Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 10 [4] March 2021 : 36-47
©2021 Academy for Environment and Life Sciences, India
Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Review on Hepatoprtoective Activity Of Some Medicinal Plants In India

Veerakumar D, Muthulingam M
Department of Zoology, Annamalai University, Annamalainagar – 608 002. Tamilnadu, India
Correspondence: veerakumarduraisamy1992@gmail.com

ABSTRACT
Liver illnesses are a significant medical issue around the world, making it important to grow new particles that help balance or forestall such maladies. By virtue of this reality, examinations intending to get characteristic and additionally synthetic compounds having hepatoprotective action have been embraced. Around 10 Lakh patients of liver cirrhosis are recently diagnosed each year in India. Liver sickness is the 10th most common reason for death in India according to the WHO. Liver illnesses may influence each one of every 5 Indians. The purpose of this work was to search for medicinal plants in India particularly Tamilnadu that have been evaluated for their hepatoprotective effect in different models. In this review we found only 12 plants evaluated for hepatoprotective activity: Acacia catechu Willd, Asteracantha longifolia (Nees.), Ceriops decandra (Griff.) Ding Hou, Erythrina indica. Lam., Ipomoea staphylina (Linn) (Roem & Schult.), Luminetzera racemosa, Morinda tinctoria Roxb, Polygala arvensis Willd, Ricinus communis L., Strychnos potatorum Linn., Tridax procumbens Linn. (Coat Buttons), Zanthoxylum armatum DC. This study describes the studies conducted in Tamilnadu, India for each of them and the international literature reports of pharmacological and phytochemical studies.
Keywords*: Liver, Hepatotoxicity, Medicinal Plants, Hepatoprotective plants, Hepatocuration, Hepatoprotective activity in India.*

Received 29.12.2020 Revised 05.01.2021 Accepted 09.03.2021

INTRODUCTION

The Greek word for liver is hepar, so therapeutic terms identified with liver regularly start with hepato or hepatic [1]. Liver is the biggest organ, representing roughly 2%–3% of normal body weight. The liver has 2 lobes and situated in the correct upper quadrant of the stomach cavity underneath the privilege hemi-stomach, it is ensured by the ribcage and keeps up its situation through peritoneal reflections, alluded to as ligamentous connections. Despite the fact that false tendons, these connections are a vascular and are in coherence with the Glisson container or what could be compared to the instinctive peritoneum of the liver [2].

The liver is an imperative organ that functions as a centre for digestion of supplements (carbohydrates, proteins and lipids) and discharge of xenobiotics from the body, in this manner giving security against foreign substances through detoxification and end forms [3]. This detoxification procedure is significant on the grounds that generally the exogenous synthetics may cause over generation of free radicals that are unsafe to liver typical capacities [4].

In 2018, the National statistics in the UK ranked liver illnesses as one of the significant reasons for death [5, 6]. Around the globe about 20,000 passings and 2, 50,000 new cases found every year [7]. Liver sicknesses are undermining the cutting edge world with its morbidity and mortality and occurrence of liver maladies are expanding step by step with an adjustment in individuals' way of life [8]. The World Health Organization (WHO) verified that around 2.4 million passings yearly are connected to some liver sickness, and that around 800 thousand of these passings are owing to cirrhosis [9, 10].

E-Times entertainment times report on Earlier regularly brought by Hepatitis B and C the most reasons of liver infections would now be able to be called liquor and other obesity released disorders. There has been a paradigm shift in the dynamics of liver cirrhosis and about 10 Lakh new patients are determined to have it consistently in India. Around, 10 Lakh patients of liver cirrhosis are recently analyzed each year in India. Liver malady is the tenth most common cause of death in India according to the WHO. Liver malady may influence each out of 5 Indians [11]. Regardless the advances in present day medicine and

the improvement of new hepatoprotective medications, the frequency of hepatic sicknesses has not diminished or halted; in actuality, statistics recommend that these keep on expanding [12].
Natural products are assuming a fundamental job in human services for a considerable length of time. Frequently various wellsprings of natural products, plants have been a source of compound substance, which fills as drugs in their very own privilege or key fixings in detailing containing manufactured drugs. The choice of the plant species is a vital factor for a definitive achievement of examination. Through irregular determination gives some clue, targeted collection dependent on chemotaxonomic connections and ethnomedical data got from Tradition Medicine are bound to yield pharmacologically active compounds. In spite of the fact that the advances in present day drugs are noteworthy, there remains an ever expanding demand for herbal medicines. Successful and intense herbal medicines require assessment by standard logical strategies in order to be approved for the treatment of diseases [13].

MATERIAL AND METHODS

In this review paper, bibliographic research was recognized through publication books, articles and indexed as well as non-indexed journals. The indexed articles were found via looking through Google Scholar, Web of Science, Pub-Med, Medigraphic, imbiomed, Scifinder and Science Direct, using the accompanying terms: hepatoprotective activity, plant extract, hepatoprotective plants, Hepatoprtoective activity in India.
Moreover, non-indexed sources were findout through wellbeing websites and Worldwide Health agency reports. We just thought about plants with a point by point depiction of hepatoprotective activity.

HEPATOTOXICITY INDUCING AGENTS

The molecules answerable for liver harm are called hepatotoxins; these days it is conceivable to mirror any type of characteristic starting point hepatic ailment with various substance sub-positions and pharmaceuticals. Hepatotoxins may be classified as intrinsic if the agent's behavior is predictable; there is a time of consistent inertness among presentation and liver harm advancement, or the damage is dose-dependent (*i.e.* carbon tetrachloride {CCl4}, thioacetamide, acetaminophen, ethanol). Another classification (characterization) is idiosyncratic, if the agents are not unsurprising, yet create liver harm in only a little segment of uncovered people, the damage isn't identified with the dosage, it happens after a variable inert period and it isn't reproducible in experimental creatures (*i.e.* halothane, sulfonamides, isoniazid) [14].

Carbon tetrachloride (CCl_4):

Carbon tetrachloride, an uncolored and uninflammable fluid, has been comprehensively applied to impersonate oxidative stress in creature model examinations [15]. First has been accounted for on CCl_4 making hepatotoxicity in rodents in 1936 [16, 17]. CCl_4 is not a medication, but high doses (≥1 mL/kg) do cause reproducible intense liver damage [18].

Mode of Action CCl_4

Carbon tetrachloride is metabolized by cytochrome P-450 in endoplasmic reticulum and mitochondria with the formation of CCl_3O-, a reactive oxidative free radical, which initiates lipid peroxidation [19]. Administration of a single dose of CCl_4 to a rodent produces, inside 24 hrs, a centrilobular corruption and greasy changes. The toxin arrives at its most extreme fixation in the liver inside 3 hrs of organization. From that point, the level falls and by 24 hrs there is no CCl_4 left in the liver. The development of necrosis is associated with leakage of hepatic enzymes into serum. Dose of CCl_4 that induces hepatotoxicity ranges from 0.1 to 3 ml/kg administered intraperitoneally [20].

Paracetamol (Acetaminophen):

Paracetamol, also known as acetaminophen, is the most commonly used antipyretic and pain reliever and since 1955 it is available over-the-counter as a single formulation or in combination with other substances and, as indicated by the World Health Organization, it can be used in all the three steps of pain intensity. Paracetamol poisonous quality is one of the most widely recognized reasons for harming around the world. While paracetamol is portrayed as generally nontoxic when directed in helpful dosages, it is known to cause poisonous quality when taken in a solitary or rehashed high portion, or after incessant ingestion. Rehashed supratherapeutic abuse, non-deliberate abuse, and purposeful ingestion may all bring about hepatic poisonous quality, the primary driver of intense liver disappointment (ALF) in the United States and Europe [21].

