang F, Wei T, Yang M, Wang K, Wang Y, Liu N, Cheng H, Zhao Z. Hepatoprotective effects of polysaccharides extracted from Zizyphus jujube cv. Huanghetanzao. Int J Biol Macromol. 2015; 76: 169-75.

Liu Q, Zhu M, Geng X, Wang H, Ng TB. Characterization of polysaccharides with anti-oxidant and hepatoprotective activities from the edible mushroom Oudemansiella radicata. Molecules 2017; 22: 234.

Longo F, Teuwa A, Fogue SK, Spiteller M, Nghoa LE. Hepato-

MacDonald I, Ogahle O-U, Ikechi EG, Orji OA. Hepato-

Madrigal-Santillán E, Madrigal-Bujaidar E, Álvarez-González I, Sumaya-Martínez MT, Gutiérrez-Salinas J, Bautista M, Morales-González A, González-Rubio MGY, Aguilar-Faisal JL, Morales-González JA. Review of natural products with hepatoprotective effects. World J Gastroenterol. 2014; 20: 14787-804.

Mishra G, Khosa R, Singh P, Jha K. Hepatoprotective potential of ethanolic extract of Pandanus odoratissimus root against paracetamol-induced hepatotoxicity in rats. J Pharm BioAllied Sci. 2015; 7: 45.

Mohamad NE, Yeap SK, Lim KL, Yusof HM, Beh BK, Tan SW. Anti-oxidant effects of pineapple vinegar in reversing of paracetamol-induced liver damage in mice. Chinese Med. 2015; 10: 3.

Mohamed MA, Eldin IMT, Mohammed A-EH, Hassan HM. Effects of Lawsonia inermis (Henna) leaves’ methanolic extract on carbon tetrachloride-induced hepatotoxicity in rats. J Int Ethnopharmacol. 2016; 5: 22.

Mohammadian A, Moradkhani S, Ataei S, Shayesteh TH, Sedadghat M, Kheiripour N, Ranjar B. Antioxidative and hepatoprotective effects of hydroalcoholic extract of Artemisia absinthium L. in rat. J HerbMed Pharmacol. 2016; 5: 29-32.

Morañes-López J, Centeno-Álvarez M, Nieto-Camacho A, López MG, Pérez-Hernández E, Pérez-Hernández N, Fernández-Martínez E. Evaluation of antioxidant and hepatoprotective effects of white cabbage essential oil. Pharm Biol. 2017; 55: 233-41.

Muruganai P, Ramamurthy V, Karmegam N. Hepatoprotective activity of Wedelia calendulacea L. against acute hepato-

Nagaraja Y, Krishna V. Hepatoprotective effect of the aqueous extract and 5-hydroxy, 7,8,2′ trimethoxy flavone of Andrographis alata Nees. in carbon tetrachloride treated rats.
Achievements in the Life Sci. 2016; 10: 5-10.

Nwobodo EI, Nwosu DC, Nwanjo HU, Ihim AC, Nnodim JK, Nwobodo CI, Edwrad UC. Vitamins C and E levels are enhanced by Azadirachta indica leaves aqueous extract in paracetamol induced hepatoxicity in Wistar rats. J Med Plants Res. 2016; 10: 338-43.

Okokon JE, Bavo MB, Mbagwu HO. Hepatoprotective activity of Mammea africana ethanol stem bark extract. Avicenna J Phytomed. 2016; 6: 248-59.

Okokon JE, Simeon JO, Umoh EE. Hepatoprotective activity of the extract of Homalium letestui stem against paracetamol-induced liver injury. Avicenna J Phytomed. 2017; 7: 27-36.

Okoye JO, Nwachukwu DA, Nnatuanya IN, Nwakulite A, Alozie I, Obi PE, Faloye GT. Anticholestasis and antisinusoidal congestion properties of aqueous extract of Annona muricata stem bark following acetaminophen induced toxicity. European J Exp Biol. 2016; 6: 1-8.

Osman SM, El-Haddad AE, El-Raey MA, El-Khalil SMA, Koheil MA, Wink M. A new octadecenoic acid derivative from Caspealpina gillesii flowers with potent hepatoprotective activity. Pharmacog Mag. 2016; 12: 5332.

Oyeyemi IT, Akanni OO, Adaramoye OA, Bakare AA. Methanol extract of Nymphaea lotus ameliorates carbon tetrachloride-induced chronic liver injury in rats via inhibition of oxidative stress. J Basic Clin Physiol Pharmacol. 2017; 28: 43-50.

Parmar S, Dave G, Patel H, Kalia K. Hepatoprotective value of some plants extract against carbon tetrachloride toxicity in male rats. J Cell Tissue Res. 2009; 2016; 10: 59-67.

Parmar SR, Vashrambhai PH, Kalia K. Hepatoprotective activity of some plants extract against paracetamol-induced hepatotoxicity in rats. J Herbal Med Toxicol. 2010; 4: 101-06.

