
***Review Article***

ISSN: 2454-5023
J. Ayu. Herb. Med.
2023; 9(1): 21-28
Received: 01-02-2023
Accepted: 14-03-2023

www.ayurvedjournal.com
DOI: 10.31254/jahm.2023.9105

# A Critical Review on Herbal Extracts as Hepatoprotective Agents

***Pavithra J[1], Jiji KN[1], Francis Kevin Raj S[1], Govindhan E[1], Yuvaraj K[1], Muralidharan P[1]***

*1 Department of Pharmacology, C.L. Baid Metha College of Pharmacy, Rajiv Gandhi Salai, Jyothi Nagar, Thoraipakkam, Chennai-600097, Tamil Nadu, India*

## ABSTRACT

Liver is a vital organ that plays a major role in metabolism and excretion of xenobiotics from the body. Liver dysfunction/ liver Injury is a major health problem that challenges not only health care professionals but also pharmaceutical industry and drug regulatory agencies. Maintenance of a healthy liver is essential for overall well being of an individual. Liver injury is caused by various hepatotoxins. Some of the most common toxicants are Paracetamol, Carbon tetrachloride, Thioacetamide, excessive consumption of Alcohol, anti-tuberculosis drugs such as Rifampicin and Isoniazid, certain antibiotics like Gentamicin, Chemotherapeutic agents and Microbes. Few synthetic drugs that are available in market to treat liver disorders in this condition are expensive and also cause other discomforts to our body. Thus herbal drugs comes into role and its use is also widespread now-a-days. Herbal medicines are used for treatment of liver diseases since long time but they are increasingly popular at recent times. Herbal remedies are focused in pharmaceutical industry to evolve a safe route for liver disorders. A number of herbal preparations are available in market. The present review is aimed at compiling on promising herbs that have been tested in various Hepatotoxic models using modern scientific system.

**Keywords:** Liver injury, Hepatotoxins, Herbal medicines, Hepatotoxicity.

## INTRODUCTION

Liver is a vital and largest internal organ of the human body that perfoms multiple functions like maintanence of glucose homeostasis, metabolism and detoxification of drugs, breakdown of various hormones, secretion of lipoprotein, excretion of bile. It also synthesizes Albumin, Fibrinogen, Pro-thrombin. Liver serves as storage organ for fat, fat soluble vitamins and glycogen [1]. It is a dark reddish brown organ with a median weight of 1800 grams in Men and 1400 grams in Women [2]. Anatomically liver is located slightly beneath the diaphragm and anterior to stomach. The portal vein nourishes the liver with the blood containing digested nutrients from GIT, Spleen, Pancreas, while the hepatic artery supplies oxygenated blood from the Lungs [3]. Some of the most common liver diseases are Alcoholic Liver Disease (ALD), Non-alcoholic Fatty Liver Disease (NAFLD), Viral Hepatitis, Liver Cirrhosis, Liver Cancer, Biliary Cirrhosis, Sclerosing Cholangitis [4]. Any injury or impairment to liver or its function is termed as Hepatotoxicity that is mainly caused due to exposure to Hepatotoxins like Paracetamol, Isoniazid and Rifampicin, Alcohol, Food additives, Environmental toxicants, Radioactive isotopes, Fungal toxins, Peroxidized fatty acids, Chlorinated solvents and some Medicinal plants too [5]. Drug Induced Liver Injury (DILI) is the most common reason to withdraw most of drug candidates in later drug developmental stages and post marketing phase. Occurrence of DILI is attributed to poor predictivity of pre-clinical animal studies. There are several other reasons too including difference in drug metabolism between human and experimental species [6]. The Liver damage that is caused due to habitual exposure to alcohol is known as Alcoholic Liver Disease. ALD represents one of the oldest form of liver injury known to mankind. Alcohol remains a major cause for liver disease worldwide. The spectrum of ALD varies from simple steatosis to cirrhosis [7]. Liver related diseases due to alcohol consumption includes alcoholic Steatosis and Hepatitis and they increase the risk of developing cirrhosis or Hepatocellular carcinoma. In case of chronic alcoholism, the balance between alcohol induced hepatocyte injury and Liver regeneration determines the severity of ALD. Therefore for finding new approaches for prevention of ALD, there must be a clear understanding on the effects of alcohol on hepatocyte proliferation and differentiation [8]. Liver diseases affects people of all ages and walks of life. At present, an estimated 5.5 millions of people have chronic Liver disease. The burden of Liver diseases currently increases drastically and it calls for greater efforts in their prevention and control. Progress in controlling these diseases largely depends on understanding them better through research [9]. Alcohol abuse is one of the major problem in recent times. There is a close relationship between alcohol intake and ALD as 80% of ingested alcohol is metabolized in Liver. Alcohol is widely used in most of the syrups, tinctures and other forms of medicines. In small dose it has

***Corresponding author:**
***Dr. P.Muralidharan***
Department of Pharmacology, C.L. Baid Metha College of Pharmacy, Rajiv Gandhi Salai, Jyothi Nagar, Thoraipakkam, Chennai-600097., Tamil Nadu, India
Email: pmuralidaran2020@gmail.com

great medicinal value but at large dose it causes severe Hepatic damage in both Human and experimental animals. Chronic ethanol consumption have a profound effect on metabolism of lipids and lipoproteins. In Liver, ethanol is metabolized into cytotoxic acetaldehyde by acetaldehyde dehydrogenase enzyme and acetaldehyde in turn is oxidized to acetate by aldehyde oxidase enzyme which gives out reactive oxygen species (ROS) like Superoxide, Hydroxyl radical and Hydrogen Peroxide via Cytochrome P450 2E1 (CYP 2E1). This causes oxidative stress to hepatic cell which leads to ALD. When there is any damage to Liver cell membrane, all the cytosolic enzymes like Aspartate transaminase (AST), Alanine transaminase (ALT), Alkaine phospahatase (ALP) are leaked to bloodstream. Thus there is an elevation of cytosolic enzyme levels in bloodstream which serves as quantitative marker of Hepatic damage. [10]. ALD is a serious health concern and it is responsible for approximately 4% deaths annualy worldwide. Despite tremendous scientific advances in Hepatology and related areas, Liver problems are still on rise. Yet there are no specific treatment or management strategies available. Most of the treatment options available are accompanied by serious side effects and health complications. Hence developing a safe and effective treatment or management strategy especially based on natural agents has been generating considerable interest of late [11]. Alcohol is the second most pyscho-active substance used after caffeine. Ethanol or its metabolites prompt a sharp increase of free radicals in Hepatic cells by reducing anti-oxidant levels, contributing to variety of chronic diseases. Reactive Oxygen species (ROS) and Reactive Nitrogen Species (RNS) are highly reactive and can damage DNA, Proteins and Lipids. Alcohol induces Oxidative stress that in turn causes Liver injury. Alcohol consumption causes accumulation of all the ROS in hepatic cells that in turn oxidizes Glutathione that leads to lipid peroxidation of cellular membrane, Oxidation of DNA and protein resulting in Hepatic damage. Prolonged alcohol intake increases Nitric Oxide (NO) levels which forms per-oxy nitrite, a toxic oxidant. Low levels of anti-oxidants leads to damage of Hepatic cells and releases ROS. Treatment options available for liver diseases are inadequate in modern medicine. Conventional drugs used in the treatment of liver disease such as Corticosteroids, anti-viral may lead to serious adverse reactions and they may even cause Hepatic damage on prolonged use. Therefore alternative drugs in the form of herbal medicines are now preferred for treatment of Liver disorders [12]. In recent times the use of natural herbal products has enhanced world wide attentions. Herbal supplements have claimed to assist a healthy lifestyle. Medicinally, herbal drugs have also made a significant contribution in treatment of Hepatotoxicity [13]. Traditional medicines is mainly of skills, knowledge, practice based on theories that are used to maintain health as well as prevent, diagnose, improve or treat physical and mental illness. Herbal treatments are most popular form of traditional medicine. Herbal medicine include herbs, herbal materials, herbal preparation and finishes herbal products that contains one or more plant extracts as active ingredients [14].