Mode of Action Paracetamol

Paracetamol administration causes necrosis of the centrilobular hepatocytes portrayed by nuclear pyknosis and eosinophilic cytoplasm followed by enormous unreasonable hepatic sore. The covalent binding of N-acetyl-P-benzoquinoneimine, an oxidative result of paracetamol to sulphydryl groups of protein, result in lipid peroxidative degradation of glutathione level and in this way, produces cell necrosis in the liver. Dose of Paracetamol is 1 gm/kg Post oral [22].

D-Galactosamine

This hepatotoxin creates a comparative harm to viral hepatitis regards to morphologic and functional qualities. A single dose can cause hepatocellular necrosis and fatty liver [10].

Mode of Action D-Galactosamine

It actuates the fatigue of the uracil nucleotide, bringing about the hindrance of RNA synthesis and consequently of proteins. The poisonous mechanism causes loss of the activity of ion pumps and an increase in cellular membrane permeability, leading to enzyme liberation and an increase in intracellular Ca^{2+} concentration, which is considered responsible for cellular demise [23].

Ethanol

Globally, long-term heavy alcohol use is one of the most important causes for illness and death from liver disease. Reports indicate that alcoholic liver disease is the second most common reason for liver transplantation. Chronic ethanol ingestion is reported to induce free radicals; stimulate hepatic oxygen consumption; and cause fatty liver, hepatomegaly, inflammation, fibrosis, and cirrhosis [24, 25]. Alcohol is a psychoactive substance and its abusive consumption is associated with various health problems worldwide [26].

Mode of Action Ethanol

The damage mechanism is due to the metabolism of ethanol by the CYP2E1 isoform of the cytochromeP450 producing oxidative stress with the generation of reactive species of oxygen and the increase of lipid peroxidation, leading to the alteration of the compositions of phospholipids of the cellular membrane[27]. Membrane lipid peroxidation results in the loss of its structure and integrity, elevating serum levels of glutamyl-transpeptidase, a membrane-bonding enzyme. Ethanol inhibits glutathione peroxidase; it reduces the activity of catalase and dismutase superoxide [28]. The decrease in the activity of antioxidant enzymes, dismutase superoxide and peroxidase glutathione is believed to come as a result of the harmful effects of free radicals produced after exposure to ethanol, or alternatively, they could be a direct effect of acetaldehyde, a product of ethanol oxidation.

Thioacetamide

Thioacetamide (TAA) is utilized as a fungicide and considered a source of sulfur in industrial field [29]. Originally used as a fungicide and currently used for the treatment of leather, in labs and in the textile and paper industries [30]. The experimental hepatotoxicity of TAA in rodents was first studied in 1948 [31]. Cell death (apoptosis and necrosis) takes place in a sequential fashion after TAA intoxication. Although, TAA causes hepatic centrilobular necrosis by generating of ROS, also it can cause hepatic apoptosis within a few hours after its administration [32]. Thioacetamide having chemical formulae on C_2H_5NS [33].

Mode of Action Thioacetamide

TAA undergoes extensive metabolism in the liver, and less than 1% of the dose is excreted unchanged. TAA-induced toxicity results from its bioactivation via cytochrome P450 (CYP) and flavin containing mono-oxygenases. Further, CYP2E1 plays a major role in the generation of toxic intermediates. Metabolic activation of TAA then leads to the formation of reactive metabolites, which are represented by sulfin or sulfen metabolites derived from thioacetamide S-oxide and reactive oxygen species (ROS) generated as intermediates. Mechanisms responsible for the development of TAA induced liver injury have been studied intensively. It is generally accepted that reactive intermediates can covalently bind to cellular macromolecules and/or induce oxidative stress. ROS generated following TAA administration can cause lipid peroxidation and glutathione depletion. In addition, TAA also induces calcium mobilization from intracellular stores. Both ROS and calcium presumably activate multiple reactions related to cellular damage or proliferation. Increased ROS formation and disruption of calcium homeostasis can increase inner mitochondrial membrane permeability, disrupt mitochondrial membrane potential, and inhibit mitochondrial respiration [34].

EVALUATION MODELS

The objective of hepatoprotective models is for the compounds, fractions or extracts being tested to counteract or avoid the damage generated by hepatotoxins. The magnitude of the hepatoprotective effect can be measured through biochemical makers, survival rate or histology of the liver. Test methods may be *in vitro, ex vivo* or *in vivo*; and each one of them can be evaluated to see if the substance is hepatoprotective or hepatocurative, depending on if the hepatoprotective agent is administered before or after the hepatotoxin [10].

***In vitro* Models**

In this models used to fresh hepatocytes, primary hepatocyte cultures and immortalized cell lines and measured to the hepatoprtoective activity. Invitro models possible on establish action of mechanisms. In this way we can easily find out the mechanism of action at a cellular and molecular level of hepatoprotective compound. Hepatocytes are treated with hepatotoxin and the impact of the test

medicate on the equivalent is assessed. The exercises of the transaminases discharged into the medium are resolved. An expanded action of marker transaminases in the medium demonstrates liver harm. Parameters for example, hepatocytes increase, morphology, macromolecular synthesis and oxygen consumption are resolved [35].

Advantages of *In vitro* models

They are quick tests (between 2-3 testing days), they require small amounts of the test substances (milligram range) and the experimental conditions may be strictly controlled; different samples may be analyzed in the same test, they are cheap tests and there is little variability; therefore they are considered are producible test. In the case of primary cultures or fresh hepatocytes, they require few experimental animals in comparison to *in vivo* models.

Disadvantages of *In vitro* models

Because of an absence of multifaceted nature present in the organ of biological system, results ought to be translated with alert. Samples do not undergo any biotransformation process.

***Ex vivo* Models**

Precision cut liver slices (PCLS) are an *ex vivo* tissue culture which imitates multi cellular characteristics of *in vivo* organs. Cellular interaction and spatial disposition remain intact in this model, with the possibility of performing morphological studies. Liver slices have the characteristic of functionally maintaining metabolizing enzymes and biliary canaliculus; they have proven to be a valid *ex vivo* system to study metabolism and liver damage and function As a Bridge between *in vivo* systems and cell cultures [36]. Isolated perfused livers represent model combining in vitro characteristics under *in vivo* circumstances. The first model was developed in porcine livers and later the livers of smaller animals (rats, mice and rabbits). This model preserves the tridimensional structure as well as the cell-to-cell interactions with the possibility of collecting bile in real time. If blood is used as a perfusor liquid, then hemo dynamic parameters may be studied [37].

Advantages of *Ex vivo* Models

Resemble the *in vivo* environment. Decrease the number of animals experimented on. A human tissue model can be developed.

Disadvantages of *Ex vivo* Models

Low oxygenation rate in the internal cells. Low cut viability (1-10 días). There are significant differences in size and function between human and murine tissue.

***In vivo* models**

This model has been widely used; through this model we are able to determine the protection mechanism. The test substance is administered alongside, preceding and additionally after the toxin treatment. Liver harm and recuperation from harm are surveyed by measuring serum marker enzymes, bilirubin, bile flow, histopathological changes and biochemical changes in liver. An augmented level of liver marker enzymes such as glutamate pyruvate transaminase (GPT), glutamate oxaloacetate transaminase (GOT) and alkaline phosphatase in the serum indicates liver damage [38].

Advantages of *in vivo* models:

It is the model with the highest degree of correlation with what occurs in humans and all biochemical and histopathological parameters can be measured. They let us take into account the possible effects of the immune and central nervous systems in the development of hepatic diseases [37].