Patel SA, Rajendra S, Setty SR. Hepatoprotective activity of Oxalis stricta Linn. on paracetamol-induced hepatotoxicity in albino rats. Algerian J Nat Prod. 2016; 4: 233-40.

Paul S, Islam MA, Tanvir E, Ahmed R, Das S, Rumpa N-E, Hossen MS, Parvez M, Gani SH, Khalil M, Sarkara (Citrus macroptera). fruit protects against acetaminophen-induced hepatoenral toxicity in rats. Evid Based Complement Altern Med. 2016; 2016.

Pithayanukul P, Nithitanakool S, Bavovrda R. Hepatoprotective potential of extracts from seeds of Areca catechu and nutgalls of Quercus infectoria. Molecules 2009; 14: 4987-5000.

Qureshi SA, Rais S, Usmani R, Zaidi SSM, Jehan M, Lateef T, Azmi MB. Centratherum anthelminticum seeds reverse the carbon tetrachloride-induced hepatotoxicity in rats. African J Pharm Pharmacol. 2016; 10: 533-39.

Raish M, Ahmad A, Alkhary KM, Ahadam SR, Mohsin K, Al-jenobi FI, Al-Mohizea AM, Ansari MA. Hepatoprotective activity of Lepidium sativum seeds against D-galactosamine/ lipopolysaccharide induced hepatotoxicity in animal model. BMC Complement Altern Med. 2016; 16: 501.

Raj V, Mishra AK, Mishra A, Khan NA. Hepatoprotective effect of Praunus armeniaca L. (Apricot) leaf extracts on paracetamol induced liver damage in Wistar rats. Pharmacog J. 2016; 8.

Rajeshkumar S, Kayalvizhi D. Anti-oxidant and hepatoprotective effect of aqueous and ethanolic extracts of important medicinal plant Pongamia pinnata (family: Leguminoseae). Asian J Pharm Clin Res. 2015; 8: 1-4.

Rafii B, Sahu J, Koul S, Khosa R, Raghav P. Hepatoprotective activity of ethanolic extract of stem bark of Berberis aristata against carbon tetrachloride (CCl4). Int J Pharmaceut Sci. 2015; 1: 43-45.

Reddy VP, Urooj A. Evaluation of hepatoprotective activity of Morus indica Linn. against toxicity induced by carbon tetrachloride in rats. Int J Pharmaceut Sci. 2017; 8: 845-51.

Roy A, Bhoumik D, Sahu RK, Dwivedi J. Medicinal plants used in liver protection: A review. UK J Pharm Biosci. 2014; 2: 23-33.

Sadeghi H, Hosseinzadeh S, Touri MA, Ghavamzadeh M, Barmak MJ. Hepatoprotective effect of Rosa canina fruit extract against carbon tetrachloride-induced hepatotoxicity in rat. Avicenna J Phytomed. 2016; 6: 181-88.

Saenthaweesuk S, Munkong N, Parklak W, Theamor A, Chaisakul J, Somparn N. Hepatoprotective and anti-oxidant effects of Cymbopogon citratus Stapf (lemon grass) extract in paracetamol-induced hepatotoxicity in rats. Trop J Pharm Res. 2017; 16: 101-07.

Sagar R, Bhaiji A, Toppo FA, Rath B, Sahoo HB. A comprehensive review on herbal drugs for hepatoprotection of 21st century. Int J Nutr Pharmacol Neurol Dis. 2014; 4: 191-97.

Saleem M, Irsahd I, Baig MK, Naseer F. Evaluation of hepatoprotective effect of chloroform and methanol extracts of Opuntia monacantha in paracetamol-induced hepatoxicity in rabbits. Bangladesh J Pharmcol. 2015; 10: 16-20.

Saleem M, Naseer F. Medicinal plants in the protection and treatment of liver diseases. Bangladesh J Pharmcol. 2014; 9: 511-26.

Saleem N, Ahmad M, Kamran S, Riaz H, Mehmood Y, Raza SA. Hepatoprotective effect of Cocos sativus on amiodarone-induced liver toxicity. Br J Pharm Res. 2016; 12.

Saleem TM, Chetty CM, Ramkanth S, Rajan V, Kumar KM, Gauthaman K. Hepatoprotective herbs: A review. Int J Res Pharm Sci. 2010; 1: 1-5.

Sangale P, Patil R. Hepatoprotective effect of alkaloid fraction of 21st century. Int J Nutr Pharmacol Neurol Dis. 2014; 4: 191-97.

Sangale P, Patil R. Hepatoprotective effect of alkaloid fraction of Cassia tora L leaves extract against carbon tetrachloride induced hepatotoxicity. Asian J Innov Res. 2017; 5: 1-5.

Saithi A, Elumalai A, Eswaraiah MC, Swathi S. An updated review on hepatoprotective medicinal plants. J Drug Deliv Ther. 2012; 2.