This review is created after a tedious literature survey, all the herbal extracts have been compiled as a tabular column.

**List of Some Herbal Extracts that act as Hepatoprotective Agents**

| S. No | Plants (Scientific & Common name) | Part of Plants Used | Extract | Inducing Agent | Animal Model | Reference |
|---|---|---|---|---|---|---|
| 1 | *Abutilon indicum* (Thuthi) | Leaves | Aqueous | Carbon tetracholride and Paracetamol | Wistar rats | E. Porchezhian *et al.*, 2004 [15] |
| 2 | *Allium cepa* (Onion) | Bulbs | Methanol | Paracetamol | Wistar rats | Ozougwu J.C *et al.*,2014 [16] |
| 3 | *Allium cepa* | Bulbs | Aqueous | Ethanol | Wistar rats | K. Eswar Kumar *et al.*,2013 [17] |
| 4 | *Allium sativum* (Garlic) | Bulb | Ethanol | Thioacetamide | Wistar rats | Krishna Mohan Chinnala *et al.*,2018 [18] |
| 5 | *Amaranthus spinosus* (Spiny amaranth) | Whole plant | Ethanol | Carbon tetrachloride | Sprague–dawley rats | Hussain Zeashan *et al.*,2008 [19] |
| 6 | *Annona squamosa* (Custard apple) | Seeds | Ethanol | Ethanol | Sprague–dawley rats | Mohammad Zahid *et al.*,2018 [20] |
| 7 | *Annona squamosa* | Leaves and Bark | Ethanol | Carbon tetrachloride | Wistar rats | Neha Sonkar *et al.*,2016 [21] |
| 8 | *Annona squamosa* | Leaves | Ethanol | Diethylnitrosamine | Swiss albino mice | D Sobiya Raj *et al.*,2009 [22] |
| 9 | *Saraca ashoka* | Bark | Hydroalcoholic and Methanolic | Carbon tetrachloride | Wistar rats | Bharti Arora *et al.*,2014 [23] |
| 10 | *Withania somnifera* (Ashwagandha) | Root | Aqueous | Paracetamol | Wistar rats | Evan prince sabina *et al.*,2013 [24] |
| 11 | *Laurus nobilis* (Bay leaf) | Leaves | Ethanol | Carbon tetrachloride | Wistar rats | H. Vardapetyan *et al.*,2016 [25] |
| 12 | *Boerhaavia diffusa L., (*Punarnava) | Root | Aqueous | Thioacetamide | Wistar rats | A.K.S.Rawat *et al.*,1996 [26] |
| 13 | *Elettaria cardmomum* (Cardamom ) | Seed | Aqueous | Gentamicin | Wistar rats | Mohamed Aboubakr *et al.*,2016 [27] |
| 14 | *Daucus carota L.* (Carrot) | Root | Aqueous | Paracetamol,Isoniazid and Alcohol | Wistar rats | Shoba S *et al.*,2008 [28] |
| 15 | *Cassia fistula* | Leaves | N-Heptane | Carbon tetrachloride | Wistar rats | T. Bhakta |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | *et al.*,1998 [29] |
| 16 | *Cinnamomum zeylanicum L* | Leaves | Aqueous | Alcohol | Wistar rats | K.Arun *et al.*,2014 [30] |
| 17 | *Cinnamomum zeylanicum L* | Bark | Ethanol | Carbon tetrachloride | Wistar rats | Akram Eidi *et al.*,2012 [31] |
| 18 | *Cinnamomum zeylanicum L* | Bark | Aqueous | Paracetamol | Wistar rats | Ashraf Elkomy *et al.*,2016 [32] |
| 19 | *Syzygium aromaticum L.* (Clove) | Buds | Hydro-ethanolic | Alcohol | Wistar rats | Svenia P. Jose *et al.*,2017 [33] |
| 20 | *Coriandrum sativum* | Leaves | Hydro-alcoholic | Carbon tetrachloride | Wistar rats | S. Sreelatha *et al.*,2008 [34] |
| 21 | *Curcuma longa* | Rhizomes | Ethanolic | Thioacetamide | Sprague dawley rats | Suzy M Salama *et al.*,2013 [35] |
| 22 | *Murraya koenigii* (Curry leaves) | Leaves | Aqueous | Lead acetate | Wistar rats | Debosree ghosh *et al.*,2013 [36] |
| 23 | *Cynodon dactylon* (Bermuda grass) | Leaves | Aqueous and Ethanolic | Rifampicin | Wistar rats | Akshay Javalgikar *et al.*,2021 [37] |
| 24 | *Trigonella feouam graceum* (Fenugreek) | Seeds | Hydro-alcoholic | Carbon tetrachloride | Wistar rats | Said. A.M *et al.*,2011 [38] |
| 25 | *Foeniculum vulgare* (Fennel) | Seeds | Essential oil | Carbon tetrachloride | Sprague–dawley rats | H. Ozbek *et al.,* 2003 [39] |
| 26 | *Kalanchoe pinnata Pers* (Bryophyllum calycinum) | Leaves | Ethanolic | Carbon tetrachloride | Wistar rats | N.P. Yadav *et al.*,2003 [40] |
| 27 | *Plectranthus amboinicus (Lour) Spreng (*Country borage ) | Leaves | Aqueous and Ethanolic | Carbon tetrachloride | Wistar rats | Roshan Patel *et al.*,2011 [41] |
| 28 | *Plectranthus amboinicus* | Leaves | Ethanolic | Paracetamol | Wistar rats | Smita shenoy *et al.*,2012 [42] |
| 29 | *Lavandula officinalis* | Aerial parts | Essential oil | Acetaminophen | Balb/c mice | Gabriel Fernando *et al.*,2021 [43] |
| 30 | *Lavandula officinalis* | Aerial parts | Essential oil | Malathion | Swiss albino mice | Slimen Selmi *et al.*,2015 [44] |
| 31 | *Cymbopogon citrates Stapf* (Lemongrass) | Whole plant | Ethanolic | Paracetamol | Wistar rats | Suphaket Saenthaweesuk *et al.*,2017 [45] |
| 32 | *Limonia acidissima Linn* | Fruit | Methanolic | Carbon tetrachloride | Wistar rats | Ilango K *et al.*,2009 [46] |
| 33 | *Mentha arvensis* | Leaves | Aqueous and Ethanolic | Carbon tetrachloride | Wistar rats | Kalpana Patil *et al.*,2012 [47] |
| 34 | *Mentha longifolia (L.)* | Aerial parts | Ethanolic | Carbon tetrachloride | Swiss Albino mice | Neda Mimica-Dukić *et al.*,2012 [48] |
| 35 | *Momordica dioica Roxb.* | Leaves | Aqueous and Ethanolic | Carbon tetrachloride | Wistar albino rats | Avijeet Jain *et al.*,2007 [49] |
| 36 | *Moringa oleifera Lam.* (Drumstick) | Leaves | Ethanolic | Carbon tetrachloride | Wistar rats | Dharmendra Singh *et al.*,2014 [50] |