Disadvantages of *in vivo* models

They require a large number of animals, and usually the studies are developed for long periods of time, increasing ethical and financial aspects. There is an inter-individual variation, and even though models imitating the different hepatic diseases have been developed, there are relevant differences in the molecular pathogenesis between the model and human species. They require a larger sample size to perform the experiment which may be a limiting factor, especially when analyzing natural products [39].

LIVER FUNCTION TEST

Liver function test is one of the most regularly performed research center examinations and comprises of a board of lab estimated serum parameters. It doesn't assess function of the liver directly yet elucidation, as a panel, reflects underlying hepatocellular damage, metabolic and synthetic functions of the liver and supplement clinical evaluation. The liver comprises of three frameworks: the hepatocytes answerable for biochemical metabolism; the biliary canaliculi liable for bilirubin transport; and the reticulo endothelial system with Kupffer cells for immune defence. Significant points to recollect in assessment of liver failure include, first, that liver transaminases reflect hepatocellular necrosis. It requires a specific level of residual cellular integrity for transaminases to be raised.

Second, biochemical derangement may only manifest when most lobular architecture is destroyed by chronic inflammation and fibrosis in advanced cirrhosis. Third, many parameters of liver function testing

are not uniquely produced in the liver, and extra-hepatic causes may present as deranged liver function. Detailed clinical history and bedside physical examination are paramount. Laboratory evaluation differentiates six causes of liver failure, hepatitis, cirrhosis, biliary disease, space occupying lesions, passive congestion and fulminant liver failure [40].

Liver Function Markers can be divided into tests identified with the liver's excretory function (bilirubin), tests related to synthetic function (albumin and prothrombin time) and tests related to the integrity of hepatocytes (transaminases, alkaline phosphatase, GGT) [41].

Transaminases or Aminotransferases

Aminotransferases take an interest in gluconeogenesis by catalyzing the exchange of amino groups from aspartic acid or alanine to ketoglutaric acid to produce oxaloacetic acid and pyruvic acid. ALT is found in its most concentrations in the liver and is more explicit to the liver than is AST, which is found in the liver, cardiac muscle, skeletal muscle, kidneys, brain, pancreas, lungs, leukocytes, and red cells. Expanded AST levels are accordingly less sensitive and explicit for liver damage. Normal values for ALT: 0 to 45 IU/L, AST: 0 to 45 IU/L [42].

Alkaline phosphatase (ALP)

ALP is a family of zinc metallohydrolase enzymes found in liver, bone, kidney, intestinal epithelium, placenta and germ cells. Hepatic isoenzyme is distinguished by heat fractionation (moderately heat stable) and electrophoretic separation. As hepatic ALP is attached to biliary canaliculi, raised levels are a predominant feature in cholestatic liver diseases, often together with elevated conjugated bilirubin. The site of biliary obstruction can be either intra-hepatic (malignancy, primary biliary cirrhosis, sclerosing cholangitis, drug induced, sepsis and infiltrations) or extra-hepatic (malignancy, choledocholethiasis). Nonappearance of intestinal ALP in extra-hepatic obstruction may be useful to identify the site of obstruction but lacks high sensitivity and specificity [40]. Normal ALP Values on 30 to 120 IU/L.

Albumin

It is the fundamental protein made by our liver. It performs numerous significant bodily capacities. For instance

1. Albumin fluid from spilling out of our veins
2. Nourishes our tissues
3. Transports hormones, nutrients and different substances all through our body.

An albumin test estimates utilized for the liver making this specific protein. Albumin found in under sum liver isn't working appropriately. The ordinary range for albumin is 3.5-5.0 grams decilitter (g/dL). Be that as it may, low albumin can likewise be a result of poor nutrition, kidney sickness, infection and irritation.

Bilirubin

It is a waste item from the breakdown of RBC. It is commonly prepared by the liver. It goes through the liver before being discharged through our body stool. A harmed liver can't appropriately process bilirubin. This prompts an anomalous significant level bilirubin in the blood. A significant level of the bilirubin demonstrate to the liver doesn't working appropriately. Total bilirubin ordinary range on 0.1-1.2 milligrams per decilitter (mg/dL). There are sure inherited diseases that raise bilirubin levels, yet the liver function is ordinary [43].

Total proteins

The liver synthesizes most plasmatic proteins, and in most hepatic ailments the levels are diminished. Albumin,α -1 antitrypsin, ceruloplasmin, and α -fetoprotein are proteins connected to intense liver harm.

Lactate deshydrogenase (LDH)

Lactate deshydrogenase is a catalyst situated in the cell cytoplasm. It catalyzes the inter change of the lactate and pyruvate; LDH freedom might be translated as the opening of the cellular membrane or cellular demise. This enzyme isn't explicit to the liver and it is generally used in *in vitro* models since it is communicated in most cellular lines[44].

AST, ALT and ALP are most normally examined in every hepatoprotective model, while the measurement of total proteins and LDH are commonly utilized as parameters of *in vitro* cytotoxicity [45].

HEPATOPROTECTIVE PLANTS:

Liver malady is one of the genuine medical issues. Natural medications assume a significant job in the treatment of hepatic issue. In the absence of reliable liver hepatoprotective drugs in present day drug, in India a various therapeutic plants and their formulations are utilized to cure hepatic disorders in traditional system of medicines In Himalayan region there are numerous plants which are use in liver sickness [46].

Many plants have been so far analyzed to be taken for a wide range of liver illnesses [47]. Natural products, including herbal extracts, could essentially add to recovery processes of the intoxicated liver. As indicated by reliable scientific information obtained from the research on therapeutic plants, plants such

as *Silybum marianum*, *Glycyrrhiza glabra*, *Phyllanthus* species (amarus, niruri, emblica), and *Picrorhiza kurroa* have been generally and more often than not productively applied for the treatment of liver issue, applying their belongings by means of via antioxidant-related properties [48, 49].

Herbal based therapeutics for liver issue has been being used in India for quite a while and has been advanced world over by leading pharmaceuticals. Regardless of the noteworthy fame of a few herbal drugs in general, and for liver diseases in specifically, they are still unacceptable treatment modalities for liver illnesses. The restricting factors that add to this inevitability are

(i) Lack of institutionalization of the herbal medications;
(ii) Lack of distinguishing of active ingredient(s)/principle(s);
(iii) Lack of randomized controlled clinical trials (RCTs) and
(iv) Lack of toxicological evaluation [50].

The utilization of natural solutions for the treatment of liver ailments has a long history, beginning with the Ayurvedic treatment, and reaching out to the Chinese, European and different frameworks of traditional drugs. An enormous number of plants and formulations have been professed to have hepatoprotective activity. About 160 phytoconstituents from 101 plants have been claimed to possess liver securing action. In India, in excess of 87 plants are utilized in 33 patented and restrictive multi-ingredient plant formulations [51].

Notwithstanding the huge advances made, no noteworthy and safe hepatoprotective agents are accessible in present day therapeutics. In this manner, due significance has been given globally to create plant based hepatoprotective drugs viable against a assortment of liver issue. The present review is aimed for ordering information dependent on reported works on promising phytochemicals from medicinal plants that have been tested in hepatotoxicity models. The hepatoprotective activities of *Acacia catechu* Willd, *Asteracantha longifolia* (Nees.), *Ceriops decandra* (Griff.) Ding Hou, *Erythrina indica.* Lam., *Ipomoea staphylina* (Linn) (Roem & Schult.), *Luminetzera racemosa, Morinda tinctoria* Roxb, *Polygala arvensis* Willd*, Ricinus communis* L.*, Strychnos potatorum* Linn., *Tridax procumbens* Linn. (Coat Buttons)*, Zanthoxylum armatum* DC.