Sultana R, Ahmed SA. Photochemical and hepatoprotective activity of Artemisia dracunculus L leaves extract. GJRA. 2017; 5: 288-91.

Sunil J, Krishna JY, Brahachari PV. Hepatoprotective activity of Holostemma ada Kodien sihlcut, extract against paracetamol...
induced hepatic damage in rats. European J Med Plants. 2015; 6: 45.

Syed SN, Rizvi W, Kumar A, Khan AA, Moin S, Ahsan A. A study to evaluate anti-oxidant and hepatoprotective activity of aqueous extract of roots of Valeriana wallichii in CCl4 induced hepatotoxicity in rats. Int J Basic Clin Pharmacol. 2017; 3: 354-58.

Tan J, Shenghua L, Zeng J, Wu X. Anti-oxidant and hepatoprotective activities of total flavonoids of Indocalamus latifolius. Bangladesh J Pharmacol. 2015; 6: 779-89.

Tan S, Lu Q, Shu Y, Sun Y, Chen F, Tang L. Iridoid glycosides fraction isolated from Veronica ciliata Fisch. protects against acetaminophen-induced liver injury in mice. Evid Based Complement Altern Med. 2017; 2017.

Tiwary BK, Dutta S, Dey P, Hossain M, Kumar A, Bihani S, Nanda AK, Chaudhuri TK, Chakraborty R. Radical scavenging activities of Lagerstroemia speciosa (L.) Pers. petal extracts and its hepato-protection in CCI4-intoxicated mice. BMC Complement Altern Med. 2017; 17: 55.

Toori MA, Joodi B, Sadeghi H, Sadeghi H, Jafari M, Talebianpoor MS, Mehrabani F, Mostafazadeh M, Ghamavizadeh M. Hepatoprotective activity of aerial parts of Otopsia persica against carbon tetrachloride-induced liver damage in rats. Avicenna J Phytomed. 2015; 5: 238-46.

Toppo R, Roy BK, Gora RH, Baxla SL, Kumar P. Hepatoprotective activity of Moringa oleifera against cadmium toxicity in rats. Vet World. 2015; 8: 537-40.

Tsai JC, Chiu CS, Chen YC, Lee MS, Hao XY, Hsieh MT, Cao PC, Peng WH. Hepatoprotective effect of Coreopsis tinctoria flowers against carbon tetrachloride-induced liver damage in mice. BMC Complement Altern Med. 2017; 17: 139.

Ubhenin A, Igbe I, Adamude F, Falodun A. Hepatoprotective effects of ethanol extract of Caesalpinia bonduc against carbon tetrachloride induced hepatotoxicity in albino rats. J Appl Sci Environ Manage. 2016; 20: 396-401.

Ullah I, Khan JA, Adhikari A, Shahid M. Hepatoprotective effect of Monotheca buxifolia fruit against antitubercular drugs-induced hepatotoxicity in rats. Bangladesh J Pharmacol. 2016; 11: 248-56.

Usunobun U, Okolie P, Eze G. Effect of Vernonia amygdalina on some biochemical indices in dimethylnitrosamine (DMN)-induced liver injury in rats. Int J Anim Biol. 2015; 1: 99-105.

Vahab A, Harindran J. Hepatoprotective activity of bark extracts of Terminalia catappa Linn. in albino rats. World J Pharm Pharmaceut Sci. 2016; 5: 1002-16.

Ved A, Gupta A, Rawat AKS. Anti-oxidant and hepatoprotective potential of phenol-rich fraction of Juniperus communis Linn. leaves. Pharmacog Mag. 2017; 13: 108.

Wahid A, Hamed AN, Eltahir HM, Abouzied MM. Hepatoprotective activity of ethanolic extract of Salix subberrata against CCl4-induced chronic hepatotoxicity in rats. BMC Complement Altern Med. 2016; 16: 263.

Yadav VC. Hepatoprotective effect of Ficus religiosa latex on cisplatin induced liver injury in Wistar rats. Rev Bras Farmacog. 2015; 25: 278-83.

Yang J, Zhu D, Ju B, Jiang X, Hu J. Hepatoprotective effects of Gentianella turkestanerum extracts on acute liver injury induced by carbon tetrachloride in mice. Am J Transl Res. 2017; 9: 569-79.

Yengkhom NS, Gunindro N, Kholi SM, Moirangthem RS, Rajkumari BD. Hepatoprotective effect of aqueous extract of Melothria perpusilla against carbon tetrachloride induced liver injury in albino rats. Int J Res Med Sci. 2017; 5: 806-10.

Zakaria ZA, Yahya F, Mamat SS, Mahmood ND, Mohdarrudin N, Taher M, Hamid SSA, Teh LK, Salleh MZ. Hepatoprotective action of various partitions of methanol extract of Bauhinia purpurea leaves against paracetamol-induced liver toxicity: Involvement of the anti-oxidant mechanisms. BMC Complement Altern Med. 2016; 16: 175.
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