| 37 | *Moringa oleifera* | Leaves | Ethanolic | Isoniazid , Rifampicin and Pyrazinamide | Wistar rats | L. Pari *et al.*,2002 [51] |
| 38 | *Moringa oleifera* | Leaves | Hydro-alcoholic | Cadmium chloride | Wistar albino rats | Reetu Toppo *et al.*,2015 [52] |
| 39 | *Musa paradisiaca* | Stem | Alcoholic and Aqueous | Carbon tetrachloride and Paracetamol | Wistar albino rats | Nirmala M *et al.*,2012 [53] |
| 40 | *Myristica Fragrans* (Nutmeg) | Seed | N-hexane,ethyl acetate and ethanol | Lipopolysaccharide/D-Galactosamine | Wistar rats | Tatsuya morita *et al.*,2003 [54] |
| 41 | *Phyllanthus emblica* | Fruits | Aqueous | Paracetamol | Wistar albino rats | H.L. Vidhya Malar *et al.*,2009 [55] |
| 42 | *Portulaca oleracea* | Whole plant | Petroleum ether and Methanol | D-Galactosamine | Wistar albino rats | Vunta Prabhakaran *et al.*,2010 [56] |
| 43 | *Cucurbita pepo L.* | Seeds | Oil | Alcohol | Wistar rats | Howida Sayed Abou Seif *et al.*,2014 [57] |
| 44 | *Solanum tuberosum L.* (Purple potato) | Tubers | Formic acid | D-Galactosamine | F344/DuCrj rats | Kyu Ho Han *et al.*,2006 [58] |
| 45 | *Ipomoea batatas L.* | Tubers | Hydrochloric acid in | Carbon tetrachloride | KunMing mice | Lin Wang *et al.*,2016 [59] |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (Purple sweet potato) | | anhydrous ethanol | | | |
| 46 | *Rosmarinus officinalis L.* | Aerial parts | Essential oil | Carbon tetrachloride | Wistar rats | Aleksandar Rašković *et al.*,2014 [60] |
| 47 | *Sesamum indicum* | Seeds | Hydro-alcoholic | Paracetamol | Wistar rats | Kumar Munish *et al.*,2011 [61] |
| 48 | *Solanum nigrum* | Whole plant | Aqueous and Methanolic | Carbon tetrachloride | Wistar albino rats | R. A. M. Elhag *et al.*,2018 [62] |
| 49 | *Illicium verum (*Star anise ) | Whole spice | Oil | Carbon tetrachloride | Wistar rats | Eman Abdallah Ismail *et al.*,2020 [63] |
| 50 | *Terminalia catappa* | Leaves | Aqueous | Carbon tetrachloride | Wistar albino rats | Chun-ching lin *et al.*,1997 [64] |
| 51 | *Solanum lycopersicum* L (Tomato) | Fruits | Pulp | Carbon tetrachloride | Wister albino rats | A. Weremfo *et al.*,2011 [65] |
| 52 | *Watercress* | Stem and Leaves | Hydro-alcoholic | Acetaminophen | Wistar rats | Nahid Azarmehr *et al.*,2019 [66] |
| 53 | *Wedelia calendulacea* L. | Leaves | Ethanolic | Carbon tetrachloride | Wistar rats | P. Murugaian *et al.*,2008 [67] |
| 54 | *Triticum aestivum* Linn. | Shoots | Methanol, Hexane, Chloroform, and Aqueous | Carbon tetrachloride | Wistar albino rats | Anand Rajoria *et al.*,2017 [68] |
| 55 | *Zea mays* L. | Husk | Ethanolic | Carbon tetrachloride | Wistar rats | J. A. Udobang *et al.*,2019 [69] |
| 56 | *Prunus amygdalus* (Almond) | Seed | Oil | Carbon tetrachloride | KunMing rats | Xiao-Yan Jia *et al.*,2010 [70] |
| 57 | *Terminalia arjuna* | Bark | Aqueous | Isoniazid | Wistar rats | P.Doorika *et al.*,2012 [71] |
| 58 | *Terminalia arjuna* | Leaves | Methanolic | Paracetamol | Swiss albino rats | Ataa said *et al.*,2014 [72] |
| 59 | *Azadirachta Indica* | Leaves | Aqueous | Paracetamol | Wistar rats | Ikechukwu E *et al.*,2018 [73] |
| 60 | *Aegle marmelos (L.) Corr.* | Leaves | Hydro-alcoholic | Carbon tetrachloride | Swiss albino mice | T. Kalaivani *et al.*,2009 [74] |
| 61 | *Anacardium occidentale* (Cashew) | Leaves | Methanolic | Carbon tetrachloride | Wistar rats | Daniel Ikyembe *et al.*,2014 [75] |
| 62 | *Cissus quadrangularis* | Stem | Methanolic | Isoniazid | Wistar albino rats | A.H.M. Viswanatha Swamy *et al.*,2010 [76] |
| 63 | *Amaranthus caudatus* | Whole plant | Methanolic | Paracetamol | Wistar rats | Ashok kumar BS *et al.*,2011 [77] |
| 64 | *Sesbania grandiflora Linn* (Agati) | Flowers | Ethanolic and aqueous | Carbon tetrachloride | Wistar rat and Swiss albino mice | Ishwer Kale *et al.*,2012 [78] |
| 65 | *Amaranthus tricolor L.* | Leaves | Ethanolic | Carbon tetrachloride | Wistar albino rats | Mohammed S. Al-Dosari *et al.*,2015 [79] |
| 66 | *Capsicum annum L.* | Fruit | Aqueous | Ethanol | Wistar rats | Moumita Das *et al.*,2018 [80] |
| 67 | *Cocos nucifera* | Fruit | Oil | Carbon tetrachloride | Albino rabbit | B. Ahmad *et al.*,2021 [81] |
| 68 | *Cocos nucifera* | Stem bark | Methanolic | Paracetamol | Wistar albino rats | Damilola Alex Omoboyowa *et al.*,2015 [82] |
| 69 | *Dichrostachys cinerea* | Leaves | Methanolic | Carbon tetrachloride | Swiss albino mice and Wistar albino rats | P. Suresh Babu et a;.,2010 [83] |
| 70 | *Ficus carica* | Leaves | Petroleum ether | Rifampicin | Wistar rats | N. Y. Gond *et al.*,2008 [84] |
| 71 | *Ficus carica Linn.* | Leaves | Methanolic | Carbon tetrachloride | Wistar rats | Krishna Mohan G *et al.*,2007 [85] |
| 72 | *Ficus carica* | Leaves | Ethanolic | Carbon tetrachloride | Swiss albino mice | Nasrin Aghel *et al.*,2011 [86] |
| 73 | *Zingiber officinale* (Ginger) | Rhizome | Essential oil | Diethylnitrosamine | Wistar rats | Abdelgawad Fahmi *et al.*,2019 [87] |
| 74 | *Zingiber officinale* | Rhizome | Aqueous | Acetaminophen | Sprague-dawely rats | Amal S Abdel-Azeem *et al.*,2013 [88] |
| 75 | Vitis vinifera L | Seeds | Ethanolic | Carbon tetrachloride | Wistar rats | Feroz Ahmad *et al.*,2012 [89] |