***Acacia catechu* Willd.**

Acacia catechu is a deciduous tree of family Fabaceae [52]. *Acacia catechu* is an industrially exploited tree for its heartwood. It likewise has various ethnomedicinal utilizes particularly in gastrointestinal tract-related disorders. It has various references in Ayurveda and Chinese traditional medicinal system. The decoction of bark in milk is utilized to treat cough, cold and diarrhea [53]. *Acacia catechu* privately known as karungali in Tamil (English name: Black cutch) [54].

Acacia catechu already possesses hepatoprotective property found in the heartwood. Lakshmi *et al*. [55] was used to the experiment female wistar rats. Hepatotoxicity induced by acetaminophen (APAP). In this study researcher used by the ethanolic extracts of Seeds and stem bark. Oral administration of APAP (750 mg/kg body weight), After the administrate on same dose level on seed and bark (400 mg/kg body weight), compared to on Anti- dote N-acetylcysteine (NAC). APAP Treated rats was shown on increased Body and liver weight at the same time decrease the liver function enzymes such as ALT, ALP and AST and reduced of antioxidant enzymes such as GSH, SOD. At the same time, Histopathology results of APAP treated rats showed on moderate degree of sinusoidal congestion, centrilobular necrosis with polymorph nuclear cells infiltration, marked vacuolations and congestion. After the treated with Ethanolic extract of seed and bark treated groups reduced LPO accumulation, decreased the liver enzymes and increased antioxidant enzymes. Ethanolic extract of Seed and bark extract showed on hepatoprotective activity[55]. Due to the presence of bioflavonoids which have antioxidant and hepatoprtoective properties.

***Asteracantha longifolia* (Nees.)**

Asteracantha longifolia (Synonym: *Hygrophila auriculata* (K. Schum) Heine, *H. schulli* (Ham.) MR & SM Almeida, *H. spinosa* T. Anders, *Barleria auriculata* Schum and *B. longifolia* Linn) has a place with family Acanthaceae. It is an erect semi woody plant found in most places throughout India along the banks of fresh or stagnant water ditches and swampy grounds, mixed with marshy grasses and sedges [56]. *A. longifolia* is portrayed as seethaveryam and mathuravipaka in the Ayurvedic writing (sushruta samhita and charak samhita). The plant was depicted as ikshura, ikshagandha and kokilasha, which means plant looking like eyes of the kokila (Indian cuckoo) by Morphologically and announced as medicine for premeham (diabetes) and athisaram (dysentery). This plant seeds are perceived as solutions for arthritis and sicknesses of the blood and biliousness. Bitter seeds are considered as aphrodisiac and tonic and used as a uterine sedative for pregnant women. The seeds are given with sugar or milk in the treatment of impotency, gonorrhea and spermatorrhoea. A paste of seeds, mixed with buttermilk, is given for diarrhea. This plant has on many pharmacological activities such as Antimicrobial, anthelmintic, antitermite, nephroprotective, hepatoprotective, central nervous system protective, antitumor, antidiabetic,

anticataract, antioxidant, haematopoietic, diuretic, antinociceptive, antiinflammatory, antipyretic, antimotility, aphrodisiac, neuroprotection, anti-endotoxin and antiurolithiatic activity [57].

The results showed *Asteracantha longifolia* significantly restored the liver marker enzymes lipid profiles and antioxidant markers in CCl_4 induced toxicity in wistar albino rats. *A.longifolia* possesses significantly hepatoprotective and antioxidant effects due to the presence of phytochemicals [58].

***Ceriops decandra* (Griff.) Ding Hou**

Ceriops decandra is a shrubby mangrove types of the Rhizophoraceae family found in the Sundarban estuary in India. The species has been accounted for to be utilized by traditional healers as alleviation for wounds, boils, hepatitis, ulcers, angina, diabetes, diarrhea and dysentery [59]. Its local name on Cirukandal in pichavaram it develops alongside with *Bruguiera cylindrica*, only neighboring *Rhizophora* species. Re- presented in Muthupet mangroves *Ceriops decandra* was reintroduced in little numbers by the Tamil Nadu Forest Department in 2001 under Biodiversity Enrichment Programme. *Ceriops tagal*, which is like *Ceriops decandra* has long peduncle, with a hanging fruit and longer hypocotyls [60]. *Ceriops decandra* it is on legends drug, the bark and leaf parts are utilized as remedy for ulcer and hepatitis [61].

Ethanol: water mixture extracts of leaves *Ceriops decandra* reversed the toxicity produced by CCl_4 in wistar rats. The extract at the doses of 100 mg/kg, 200 mg/kg and 400 mg/kg are comparable to the effect silymarin. Hepatoprotective nature was find out as dose dependent manner and the liver marker enzymes found to be significantly decreased compared on toxic group. The result of histopathology did not show any significant variations between to the control and high dose (400 $mg/kg^{-1}bw$) of leaf extract treated animals. The study of the preliminary phytochemical analysis showed on various phytochemicals presented on such as phenols, alkaloids, triterpenoids, flavonoids, catechin and anthraquinone. On the other hand, in vitro antioxidant study also was carried out; IC_{50} value identified with hypocotyl extract in the SOD assay was 169.92 ± 2.02g ml^{-1}. Hepatoprotective activity of the *C.decandra* leaf extract might be due to the occurrence of unique secondary metabolites and their antioxidant scavenging properties [62].

***Erythrina indica.* Lam.**

Erythrina indica (Family: Papilionaceae) is a medium sized tree generally appropriated all through India. Traditionally, its leaves are utilized as purgative, diuretic, emmenagogue, galactagogue and furthermore utilized in the treatment of worm infestation, liver ailment and joints torment [63]. Prior scientific examination of *E. indica* demonstrated that the crude extract has anti-osteoporotic, cytotoxic, cardiovascular, central nervous system effect, anthelmintic, analgesic, antiulcer, antioxidant, and diuretic action [64]. Equivalent words of this plant *Erythrina variegata* orientalis, *Erythrina variegata* parcelli, *Erythrina variegata* picta. Vernacular names of the *Erythrina indica* English name: Indian coral tree, Tigers clow, Moochy wood tree, Sunshine tree; Tamil: Kalyan- Morangai [65].

The role antihepatotoxic of methanolic extract of *Erythrina indica* at a dose of 100 and 200 mg/kg was investigated in antitubercular drugs (INH+ RIF) induced liver damage in rats. The hepatoprotective activity was assessed used by various biochemical parameters SGOT, SGPT, ALP, bilirubin, total protein, albumin and LDH. Meanwhile, in vivo antioxidant activities as SOD, CAT, GSH and, LPO were measured in liver homogenate also histological examinations was carried out to assessed by hepatoprotective activity. Significant reduction in all biochemical parameters were found in groups treated with *Erythrina indica*. The severe liver damage in rats caused by (INH+RIF) were in came to near normal to treat by plant extract. Supported, by the evidenced on histopathology of liver showed that *Erythrina indica* attenuated the hepatocellular necrosis and repair of cells toward normal [66].

***Ipomoea staphylina* (Linn) (Roem & Schult.)**

Ipomoea staphylina (Family-Convolvulaceae) is a climber plant develops near water assets and dispersed all through India, China, and Sri Lanka Deciduous forests. Basic names on Clustered Morning Glory, Kannada: Ugina kodi, Unang kodi, Sunang kodi, Tamil: Onan Kodi [67]. The roots of this plant are utilized for remedy for snake bite and the paste of its crisp leaves and green stem bark are applied to cure piles [68]. This plant generally used to the treatment of liver maladies, pugation, stomach issue, pain, irritation and rheumatism [69].