| | | | | | | |
|---|---|---|---|---|---|---|
| 76 | *Hibiscus rosa sinensis* | Flowers | Aqueous | Cholesterol and Cholic acid with Coconut oil | Wistar albino rats | Anupam Biswas *et al*.,2014 [90] |
| 77 | *Acalypha indica* linn | Aerial parts | Methanolic | Thioacetamide | Wistar albino rats | S V Suresh kumar *et al*.,2013 [91] |
| 78 | *Nelumbo nucifera Gaertn.* | Leaves | Ethanolic | Carbon tetrachloride | Sprague–dawley rats and Kun Ming Mice | Bo Huang *et al*.,2009 [92] |
| 79 | *Mangifera-indica* | Stem bark | Aqueous and Ethanolic | Paracetamol | Wistar rats | Mutiat Adetayo Omotayo *et al*.,2015 [93] |
| 80 | *Mangifera indica L.* | Fruits | Aqueous | Cumene Hydroperoxide | Sprague-dawley rats | Jalal Pourahmad *et al*.,2010 [94] |
| 81 | *Ocimum sanctum* | Leaves | Ethanolic | Paracetamol | Wistar rats | Kingshuk Lahon *et al*.,2011 [95] |
| 82 | *Carica papaya Linn* | Fruits | Aqueous and Ethanolic | Carbon tetrachloride | Wistar Rats | Md. Zafor Sadeque *et al*.,2010 [96] |
| 83 | *Carica papaya Linn* | Leaves | Aqueous | Ethanol and Isoniazid, Rifampicin | Wistar rats | Aashish Pandit *et al*.,2013 [97] |
| 84 | *Carica papaya Linn* | Seeds | Aqueous | Carbon tetrachloride | Wistar rats | Adeneye AA *et al*.,2009 [98] |
| 85 | *Piper nigrum* L. | Fruits | Essential oil | Carbon tetrachloride | C57BL/6 mice | Chi Zhang *et al*.,2020 [99] |
| 86 | *Phyllanthus acidus (L.) Skeels* | Leaves | Aqueous and Ethanolic | Acetaminophen and Thioacetamide | Wistar albino rats and Swiss albino mice | Nilesh Kumar Jain *et al*.,2011 [100] |
| 87 | *Piper betel* | Leaves | Ethanolic | Carbon tetrachloride | Wistar rats | Ashish Manigauha *et al*.,2009 [101] |
| 88 | *Piper longum linn.* | Fruits | Ethanolic | Carbon tetrachloride | Wistar rats | S.S.Jalalpure *et al*.,2003 [102] |
| 89 | *Alternanthera sessilis* | Whole plant | Methanolic | Carbon tetrachloride | Wistar rats | Biman Bhuyan *et al*.,2017 [103] |
| 90 | *Vetiveria Zizanioides* | Roots | Methanolic | Carbon tetrachloride | Wistar albino rats | Mihir parmar *et al*.,2013 [104] |
| 91 | *Tinospora cordifolia* | Leaves, Stem and Roots | Petroleum ether, Ethanol and Aqueous | Carbon tetrachloride | Wistar rats | B. T. Kavitha *et al*.,2011 [105] |

**CONCLUSION**

Due to prevalence of Hhepatotoxicity among wide range of population, it is necessary to develop a safe and an effective treatment. There is a need to develop, protect and promote traditional medicines for the betterment of the health care system. The present review elaborates various therapeutic and innovative approaches to find out the perspective on globalization of safe and cost-effective Herbal treatment for hepatotoxicity.

**Acknowledgement**

We are thankful to our Management Tamil Nadu Chemists & Druggists Educational Trust for their support.

**Conflict of interest**

None declared.

**Financial support**

None declared.

**REFERENCE**

1. Arika WM Nyamai DW Osano KO Ngugi MP Njagi ENM. Biochemical Markers of *In vivo* Hepatotoxicity.*Journal of Clinical Toxicology. 2016;*6(2):1.
2. Sherif R. Z, Misih A,Bloomston M. Liver Anatomy. *Surgical clinics of North America*.2010;90(4):643-53.
3. Arika WM Nyamai DW Osano KO Ngugi MP Njagi ENM. Biochemical Markers of *In Vivo* Hepatotoxicity. *Journal of Clinical Toxicology.2016;*6(2):1.
4. Lauschke VM, Hendriks DFG, Bell CC, Andersson TB, Sundberg MI. Novel 3D Culture Systems for Studies of Human Liver Function and Assessments of the Hepatotoxicity of Drugs and Drug Candidates. *Chemical Research in Toxicology.* 2016; 8(3):B.
5. Paniagua AC, Amariles P. Hepatotoxicity by Drugs. *Pharmacokinetics and Adverse Effects of Drugs - Mechanisms and Risks*. 2018;3(5):77.
6. Donato MT, Jover R, Gómez-Lechón MJ. Hepatic Cell Lines for Drug Hepatotoxicity Testing: Limitations and Strategies to Upgrade their Metabolic Competence by Gene Engineering.*Current Drug Metabolism.* 2013;*14(9):946.*
7. O'Shea RS , Dasarathy S , McCullough AJ.Alcoholic Liver Disease .*The American Journal of Gastroenterology*.2010;105:14-15.
8. Do THT, Gaboriau F,Cannie I, Batusanski F, Ropert M, Moirand R, Brissot P, Loreal O, Lescoat G. Iron-mediated effect of alcohol on hepatocyte differentiation in HepaRG cells. *Chemico-Biological Interactions.*2013;1.
9. Rasheed A, Reddy BS, Azeem AK, Roja C.Formulation and Evaluation of Poly Herbal Formulation against CCl4 Induced Hepatotoxicity, Jordan Journal of Pharmaceutical Sciences.2014;7:67-69.
10. Kumar KE, Harsha KN, Sudheer V, Babu NG. *In vitro* antioxidant activity and *in vivo* hepatoprotective activity of aqueous extract of *Allium cepa* bulb in ethanol induced liver damage in Wistar rats. *Food Science and Human Wellness 2.2013;1(4):132.*

11. Jose SP , Ratheesh M, Asha S , Krishnakumar IM , Sandya S, Girish KB. Hepato-protective Effect of Clove Bud Polyphenols (Syzygium aromaticum L.) (Clovinol® ) by Modulating Alcohol Induced Oxidative Stress and Inflammation. Journal of Food Research.2018;7(1):10-20.
12. Seif HSA. Ameliorative effect of Pumpkin oil (Cucurbita pepo L.) against alcohol-induced hepatotoxicity and oxidative stress in albino rats. *Beni- Suef University Journal of Basic and Applied Sciences*.2014;3(5);178-79.
13. Kumar KE, Harsha KN, Sudheer V, Babu NG. *In vitro* antioxidant activity and *in vivo* hepatoprotective activity of aqueous extract of *Allium cepa* bulb in ethanol induced liver damage in Wistar rats. *Food Science and Human Wellness 2.2013;1(4):132.*
14. Shareef MZ, Malathy PS, Babu GS. Hepatoprotective activity of aqueous extract of Ocimum tenuflorium. *Journal of Global Trends in Pharmaceutical Sciences*.2018;9(4):5983-5985.
15. Porchezhian E, Ansari SH. Hepatoprotective activity of Abutilon indicum on experimental liver damage in rats.*Phytomedicine.* 2005;12:62-64.
16. Ozougwu JC, Eyo JE. Hepatoprotective effects of Allium cepa (onion) extracts against paracetamol induced liver damage in rats. *African Journal of Biotechnology*. 2014;13(26): 2679-88.
17. Kumar KE,Harsha KN, Sudheer V, Babu NG. *In vitro* antioxidant activity and *in vivo* hepatoprotective activity of aqueous extract of *Allium cepa* bulb in ethanol induced liver damage in Wistar rats. *Food Science and Human Wellness.2013;2:132-138* .
18. Chinnala KM, Jayagar PP, Motta G, Adusumilli RG, Elsani MM. Evaluation of hepatoprotective activity of *Allium sativum* ethanolic extract in thioacetamide-induced hepatotoxicity in albino Wistar rats. American Journal Of Research In Medical Sciences. 2018;3(2):48-53.
19. Zeashan H, Amresh G, Singh S, Rao CV. Hepatoprotective activity of Amaranthus spinosus in experimental animals. *Food and Chemical Toxicology*. 2008;46:3417-3421.
20. Zahid M, Arif M, Rahman MA, Mujahid M. Hepatoprotective and antioxidant activities of Annona squamosa seed extract against alcoholinduced liver injury in Sprague Dawley rats. *Drug and Chemical Toxicology*.2018;3:1-7.
21. Sonkar N, Yadav AK , Mishra PK , Jain PK , Rao CV. Evaluation Of Hepatoprotective Activity Of Annona Squamosa Leaves And Bark Extract Against Carbon Tetrachloride Liver Damage In Wistar Rats. *World Journal Of Pharmacy And Pharmaceutical Sciences*.2016;5(8):1353-1360.
22. Raj DS, Vennila JJ, Aiyavu C, Panneerselvam K. The hepatoprotective effect of alcoholic extract of Annona squamosa leaves on experimentally induced liver injury in swiss albino mice. *International Journal of Integrative Biology*. 2009;5(3):182-186.
23. Arora B, Choudhary M, Arya P,Kumar S, Choudhary N, Singh S. Hepatoprotective potential of Saraca ashoka (Roxb.) De Wilde bark by carbon tetrachloride induced liver damage in rats. *Bulletin of Faculty of Pharmacy, Cairo University*.2014;11:1-6.
24. Sabina EP, Rasool M, Vedi M, Navaneethan D, Ravichander M, Parthasarthy P, Thella SR. Hepatoprotective And Antioxidant Potential Of Withania Somnifera Against Paracetamol-Induced Liver Damage In Rats. *International Journal of Pharmacy and Pharmaceutical Sciences.* 2013;5(2): *648-651.*
25. Vardapetyan H, Tiratsuyan S, Hovhannisyan A. Hepatoprotective Activity of Leaf Extract of Laurus Nobilis L. against CCL4 Induced Hepatotoxicity in Rats. *International Federation for Medical and Biological Engineering* .2016;55:419-20.
26. Rawat AKS, Mehrotra S, Tripathi SC, Shome U. Hepatoprotective effects of Boerhaavia diffusa L. roots - a popular Indian Ethnomedicine. *Journal of Ethnopharmacology*.1997;56:61-66.
27. Aboubakr M, Abdelazem AM. Hepatoprotective effect of aqueous extract of cardamom against gentamicin induced hepatic damage in rats. International Journal of Basic and Applied Sciences. 2016;5(1):1-4.
28. Shoba S, Patil PA, Vivek V. Hepatoprotective Activity Of Daucus Carota L. Aqueous Extract Against Paracetamol, Isoniazid And Alcohol Induced Hepatotoxicity In Male Wistar Rats. *Pharmacologyonline. 2008;3:*776-787.
29. Bhakta T, Mukherjee PK , Mukherjee K, Banerjee S, Mandal SC, Maity TK, Pal M , Saha BP. Evaluation of hepatoprotective activity of Cassia fistula leaf Extract. *Journal of Ethnopharmacology*. 1999;66:277-282.
30. Arun K , Suguna S , Balasubramanian U , Yusoff MM, Maniam GP , Serfoji P, Govindan N. Hepatoprotective Activity of Cinnamon Zeylanicum Leaves against Alcohol Induced Albino Rats. *Int. Journal of Engineering Research and Applications*. 2014;4(8):.177-184 .
31. Eidi A, Mortazavi P , Bazargan M, Zaringhalam J. Hepatoprotective Activity Of Cinnamon Ethanolic Extract Against Ccl4-Induced Liver Injury In Rats. *EXCLI Journal*.2012;11:495-507.
32. Elkomy A , Aboubakr M, Soliman A , Abdeen A , Abdelkader A, Hekal H. Paracetamol induced hepatic toxicity and amelioration by cinnamon in rats. *International Journal of Pharmacology and Toxicology*.2016;4(2):*187-190* .
33. Jose SP , Ratheesh M, Asha S , Krishnakumar IM , Sandya S, Girish KB. Hepato-protective Effect of Clove Bud Polyphenols (Syzygium aromaticum L.) (Clovinol® ) by Modulating Alcohol Induced Oxidative Stress and Inflammation. Journal of Food Research.2018;7(1):10-20.
34. Sreelatha S, Padma PR, Umadevi M. Protective effects of Coriandrum sativum extracts on carbon tetrachloride-induced hepatotoxicity in rats. *Food and Chemical Toxicology*.2009;47:702-708.
35. Salama SM, Abdulla MA, AlRashdi AS , Ismail S , Alkiyumi SS, Golbabapour S. Hepatoprotective effect of ethanolic extract of Curcuma longa on thioacetamide induced liver cirrhosis in rats. *BMC Complementary and Alternative Medicine*. 2013;13(56):1-17.
36. Ghosh D, Firdaus SB, Mitra E, Dey M, Chattopadhyay A, Pattari SK, Dutta S, Jana K, Bandyopadhyay D. Hepatoprotective Activity Of Aqueous Leaf Extract Of *Murraya Koenigii* Against Lead-Induced Hepatotoxicity In Male Wistar Rat. *International Journal of Pharmacy and Pharmaceutical Sciences*. 2013;5(1):*285-295* .
37. Javalgikar A, Mahurkar N, Keerthi K. Hepatoprotective activity of Cynodon dactylon leaf extract against rifampicin- induced liver damage in albino rats . *Journal of Ayurvedic and Herbal Medicine*. 2021;7(2):71-76.
38. Said AM , Al-Khashali D, Al-Khateeb E, Al-Wakeel N. The hepatoprotective activity of Fenugreek seeds' extract against carbon tetrachloride induced liver toxicity in rats . *AJPS*. 2011;9(1):94-103.
39. Ozbek H, Ugras S, Dulger H, Bayram I, Tuncer I, Ozturk G, Ozturk A. Hepatoprotective effect of Foeniculum vulgare essential oil. *Fitoterapia*.2003;74:317-19.
40. Yadav NP, Dixit VK. Hepatoprotective activity of leaves of Kalanchoe pinnata Pers. *Journal of Ethnopharmacology*. 2003;86:197-202.
41. Patel R. Hepatoprotective effects of Plectranthus amboinicus (Lour) Spreng against carbon tetrachloride-induced hepatotoxicity. *Journal of Natural Pharmaceuticals*.2011;2(1):28-35.
42. Shenoy S, Kumar H, Thashma, Nayak V, Prabhu K, Pai P, Warrier I, Somayaji, Madhav V, Bairy KL, Kishore A. Hepatoprotective activity of Plectranthus amboinicus against paracetamol induced hepatotoxicity in rats. *International journal of pharmacology and clinical sciences*. 2012;1(2):32-38.
43. Cardia GFE, Comar FMSS, Silva EL, Rocha EMT, Comar JF, Filho SES, Zagotto M, Uchida NS, Amado CAB, Cuman RKN. Lavender (Lavandula officinalis) essential oil prevents acetaminophen-induced hepatotoxicity by decreasing oxidative stress and inflammatory response. *Research, Society and Development*. 2021;10(3):1-16.
44. Selmi S, Jallouli M, Gharbi N, Marzouki L. Hepatoprotective and Renoprotective Effects of Lavender (Lavandula stoechas L.) Essential