In vitro free radical scavenging activity of aqueous extract of *Ipomoea staphylina* was study used by the parameters on ABTS and DPPH. Free radical scavenging results on IC_{50} value of 32.08+0.12 and 45.24+0.65 µg/mL. HPLC analysis showed on the presence of polyphenolic compounds such as protocatechuic acid, chlorogenic acid, caffeic acid, vanillin, p-coumaric acid, naringinin, qurecetin, rutin and flavon. Hepatotoxicity was induced by CCl_4 (1 mL/kg body weight), aqueous extract administered on orally at the doses of 250 and 500 mg/kg. Authours used on reference drug by silymarin. Treatment with extract that is restored the biochemical parameters towards normal level, preventing the occurrence of LPO and significantly raised the levels of SOD, CAT and reduced glutathione in CCl4 treated wistar rats. Histopathology results also confirmed the hepatoprotective activity of *Ipomea staphylina*. This plant leaves extract has potent strong antioxidant and hepatoprotective activity [70].

Luminetzera racemosa

Ethanol and water mixture extract of the bark of *Luminetzere racemosa* was evaluated in CCl_4 induced hepatotoxicity in rats and levels of AST, ALT and ALP, Bilirubin, Cholesterol , sugar and LDH were evaluated. The hepatoprotective and antioxidant activities of the bark extract might be to the presence of unique chemical classes such as flavonoids, alkaloids and polyphenols [71].

***Morinda tinctoria* Roxb**

Morinda tinctoria, (Family-Rubiaceae) generally known as Nunaa, is developed in several parts of Southeast Asia, particularly in the farming grounds and foul lands [72]. *Morinda pubescens* J.E. Smith (synonyms: *Morinda tinctoria* Roxb. and *Morinda coreia* Buch.) dominatingly develops as a weed tree in empty rural land, and particularly on uncultivated grounds and along the boundaries of the cultivated fields. In spite of the fact that the South Indian progenitors understood the remedial estimation of *M. pubescens* and utilized it in the traditional Indian therapeutic frameworks like Siddha, lack of proper documentation resulted in loss of that knowledge [73]. Morinda species for the treatment of various types of illness ``for example joint pain, cancer, gastric ulcer, heart sicknesses and so on. The ashes of *M. tinctoria* leaves are likewise reported to go about as biosorbents in controlling ammonia pollution in squander waters [74]. There is a more prominent interest for fruit extract of morinda species in treatment for various types of diseases Anti Convulsant, analgesic, anti inflammatory, anti oxidant activity and cytoprotective impact of *Morinda tinctoria* leaves has been accounted for [75].

The hepatoprotective activity of aqueous and methanol extract of leaves of *Morinda tinctoria* against paracetamol induced liver damage in sparaguee dawley rats. Hepatoprotective activity was assesed various parameters like SGPT, SGOT, TB, DB and TC and Histopathology of liver also was done. The preliminary phytochemical analysis of both extracts showed the presence of alkaloids, flavonoids, glycosides, carbohydrates, saponin, tannin and phenols. Paracetamol treated rats showed on lead to histological and biochemical deterioration. Extract treated rats reduced the level of blood biochemical levels and also reversed the hepatic damage towards normal. These are evidenced showed on *M.tinctoria* has significant hepatoprotective activity [76].

***Polygala arvensis* Willd**

Polygala arvensis Willd., (Syn: *Polygala chinensis* L., Family- Polygalaceae). The leaves and root portions of this plant have wide scope of pharmacological exercises for example, febrifuge, dizziness, anti-asthmatic, snake-bite poisoning and anti-diabetic [77]. The leaves of *P. arvensis* have been customarily utilized as a folk remedy for the treatment of jaundice in southern parts of India particularly by the tribal people of Nilgiri hills [78].

Chloroform extract of leaves in CMC was evaluated for hepatoprotective activity in albino wistar rats. Hepatotoxicity induced by D-galactosamine. The chloroform extract protect by the towards normal levels of AST, ALT, ALP, TB, LDH, TC, TGL, Albumin, total protein which were significantly increased in D-galactosamine treated rats. That the chloroform extract of *P.arvensis* leaves seemed to possessed hepatoprotective activity in rats [78].

***Ricinus communis* L.**

Ricinus communis (Family- Euphorbiaceae), normally known as castor oil plant, is a delicate wooden little tree developed all through tropics and warm temperature regions. This plant is indigenous toward the southeastern Mediterranean Basin, Eastern Africa, and India however is widespread throughout tropical regions and is generally utilized as a fancy plant. The plant is known to show antimicrobial activity and has been utilized to treat a few diseases. Its leaf, root, and seed oil are used in inflammation treatment, liver issue, hypoglycemic and as a diuretic. In Tunisia, the plant is used as a preventative. The plant is likewise used in African folk medicine in the treatment of moles, cold tumors, and indurations of mammary glands, corns, and moles. The anti-inflammatory, antioxidant, antimicrobial, and cytotoxic exercises of the plant was exhibited [79]. Tamil name additionally called on Amanakku.

Serum markers such as ALT, AST, ALP and Malandialdehyde were raised and the levels of antioxidant enzymes viz., SOD, CAT, GR, GPx and non enzymatic antioxidant GSH levels are decreased in the liver of hepatitis induced rats when compared to the control groups. Pre and post treatment with *R.communis* methanolic extract of leaves significantly altered the enzyme levels GSH and MDA to the normal levels. Histopathological results also showed protective and curative effective of methanolic extract of *R.communis* against D-galactosamine intoxication. These are results evidenced that extract significantly protect the liver from D-galactosamine induced hepatitis, improved the curative effect in the liver [80].

***Strychnos potatorum* Linn.**

Strychnos potatorum (Fam: Loganiaceae) is a moderate sized tree found in southern and central parts of India, Srilanka and Burma. In traditional system of medication, the seeds are utilized in the treatment of gonorrhoea, leucorrhoea, gastropathy, bronchitis, chronic diarrhoea, dysentery, renal and vesicle calculi, diabetes, conjunctivitis, scleritis, ulcers and other eye illness. The ripe seeds are utilized for clearing

sloppy water. The explanation is because of the consolidated activity of colloids and alkaloids in the seeds [81]. *Strychnos potatorum* it is commonly referred to as clearing nut tree or nirmali or thettham kottai [82].

The study of hepatoprotective and antioxidant activities of the seed powder and aqueous extract of *Strychnos potatorum* seeds against CCl_4 induced acute hepatic injury wistar albino rats. Powder and seed extract showed on significant hepatoprotective action because, these plant has on significant antioxidant activity and phytochemicals. Polysaccharides might contribute to the hepatoprotective antioxidant activities [83].

***Tridax procumbens* Linn. (Coat Buttons)**

Tridax procumbens (Family-Asteraceae) is in the daisy family which are blooming plant species. This family normally known as "Ghamra". The presence of flowers they are prevalently known as ''Coat buttons'' in English. In Ayurvadic medicinal system Tridax utilized for different illnesses and is apportioned for "Bhringraj". Numerous Ayurveda specialists are utilizing this plant as a prescription for liver Disorders. The local of the plant is tropical America and naturalized in tropical Africa, Asia, Australia and India. All through India, Tridax is circulated and is likewise found along roadsides, glades, squander grounds, railroads, riverbanks, dikes and ridges (Tamil - Thata poodu) [84].'The ethereal pieces of Tridax show hepatoprotective activity. The plant posse's critical security in mitigation of D-Galactosamine/Lipopolysaccharide (DGalN/LPS) instigated hepatocellular damage. D-GalN/LPS have been proposed to be hepatotoxic because of its capacity to destruct liver cells. The multifocal necrosis produced by D-GalN and the injury of viral hepatitis in humans are comparable. This amino sugar is known to specifically obstruct the interpretation and by implication hepatic protein synthesis and as an outcome of endotoxin lethality, it causes fulminant hepatitis inside 8 hrs after administration [85].