Oils Against Malathion-Induced Oxidative Stress in Young Male Mice. *Journal Of Medicinal Food*.2015;0(0):1-9.

45. Saenthaweesuk S, Munkong N, Parklak W, Thaeomor A, Chaisakul J, Somparn N. Hepatoprotective and antioxidant effects of Cymbopogon citratus Stapf (Lemon grass) extract in paracetamolinduced hepatotoxicity in rats. *Tropical Journal of Pharmaceutical Research*. 2017;16(1): 101-107.
46. Ilango K, Chitra V. Hepatoprotective and Antioxidant Activities of Fruit pulp of Limonia acidissima Linn. *International Journal of Health Research*.2009;2(4):361-367.
47. Patil K, Mall A. Hepatoprotective activity of Mentha arvensis Linn. leaves against CCL4 induced liver damage in rats. *Asian Pacific Journal of Tropical Disease*.2012;S223-S226.
48. Dukic NM, Popovic M, Jakovljevic V, Szabo A, Gasic O. Pharmacological Studies Of Mentha Longifolia Phenolic Extracts Hepatoprotective Activity. *Pharmaceutical Biology*.1999;37(3):221-224.
49. Jain A, Soni M, Deb L, Jain A, Rout SP, Gupta VB, Krishna KL. Antioxidant and hepatoprotective activity of ethanolic and aqueous extracts of Momordica dioica Roxb. Leaves. *Journal of Ethnopharmacology*.2008;115:61-66.
50. Singh D , Arya PV , Aggarwal VP, Gupta RS. Evaluation of Antioxidant and Hepatoprotective Activities of *Moringa oleifera* Lam. Leaves in Carbon Tetrachloride-Intoxicated Rats. *Antioxidants.*2014;*3*:569-591.
51. Pari L, Kumar NA. Hepatoprotective Activity of Moringa oleifera on Antitubercular Drug-Induced Liver Damage in Rats. *Journal Of Medicinal Food*.2002;5(3):171-177.
52. Toppo R, Roy BK, Gora RH, Baxla SL, Kumar P. Hepatoprotective activity of Moringa oleifera against cadmium toxicity in rats. *Veterinary World*.2015;8:537-40.
53. Nirmala M, Girija K, Lakshman K, Divya T. Hepatoprotective activity of Musa paradisiaca on experimental animal models. *Asian Pacific Journal of Tropical Biomedicine*.2012:11-15.
54. Morita T, Jinno K, Kawagishi H,Arimoto Y, Suganuma H, Inakuma T,Sugiyama K. Hepatoprotective Effect of Myristicin from Nutmeg (Myristica fragrans) on Lipopolysaccharide/D-Galactosamine-Induced Liver Injury. *Journal of agricultural and food chemistry*.2003;51(6):1560-65.
55. Malar HLV, Bai SMM. Hepato-Protective Activity of Phyllanthus emblica Against Paracetamol Induced Hepatic Damage in Wister Albino Rats. *African Journal of Basic & Applied Sciences.*2009;1(2):21-25.
56. Prabhakaran V, Kumar BSA, Shekar DS, Nandeesh R, Subramanyam P, Ranganayakulu D. Evaluation of the hepatoprotective activity of Portulaca oleracea L. on D-galactosmaine-induced hepatic injury in rats. *Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas*. 2010;9(3):199-205.
57. Seif HSA. Ameliorative effect of Pumpkin oil (Cucurbita pepo L.) against alcohol-induced hepatotoxicity and oxidative stress in albino rats. *Beni- Suef University Journal of Basic and Applied Sciences*.2014;3(5);178-79.
58. Han KH, Hashimoto N, Shimada K, Sekikawa M, Noda T, Yamauchi H, Hashimoto M, Chiji H, Topping DL, Fukushima M. Hepatoprotective effects of purple potato extract against D-galactosmaine-induced Liver injury in rats. *Biosci.Biotechnol.Biochem*.2006;70(6):1432-1437.
59. Wang L, Zhao Y, Zhou Q, Luo CL , Deng AP, Zhang ZC, Zhang JL. Characterization and hepatoprotective activity of anthocyanins from purple sweet potato. *Journal Of Food And Drug Analysis*.2017;25:607-18.
60. Raskovic A, Milanovic I, Pavlovic N, Cebovic T, Vukmirovic S, Mikov M. Antioxidant activity of rosemary (Rosmarinus officinalis L.) essential oil and its hepatoprotective Potential. *BMC Complementary and Alternative Medicine*. 2014;14:1-9.
61. Kumar M, Sisodia SS , Anjoo K, Vaibhav R. valuation of Hepatoprotective Effect of Sesamum indicum Linn. Seed Extract against Paracetamol Induced Hepatotoxicity in Rats. *International Journal of Pharmaceutical and Clinical Research*. 2011;3(3):66-69.
62. Elhag RAM, El Badwi SMA, Bakhiet AO, Galal M. Hepatoprotective activity of Solanum nigrum extracts on chemically induced liver damage in rats. *International journal of urology and nephrology*.2018;6(1):1-6.
63. Ismail EA, Nafie E, Farid AS. Star Anise (Illiciumverum) oil administration alleviates carbon tetrachloride-induced hepatotoxicity in rats. *Benha Veterinary Medical Journal.* 2020;39:100-104.
64. Lin CC, Chen YL, Lin JM, Ujiie T. Evaluation of the antioxidant and hepatoprotective activity of Terminalia Catappa. *American Journal of Chinese medicine*.1997;25(2):153-161.
65. Weremfo A, Asamoah KA, Abassah-Oppong S. Preliminary Study on Hepatoprotective Activity of Tomato (Solanum lycopersicum L.) Pulp Against Hepatic Damage in Rats. *Advances in Biological Research*. 2011;5(5):248-250.
66. Azarmehr N, Afshar P, Moradi M, Sadeghi H, Sadeghi H, Alipoor B, Khalvati B, Barmoudeh Z, Goudarzi KA, Doustimotlagh AH. Hepatoprotective and antioxidant activity of watercress extract on acetaminophen-induced hepatotoxicity in rats. *Heliyon*. 2019;5:2072.
67. Murugaian P, Ramamurthy V, Karmegam N. Hepatoprotective Activity of Wedelia calendulacea L. Against Acute Hepatotoxicity in Rats. *Research Journal of Agriculture and Biological Sciences*.2008;4(6):685-687.
68. Rajoria A, Mehta A, Mehta P, Ahirwal L, Shukla S, Bajpai VK. Evaluation Of Antiproliferative And Hepatoprotective Effects Of Wheat Grass (Triticum Aestivum). *Acta Biologica Hungarica.*2017;68(2):150-161.
69. Udobang JA, Okokon JE , Obot D , Agu EC. Hepatoprotective Activity Of Husk Extract Of Zea Mays Against Carbon Tetrachloride-Induced Liver Injury In Rats. *Reseach Journal of Life Sciences, Bioinformatics, Pharmaceuticals And Chemical Sciences*.2019;5(5):82-94.
70. 70.Jia XY, Zhang QA, Zhang ZQ, Wanga Y, Yuan JF, Wang HY, Zhao D. Hepatoprotective effects of almond oil against carbon tetrachloride induced liver injury in rats. *Food Chemistry*.2011;125:673-678.
71. Doorika P, Ananthi T. Antioxidant and Hepatoprotective properties of Terminalia arjuna Bark on Isoniazid Induced Toxicity in Albino rats. *Asian Journal of Pharmacy and Technology*. 2012;2(1):15-18.
72. Said A, El-Fishawy AM, El-Shenawy S, Hawas UW, Aboelmagd M. Hepatoprotective And Gastro Protective Studies Of Terminalia Arjuna Leaves Extract And Phytochemical Profile. *Banat's Journal of Biotechnology*. 2014;10:30-36.
73. Ikechukwu E, Dennis C, Ogbonna S, Onukwube F, Augustine C, ANI N, Kennedy J, ANI O. Effects of Azadirachta indica leaf aqeous extract on the antioxidant enzymes in paracetamol-induced hepatotoxicity in Wistar rats. *International Journal of Biological and Chemical Sciences.* 2018;12(1):1-10.
74. Kalaivani T, Premkumar N, Ramya S, Siva R, Vijayakumar V, Meignanam E, Rajasekaran C, Jayakumararaj R. Investigations on Hepatoprotective Activity of Leaf Extracts of Aeglemarmelos (L.) Corr. (Rutaceae). *Ethnobotanical Leaflets*. 2009;13:47-50.
75. Ikyembe D, Pwavodi C, Agbon AN. Hepatoprotective Effect of Methanolic Leaf Extract of Anacardium occidentale (Cashew) on Carbon-Tetrachloride-Induced Liver Toxicity in Wistar Rats. *Sub-Saharan African Journal of Medicine*. 2014;1(3):124-131.
76. Swamy AHMV, Kulkarni RV, Koti BC, Gadad PC, Thippeswamy AHM. Hepatoprotective Effect of Cissus quadrangularis Stem Extract Against Rifampicin-induced Hepatotoxicity in Rats.*Indian Journal of pharmaceutical sciences*. 2012; 74(2):183-7.
77. Ashok kumar BS, Lakshman K, Arun Kumar PA, Viswantha GLS, Veerapur VP, Thippeswamy BS, Manoj B. Hepatoprotective activity of methanol extract of Amaranthus caudatus Linn. against paracetamol-induced hepatic injury in rats. *Journal of Chinese integrative medicine*. 2011;9(2):194-200.