***Zanthoxylum armatum* DC**

Zanthoxylum armatum (Family-Rutaceae) is generally seen in India, Nepal, Malaysia, Pakistan and Japan at elevations of 1300 to 1500 m [86]. *Zanthoxylum armatum* [Syn. *Zanthoxylum alatum* Roxb] an evergreen or sub-deciduous bush found in India is broadly utilized in the Indian System of Medicine, as carminative, stomachic and anthelmintic and seeds are employed as an aromatic tonic in fever, dyspepsia, and for removing roundworms. It is has just investigated the essential oil of fruits of *Zanthoxylum armatum* displayed great antibacterial, antifungal and anthelmintic exercises. Moreover, shows critical insecticidal action against Culex spp [87]. (Tamil- Tumpunalu) [88].

Administration of its ethanolic leaves extract secure mice liver against the CCl_4 instigated hepatotoxicity and inflammation[89].

CONCLUSION

In this review paper, exertion has been taken to gather and accumulate the insights about a couple of hepatoprotective natural items, which will be valuable to the general public to wander in to a field of elective systems of medication. A progressively intensive review on different herbal items available in India and abroad as a hepatoprotectant is in not so distant future.

ACKNOWLEDGEMENT

The authors are grateful to the Professor and Head, Department of Zoology, and University authorities of Annamalai University, Tamilnadu, India, for providing various facilities in connection with this review work.

CONFLICTS OF INTEREST

Authors declare that there are no potential conflicts of interest.

REFERENCES

1. Sai Sruthi Arige, Sai Datri Arige and Lakshmana Rao A. (2017).A Review on Hepatoprotective activity. International Journal of Current Research; 9 (06): 51876- 51881.
2. Pingili RB, Pawar AK, Challa SR, Kodali T, Koppula S & Toleti V. (2019). A comprehensive review on hepatoprotective and nephroprotective activities of chrysin against various drugs and toxic agents. Chemico-biological interactions. 308: 51–60.
3. Gnanadesigan M, Ravikumar S, Anand M. (2017). Hepatoprotective activity of *Ceriops decandra* (Griff.) Ding Hou mangrove plant against CCl_4 induced liver damage. Journal of Taibah University for Science; 11: 450–457.
4. Hussain F, Malik A, Ayyaz U, Shafique H, Rana Z, Hussain Z. (2017). Efficient hepatoprotective activity of cranberry extract against CCl_4-induced hepatotoxicity in Wistar albino rat model: Down-regulation of liver enzymes and strong antioxidant activity. Asian Pacific journal of tropical medicine; 10(11):1054-1058.
5. UK national statistics, http://www.statistics.gov.uk/ [consulted 16-03-2019].

6. Abdel-Kader MS, Hamad AM, Alanazi MT, Alanazi AH, Ali R, Foudah AI, Alqarni MH. (2019). Characterization and hepatoprotective evaluation of sesquiterpenes and diterpenes from the aerial parts of *Juniperus sabina* L. Saudi Pharmaceutical Journal; 27: 920–929.
7. Nallamilli BR, Kumar CS, Reddy KV, Prasanna ML, Maruthi V, Sucharita P. (2013). Hepatoprotective activity of *Cichorium intybus* (Linn.) root extract against carbon tetrachloride induced hepatotoxicity in albino Wistar rats. Drug Invention Today; 5(4):311-4.
8. Babu PR, Bhuvaneswar C, Sandeep G, Ramaiah CV, Rajendra W. (2017). Hepatoprotective role of *Ricinus communis* leaf extract against d-galactosamine induced acute hepatitis in albino rats. Biomedicine & Pharmacotherapy; 88:658-66.
9. Organización Mundial de la Salud. OMS-cirrosis; 2014www.who.int/en
10. Delgado-Montemayor C, Cordero-Pérez P, Salazar-Aranda R, Waksman-Minsky N. (2015). Models of hepatoprotective activity assessment. Medicina Universitaria; 17(69):222-8.
11. https://timesofindia.indiatimes.com/life-style/health-fitness/health-news/liver cirrhosis - causes- signs-symptoms- prevention/article show/61738204.cms
12. Abdallah HM, Ezzat SM, El Dine RS, et al. (2013). Corrigendum to ''Protective effect of *Echinops galalensis* against CCl_4-induced injury on the human hepatoma cell line (Huh7)'' Phytochem. Lett ; 6 : 73-78.
13. Jannu V, Baddam PG, Boorgula AK, Jambula SR. (2012). A review on hepatoprotective plants. Int J Drug Devel Res ; 4(3):1-8.
14. Russmann S, Kullak-Ublick G, Grattagliano I. (2009). Current concepts of mechanisms in drug-induced hepatotoxicity. Curr Med Chem; 16(23):3041-53.
15. Yousefdoost S, Samadi F, Jafari SM, Ramezanpour SS, Hassani S, Ganji F. (2019). Application of nanoencapsulated silymarin to improve its antioxidant and hepatoprotective activities against carbon tetrachloride-induced oxidative stress in broiler chickens. Livestock Science; 228:177-86.
16. Cameron GR, Thomas JC, Karunarathe WAE. (1936). The pathogenesis of liver injury in carbon tetrachloride and thioacetamide poisoning. Journal of Pathology and Bacteria; 41: 297-304.
17. Towseef Hassan, Veerakumar D, (2019). Insha Naseer et al. Hepatoprotective activity of some medicinal plants: A Review. Int. Res. J. Pharm ; 10(5):9-16.
18. McGill MR, Jaeschke H. (2019). Animal models of drug-induced liver injury. BBA - Molecular Basis of Disease ; 1865: 1031–1039.
19. Agarwal AK, Mehendale JK. (1983). Potentiation of carbon tetrachloride hepatotoxicity and lethality by chlordecone in female rats. Toxicology; 26: 231-42.
20. Dawkins MJR. (1963). Carbon tetrachloride poisoning in the liver of the new born rat. J Path Bact; 85:189-196.
21. Tittarelli R, Pellegrini M, Scarpellini MG, Marinelli E, Bruti V, Di Luca NM, Busardo FP, Zaami S.(2017). Hepatotoxicity of paracetamol and related fatalities. Eur Rev Med Pharmacol Sci; 21(1 Suppl):95-101.
22. Liu J, Luo D, Wu Y, Gao C, Lin G, Chen J, Wu X, Zhang Q, Cai J, Su Z.(2019). The Protective Effect of *Sonneratia apetala* Fruit Extract on Acetaminophen-Induced Liver Injury in Mice. Evidence-Based Complementary and Alternative Medicine; Article ID 6919834, 12 pages.
23. Raish M, Ahmad A, Alkharfy KM, Ahamad SR, Mohsin K, Al-Jenoobi FI, Al-Mohizea AM, Ansari MA. (2016). Hepatoprotective activity of *Lepidium sativum* seeds against D-galactosamine/lipopolysaccharide induced hepatotoxicity in animal model. BMC complementary and alternative medicine; 16(1):501.
24. Mandayam S, Jamal MM, Morgan TR. (2004). Epidemiology of alcoholic liver disease. Semin Liver Dis ; 24:217–32
25. Baliga MS, Shivashankara AR, Venkatesh S, Bhat HP, Palatty PL, Bhandari G, Rao S. Phytochemicals in the Prevention of Ethanol-Induced Hepatotoxicity: A Revisit. Dietary Interventions in Liver Disease 2019 (pp. 79-89). Academic Press.
26. Rabelo AC, de Pádua Lúcio K, Araújo CM, de Araújo GR, de Amorim Miranda PH, Carneiro AC, de Castro Ribeiro ÉM, de Melo Silva B, de Lima WG, Costa DC. (2018). *Baccharis trimera* protects against ethanol induced hepatotoxicity in vitro and in vivo. Journal of ethnopharmacology; 6: 215:1-3.
27. Simeonova R, Kondeva-Burdina M, Vitcheva V, et al. (2014). Some in vitro/in vivo chemically-induced experimental models of liver oxidative stress in rats. Biomed Res Int; Article ID 706302, 6 Pages.
28. Ahmad F, Tabassum N. (2012). Experimental models used for the study of anti-hepatotoxic agents. J Acute Dis 2012; 1:85-9.
29. El-Kashef DH, Serrya MS. (2019). Sitagliptin ameliorates thioacetamide-induced acute liver injury via modulating TLR4/NF-KB signaling pathway in mice. Life sciences; 228:266-73.
30. Akhtar T, Sheikh N. (2013). An overview of thioacetamide-induced hepatotoxicity. Toxin Reviews ; 32(3):43-6.
31. Wang H, Zhang H, Wang Y, Yang L, Wang D.(2019). Embelin can protect mice from thioacetamide-induced acute liver injury. Biomedicine & Pharmacotherapy; 118:109360.
32. Hassan SM, Taha AM, Eldahshan OA, Sayed AA, Salem AM. (2019). Modulatory effect of Prosopis juliflora leaves on hepatic fibrogenic and fibrolytic alterations induced in rats by thioacetamide. Biomedicine & Pharmacotherapy ; 115:108788.
33. Lebda MA, Sadek KM, Abouzed TK, Tohamy HG, El-Sayed YS. (2018). Melatonin mitigates thioacetamide-induced hepatic fibrosis via antioxidant activity and modulation of proinflammatory cytokines and fibrogenic genes. Life sciences ; 192:136-43.
34. Jeong ES, Kim G, Shin HJ, Park SM, Oh JH, Kim YB, Moon KS, Choi HK, Jeong J, Shin JG, Kim DH.(2015). Increased serum bile acid concentration following low-dose chronic administration of thioacetamide in rats, as evidenced by metabolomic analysis. Toxicology and applied pharmacology; 288(2):213-22.

35. Pradeep HA, Khan S, Ravikumar K, Ahmed MF, Rao MS, Kiranmai M, et al.(2009). Hepatoprotective evaluation of *Anogeissus latifolia*: in vitro and in vivo studies. World J Gastroenterol; 15: 4816-4822.
36. Gandolfi AJ, Wijeweera J, Brendel K. (1996). Use of precision-cut liver slices as an in vitro tool for evaluating liver function. Toxicologic pathology ; 24(1):58-61.
37. Guillouzo A. (1998). Liver cell models in in vitro toxicology. Environmental health perspectives; 106 (suppl 2):511-32.
38. Amat N, Upur H, Blazeković B. (2010). *In vivo* hepatoprotective activity of the aqueous extract of *Artemisia absinthium* L. against chemically and immunologically induced liver injuries in mice. J Ethnopharmacol; 131: 478-484.
39. Natanzi AE, Ghahremani MH, Monsef-Esfahani HR, Minaei B, Nazarian H, Sabzevari O. (2009). An experimental model for study of the hepatoprotective activity of *Nasturtium officinale* (Watercress) against acetaminophen toxicity using in situ rat liver system. European Journal of Scientific Research ; 38(4):556-64.
40. Lui F, (2018). Laboratory tests in liver failure, Anaesthesia and intensive care medicine; 19 (1): 1-3.
41. Strasser M, Singh D. (2014). Interpretation of abnormal liver function tests. Hospital Medicine Clinics; 3(1):e139-48.
42. Ruhl CE, Everhart JE. (2012). Upper limits of normal for alanine aminotransferase activity in the United States population. Hepatology 55:447.
43. Gowda S, Desai PB, Hull VV, Math AA, Vernekar SN, Kulkarni SS. (2009). A review on laboratory liver function tests. The Pan African Medical Journal. 3.11-17
44. Donfack JH, Fotso GW, Ngameni B, et al. (2010). In vitro hepatopro-tective and antioxidant activities of the crude extract and isolated compounds from *Irvingia gabonensis*. Asian J Tradit Med; 5:79-88.
45. Kikkawa R, Yamamoto T, Fukushima T, et al. (2005). Investigation of a hepatotoxicity screening system in primary cell cultures -"what biomarkers would need to be addressed to estimate toxicity in conventional and new approaches?". J Toxicol Sci ; 30:61-72.
46. Sachin C, Ajay P. (2011). Indian medicinal plants used in liver disease: A short review. Pharmacognosy Journal ; 3(19):91-4.
47. Asadi-Samani M, Bahmani M, Rafieian-Kopaei M. (2014). The chemical composition, botanical characteristic and biological activities of *Borago officinalis*: a review. Asian Pac J Trop Med; 7: S22-S28.
48. Tatiya AU, Surana SJ, Sutar MP, Gamit NH. (2012). Hepatoprotective effect of poly herbal formulation against various hepatotoxic agents in rats. Pharmacognosy Res; 4: 50-56.
49. Asadi-Samani M, Kafash-Farkhad N, Azimi N, Fasihi A, Alinia-Ahandani E, Rafieian-Kopaei M. (2015). Medicinal plants with hepatoprotective activity in Iranian folk medicine. Asian Pacific Journal of Tropical Biomedicine ; 5(2):146-57.
50. Radha KD, Yogesh KC. (2005). Herbal medicines for liver diseases. Digestive Diseases and Sciences; 50(10): 1807–1812.
51. Handa SS, Sharma A, Chakraborti KK. (1986). Natural products and plants as liver protecting drugs. Fitoterapia ; 57(5): 307-352.
52. Kumar R, Kaur R, Singh AP, Arora S. (2014). Diminution of hepatic response to 7, 12-dimethylbenz (α) anthracene by ethyl acetate fraction of *Acacia catechu* willd. Through modulation of xenobiotic and anti-oxidative enzymes in rats. PloS one; 9(2):e90083.
53. Kumar R, Mahey S, Arora R, Mahajan J, Kumar V, Arora S. (2019). Insights into biological properties of less explored bark of industrially important *Acacia catechu* Willd. Industrial Crops and Products; 138:111486.
54. Lakshmi T, Geetha RV, Anitha R. *Acacia catechu* Willd: (2011). A Pharmacological Review. International Journal of Current Research and Review;3(5):101-11.
55. Lakshmi T, Renukadevi BS, Senthilkumar S, Haribalan P, Parameshwari R, Vijayaraghavan R, Rajeshkumar S. (2018). Seed and bark extracts of *Acacia catechu* protects liver from acetaminophen induced hepatotoxicity by modulating oxidative stress, antioxidant enzymes and liver function enzymes in Wistar rat model. Biomedicine & Pharmacotherapy ; 108:838-44.
56. Chauhan NS, Dixit VK. (2010). *Asteracantha longifolia* (L.) Nees, Acanthaceae: chemistry, traditional, medicinal uses and its pharmacological activities—a review. Rev Bras Farmacogn; 20(5): 812–7.
57. Sethiya NK, Ahmed NM, Shekh RM, Kumar V, Singh PK, Kumar V.(2018). Ethnomedicinal, phytochemical and pharmacological updates on *Hygrophila auriculata* (Schum.) Hiene: an overview. Journal of integrative medicine ; 16(5):299-311.
58. Mariappan A, Ramalingam S, Hameed SS, Saravanan R. (2015). In Vivo Investigation of Hepatoprotective activity of *Asteracantha longifolia* Nees. On CCL_4 In-Vivo. Asian J Pharm Clin Res; 8(6): 218-222
59. Simlai A, Roy A. (2013). Biological activities and chemical constituents of some mangrove species from Sundarban estuary: An overview. Pharmacog Rev ; 7:170-8.
60. Selvam V, Eganathan P, Karunagaran VM, Ravishankar T, Ramasubramanian R: (2014). A Text Book of Mangrove Plants of Tamil Nadu. M.S. Swaminathan Research Foundation, Taramani, Chennai. pp114.
61. Bandaranayake WM. (2002). Bioactivities, bioactive compounds and chemical constituents of mangrove plants. Wet. Ecol. Manag; 10: 421–452.
62. Gnanadesigan M, Ravikumar S, Anand M. (2017). Hepatoprotective activity of *Ceriops decandra* (Griff.) Ding Hou mangrove plant against CCl_4 induced liver damage. Journal of Taibah University for Science; 11(3): 450-7.
63. Kamalraj R. (2011). Hepatoprotective effects of different fractions of *Erythrina indica* in alloxan induced diabetic rats. Int J Pharm Sci Rev Res; 11(1):29-31.