78. Kale I, Khan MA, Irfan Y, Goud AV. Hepatoprotective potential of ethanolic and aqueous extract of flowers of Sesbania grandiflora (Linn) induced by CCl4. Asian Pacific Journal of Tropical Biomedicine. 2012:S670-S679.
79. Al-Dosari MS. The Effectiveness of Ethanolic Extract of Amaranthus tricolor L.: A Natural Hepatoprotective Agent. *The American Journal of Chinese Medicine*. 2010;38(6):1051–1064.
80. Das M, Basu S, Banerjee B, Sen A, Jana K, Datta G. Hepatoprotective Effects of Green Capsicum annum against Ethanol Induced Oxidative Stress, Inflammation and Apoptosis in Rats. *Journal of Ethnopharmacology*. *2018;*227(4):1-15.
81. Ahmad B, Khan W, Haq TU, Ahmad S , Zahoor M, Alotaibi A, Ullah R. Beneficial effects of coconut oil (Cocos nucifera) on hematobiochemicl and histopathological markers in CCL4-intoxicated rabbits. *Brazilian Journal of Biology*. 2021;84:1-8.
82. Alex D, Ajuka N, Otuchristian G, Danladi GJ, Okon MU. Protective Effect of Methanol Stem Bark Extract of Cocos nucifera on Paracetamol-induced Hepatotoxicity in Adult Wistar Rats. International Journal of Tropical Disease & Health. 2016;11(4):1-10.
83. Babu PS, Krishna V, Maruthi KR , Shankarmurthy K, Babu RK. Evaluation of acute toxicity and hepatoprotective activity of the methanolic extract of Dichrostachys cinerea (Wight and Arn.) leaves. *Pharmacognosy Research*.2011;3(1):40-43.
84. Gond NY, Khadabad SS. Hepatoprotective Activity of Ficus carica Leaf Extract on Rifampicin-Induced Hepatic Damage in Rats. *Indian Journal of Pharmaceutical Sciences*. 2008, 364-66.
85. Krishna Mohan G, Pallavi E, Ravi Kumar B, Ramesh M, Venkatesh S. Hepatoprotective activity of Ficus carica Linn. leaf extract against carbon tetrachloride-induced hepatotoxicity in rats. DARU Journal of Pharmaceutical Sciences. 2007;15(3):162-66.
86. Aghel N, Kalantari H, Rezazadeh S. Hepatoprotective Effect of Ficus carica Leaf Extract on Mice Intoxicated with Carbon Tetrachloride. Iranian Journal of Pharmaceutical Research. 2011;10(1):63-68.
87. Fahmi A, Hassanen N, Abdur-Rahman M, Shams-Eldin E. Phytochemicals, antioxidant activity and hepatoprotective effect of ginger (Zingiber officinale) on diethylnitrosamine toxicity in rats. *Biomarkers.* 2019;24(5):436-447 .
88. Abdel-Azeem AS, Hegazy AM, Ibrahim KS, Farrag ARH, El-Sayed EM. Hepatoprotective, Antioxidant, and Ameliorative Effects of Ginger (Zingiber officinale Roscoe) and Vitamin E in Acetaminophen Treated Rats. *Journal of Dietary Supplements*.2013;10(3):195-209.
89. Ahmad F, Khan GM. Study of Aging and Hepatoprotective Activity of Vitis vinifera L. Seeds in Albino Rats. *Asian Pacific Journal of Tropical Biomedicine*. 2012:S1770-S1774.
90. Biswas A, D'Souza UJA, Bhat S, Damodar D. The Hepatoprotective Effect Of Hibiscus Rosa Sinensis Flower Extract On Diet - Induced Hypercholesterolemia In Male Albino Wistar Rats. International Journal of Medical & Pharmaceutical Sciences. 2014;4(6):1-10.
91. Kumar SVS, Kumar CV, Vardhan AV. Hepatoprotective Activity Of Aclypha Indica Linn Against Thioacetamide Induced Toxicity. *International Journal of Pharmacy and Pharmaceutical Sciences*.2013;5(4):356-359.
92. Huang B, Ban X, He J, Tong J, Tian J, Wang Y. Hepatoprotective and antioxidant activity of ethanolic extracts of edible lotus (Nelumbo nucifera Gaertn.) leaves. *Food Chemistry*.2010;120:873-878.
93. Omotayo MA, Ogundare OC, Oluwafunmilayo A. Hepatoprotective Effect Of Mangifera-Indica Stem Bark Extracts On Paracetamol-Induced Oxidative Stress In Albino Rats. *European Scientific Journal*. 2015;11(24):299-309.
94. Pourahmad J, Eskandari MR, Shakibaei R, Kamalinejad M. A Search for Hepatoprotective Activity of Fruit Extract of Mangifera indica L. Against Oxidative Stress Cytotoxicity. *Plant Foods for Human Nutrition*.2010;65:83-89.
95. Lahon K, Das S. Hepatoprotective activity of Ocimum sanctum alcoholic leaf extract against paracetamol-induced liver damage in Albino rats. *Pharmacognosy Research*. 2011;3(1):13-18.
96. Sadeque MZ, Begum ZA. Protective effect of dried fruits of Carica papaya on hepatotoxicity in rat. *Bangladesh journal of pharmacology*. 2010;5:48-50.
97. Pandit P, Sachdeva T, Bafna P. Ameliorative Effect of Leaves of Carica papaya in Ethanol and Antitubercular Drug Induced Hepatotoxicity. *British Journal of Pharmaceutical Research*. 2013;3(4):648-661.
98. Adeneye AA, Olagunju JA , Banjo AAF , Abdul SF , Sanusi OA , Sanni OO, Osarodion BA, Shonoiki OE. The Aqueous Seed Extract Of Carica papaya Linn. Prevents Carbon Tetrachloride Induced Hepatotoxicity In Rats. *International Journal of Applied Research in Natural Products*. 2009;2(2):19-32.
99. Zhang C, Zhao J, Famous E, Pan S, Peng, X, Tian J. Antioxidant, hepatoprotective and antifungal activities of black pepper (Piper nigrum L.) essential oil. *Food Chemistry*.2021;346:1-10.
100. Jain NK, Singhai AK. Protective effects of Phyllanthus acidus (L.) Skeels leaf extracts on acetaminophen and thioacetamide induced hepatic injuries in Wistar rats. *Asian Pacific Journal of Tropical Medicine*. 2011:470-74.
101. Manigauha A, Patel S, Ali H, Chandy A, Maheshwari MU. Study the Effect of Phytochemical Constituents of Piper betel Leaves Extracts on Liver Disorders by in vivo Model. *Journal of Pharmacy Research*.2009;2(3):353-56.
102. Jalalpure SS, Patil MB, Prakash NS, Hemalata K, Manvi FV. Hepatoprotective activity of the fruits of Piper Longum Linn. *Indian Journal of pharmaceutical sciences*.2003;65(4):363-66.
103. Bhuyan B, Baishya K, Rajak P. Effects of Alternanthera sessilis on Liver Function in Carbon Tetra Chloride Induced Hepatotoxicity in Wister Rat Model. *Indian Journal of Clinical Biochemistry*. 2018;33(2):190-195.
104. Parmar M, Shah P, Thakkar V, Al-Rejaie S, GAndhi T. Hepatoprotective Potential Of Methanolic Extract Of Vetiveria Zizanioides Roots Against Carbon TetrachlorideInduced Acute Liver Damage In Rats. Digest Journal of Nanomaterials and Biostructures. 2013;8(2):835-844.
105. Kavitha BT, Shruthi SD, Rai SP, Ramachandra YL. Phytochemical analysis and hepatoprotective properties of Tinospora cordifolia against carbon tetrachloride-induced hepatic damage in rats.Journal of Basic and Clinical Pharmacy. 2011;2(3):139-142.

**HOW TO CITE THIS ARTICLE**

Pavithra J, Jiji KN, Francis Kevin Raj S, Govindhan E, Yuvaraj K, Muralidharan P. A Critical Review on Herbal Extracts as Hepatoprotective Agents. J Ayu Herb Med 2023;9(1):21-28. DOI: 10.31254/jahm.2023.9105