64. Pingale R, Dash GK. (2014). A review on ethnopharmacology, phytochemistry and bioactivity of *Erythrina indica* Lam (fabaceae). Int J Pharm Phytopharm Res;3(6):487-90
65. Suryawanshi HP, Patel MR. (2011). Traditional uses, medicinal and phytopharmacological properties of *Erythrina indica* Lam.: an overview. International Journal of Research in Ayurveda & Pharmacy; 2(5):1531-3.
66. Mujahid M, Hussain T, Siddiqui HH, Hussain A. (2017). Evaluation of hepatoprotective potential of *Erythrina indica* leaves against antitubercular drugs induced hepatotoxicity in experimental rats. Journal of Ayurveda and integrative medicine ; 8(1):7-12.
67. Padmashree MS, Roopa B, Ashwathanarayana R, Raja N. (2018). Antibacterial properties of *Ipomoea staphylina* roem and schult. Plant extracts with comparing its preliminary qualitative phytochemical and quantitative GC-MS analysis. Trop Plant Res; 5:349-69.
68. Santhanam K, Kumaravel A, Saravanakumar SS, Arthanarieswaran VP. (2016). Characterization of new natural cellulosic fiber from the *Ipomoea staphylina* plant. International Journal of Polymer Analysis and Characterization; 21(3):267-74.
69. Mullaicharam AR, Maheswari RU, Geetha K, Panicker PS, Chandralekha V. (2010). Hemorrhoids: a review. Res J Pharm Technol; 3:296–9.
70. Jeyadevi R, Ananth DA, Sivasudha T. (2019). Hepatoprotective and antioxidant activity of *Ipomoea staphylina* Linn. Clinical Phytoscience ; 5(1):18.
71. Gnanadesigan M, Ravikumar S, Inbaneson SJ. (2011). Hepatoprotective and antioxidant properties of marine halophyte *Luminetzera racemosa* bark extract in CCL_4 induced hepatotoxicity. Asian pacific journal of Tropical Medicine; 4(6):462-5.
72. Sivakumar TH, Sivamaruthi BS, Priya KL, Kesika PE, Chaiyasut CH. (2018). Evaluation of bioactivities of *Morinda tinctoria* leaves extract for pharmacological applications. Evaluation. Asian J Pharm Clin Res; 11(2):100-5.
73. Mathivanan N, Surendiran G, Srinivasan K, Malarvizhi K. (2006). *Morinda pubescens* JE Smith (*Morinda tinctoria* Roxb.) fruit extract accelerates wound healing in rats. Journal of medicinal food ;9(4):591-3.
74. Kumar NS, Simon NK, Parvathy BM. In vitro Antimicrobial Activities and Phytochemical Analysis of *Morinda Tinctoria* (L) Leaf Extracts. Int. J. Pharm. Sci. Rev. Res 2016; 38(1): 58-61.
75. Deepti K, Umadevi P, Vijayalakshmi G. Antimicrobial activity and phytochemical analysis of *Morinda tinctoria* Roxb. leaf extracts. Asian Pacific Journal of Tropical Biomedicine 2012 ;2(3):S1440-2.
76. Subramanian M, Balakrishnan S, Chinnaiyan SK, Sekar VK, Chandu AN. Hepatoprotective effect of leaves of *Morinda tinctoria* Roxb. against paracetamol induced liver damage in rats. Drug Invention Today 2013; 5(3):223-8.
77. Yohanarasimhan SN. Medicinal plants of India. Tamilnadu, vol. II. Bangalore: Cybermedia Publishers; 2000. p. 431.
78. Dhanabal SP, Syamala G, Kumar MS, Suresh B. (2006). Hepatoprotective activity of the Indian medicinal plant *Polygala arvensis* on D-galactosamine-induced hepatic injury in rats. Fitoterapia ;77(6):472-4.
79. Kuete V. Physical, (2014). Hematological, and histopathological signs of toxicity induced by African medicinal plants. In Toxicological Survey of African Medicinal Plants (pp. 635-657). Elsevier.
80. Babu PR, Bhuvaneswar C, Sandeep G, Ramaiah CV, Rajendra W. (2017). Hepatoprotective role of *Ricinus communis* leaf extract against d-galactosamine induced acute hepatitis in albino rats. Biomedicine & Pharmacotherapy; 88:658-66.
81. Sanmuga PE, Venkataraman S. (2010). Pharmacognostical and phytochemical studies of *Strychnos potatorum* Linn seeds. Pharmacognosy Journal ; 2(8):190-7.
82. Packialakshmi N, Suganya C, Guru V. (2014). Phytochemical and IR–Spectrum analysis of *Strychnos potatorum* linn. International journal of Phytopharmacy;4(2).11-19
83. Sanmugapriya E, Venkataraman S. (2006). Studies on hepatoprotective and antioxidant actions of *Strychnos potatorum* Linn. seeds on CCl_4-induced acute hepatic injury in experimental rats. Journal of Ethnopharmacology ; 105(1-2):154-60.
84. Amutha R, Sudha A, Pandiselvi P. (2019). *Tridax procumbens* (Coat Buttons)–A Gift of Nature: An Overview.Pharmacological Benefits of Natural Products; First Edition: 193-212.
85. Ravikumar V, Shivashangari KS, Devaki T. (2005). Hepatoprotective activity of *Tridax procumbens* against d-galactosamine/lipopolysaccharide-induced hepatitis in rats. Journal of Ethnopharmacology; 101(1-3):55-60.
86. Wang YR, Li YH, Guo T, Li HL, Tan YF, Zhang Z, Zhang XG, Mai SY, Zhang JQ. (2018). Measurement of pharmacokinetics and tissue distribution of three bioactive constituents from *Zanthoxylum armatum* DC in rat plasma and tissues through UFLC-MS/MS. Journal of Chromatography B ;1087:80-9.
87. Ranawat L, Bhatt J, Patel J. (2010). Hepatoprotective activity of ethanolic extracts of bark of *Zanthoxylum armatum* DC in CCl_4 induced hepatic damage in rats. Journal of ethnopharmacology; 127(3):777-80.
88. Phuyal N, Jha PK, Raturi PP, Rajbhandary S. (2019). *Zanthoxylum armatum* DC.: Current knowledge, gaps and opportunities in Nepal. Journal of ethnopharmacology. 229:326-41.
89. Verma N, Khosa RL. (2010). Hepatoprotective activity of leaves of *Z. armatum* DC in CCl4 induced hepatotoxicity in rats. Ind. J. Biochem. Biophys; 47:124-127.

CITATION OF THIS ARTICLE

Veerakumar D, Muthulingam M. Review on Hepatoprtoective Activity Of Some Medicinal Plants In India. . Bull. Env.Pharmacol. Life Sci., Vol10[4] March 2021 : 36-47