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HEPATOPROTECTIVE HERBAL POTENTIALS OF *AYURVEDA*

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ABSTRACT

Liver disorders like viral hepatitis, cirrhosis, alcoholic liver disease, fatty liver, jaundice etc do not have specific treatment modalities in modern medicine even though they are the cause for death and secondary complications among the population of developed and developing countries. The traditional systems of medical practice in several parts of the world constitute several hepatoprotective herbs. Extensive researches have been carried out in different parts of the world on single herbal drugs and formulations delineated in Ayurvedic texts to explore the mode of protection of liver from causative factors like virus, alcohol and other toxins. Drugs like *Andrographis paniculata*, *Boerhavia diffusa*, *Eclipta alba*, *Plumbago zeylanica*, *Swertia chirayita* etc have studied extensively in this regard which has been reviewed in the present article. Research on *Andrographis paniculata*, *Plumbago zeylanica* etc has evidenced the Ayurvedic claim of protective and curative effect when drug is used as a whole.

Keywords: viral hepatitis, hepatoprotective herbs, *Andrographis paniculata*, *Plumbago zeylanica*.

INTRODUCTION

In all age groups liver disorders have been recognized as an important cause of morbidity and mortality. Liver being the largest organ of the body plays an important role in the metabolism of food as well as drugs. Liver can be invaded by several toxins, micro organisms and alcohol. The prevalence of alcoholic liver disease is increasing worldwide leading to more than 2,00,000 deaths every year and is the 4th leading cause of death in USA.[1]

In India, alcoholic liver disease comprises more than 60 percent of all patients with chronic liver diseases due to alcohol. Viruses like A, B, C, D, E are responsible for hepatitis in humans. Other viruses which cause hepatitis includes cytomegalo virus.

Hepatitis C virus is being recognized as an important cause of hepatocellular carcinoma, which is the 7th most common cancer worldwide. [2]

The description of *yakrit*, located in the right side of the thoraco-abdominal cavity in Ayurvedic classics is interpreted as liver, which is considered to be the seat of *ranjaka pitta* (component of *pitta* responsible for *rakta* formation). The diseases related to *yakrit* are referred to as *yakritdalyodara*, *kamala, kumbhakamala* etc. Some of the symptoms recorded by *Charaka* under *grahani roga* (a syndrome) appear to be related to cirrhosis of the liver.[3] *Charaka* and *Susruta* have described treatment modalities for *kamala* (jaundice including viral hepatitis). The medieval Ayurvedic works have recorded the efficacy of single as well as simple herbal recipes in the management of *kamala*.

During 20th century, Ayurvedic physicians, modern pharmacologists and phytochemists have attempted to document experimental as well as clinical evidences with regard to hepatoprotective medicinal plants. Notable observations made on few of the important medicinal plants which are frequently mentioned in Ayurvedic classics are enumerated in this review.

MATERIAL AND METHODS

1. Herbs mentioned in the treatment of *Kamala* (Jaundice) were collected from classical Ayurvedic texts like *Bruhatrayis* (*Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hrudaya*) and texts like *Bhavaprakasha*, *Yogaratnakara* etc.
2. The drugs quoted repeatedly were investigated for researches in the direction of hepatoprotection from different sources like internet, publications from CCRAS, ICMR etc
3. Details of pharmacological and clinical research profiles are summarized and tabulated.

Observations

1. Andrographis paniculata (Burm.) Wall. Ex Nees (Acanthaceae) -*Bhunimba*

Pharmacological study-The aqueous extract of *A. paniculata* increased biliary flow and liver weight in rats and decreased the duration of hexabarbitone induced sleep in mice,[4]

also single dose of leaf aq. extract administered 4h before intoxicating the rats with CCl_4 (5ml/kg oral) has been shown to decrease CCl_4 induced hepatic microsomal lipid peroxidation.[5] *A.paniculata* has protective as well as curative effect on alchohol induced toxic liver damage in comparision with andrographolide which demonstrated a protective action against CCl4 induced increase in serum transaminase activity in rats.[6] Another study showed *A. paniculata* liquid extract produced stronger immunostimulation compared to isolated andrographolide. In this study it is also observed that both (whole drug and andrographolide) stimulated antigen specific and non-specific immune responses in mice.[7]

Clinical trial- Decoction of *A. paniculata* 60 ml per day (equivalent to 40 g of crude drug) in three divided doses for 23 ± 4 d in human clinical trials (60 patients with hepatocellular jaundice) revealed that yellow color of the conjunctiva improved 100 per cent, tender hepatic enlargement decreased in 90 percent of patients within 20 d of treatment. Loss of appetite in 100 percent was improved after 4-5 d. Several tests for biochemical markers such as serum bilirubin, alkaline phosphatase and serum transferase were highly significant after the treatment.[8]

Pharmacokinetics -Oral doses of radio-labelled andrographolide given to mice were rapidly absorbed and distributed to organs, especially gall bladder, kidney, ovary and lungs. Andrographolide levels appeared to be low in spleen, heart and brain. Approximately 90 percent was excreted in the urine and faeces after 24h and 94 percent after 48h. At 48 h, radio-labelled andrographolide only accounted for approximately 11 percent of urine and liver fractions, the remainder consisting of metabolites.[9]

2. *Azardirachta indica* A. Juss.(Meliaceae)-*Nimba*

Pharmacological study-Aqueous extract of neem leaves and fresh juice from tender leaves showed hepatoprotective activity in paracetamol induced hepatotoxicity in rats. [10]

3. *Berberis aristata* (Berberidaceae)- *Daruharidra*

Pharmacological study- Isoquinoline alkaloid berberine on CCL_4 induced hepatotoxicity in mice suppressed elevated serum levels of alanine aminotransferase (ALT),

aspertaseaminotransferase (AST) and alkaline phosphatise (ALP) in a concentration dependent manner. The decrease in hepatic activity of superoxide dismutase and an increase in lipid peroxidation were significantly prevented by berberine. Histopathological changes were reduced and the expression of tumor necrosis factor-α, cyclooxygenase-2 and inducible nitric oxide synthase was markebly attenuated by berberine 10mg/kg. The results indicate that berberine could be effective in protecting the liver from acute CCL_4 induced injury.[11]

4. *Boerhavia diffusa* Linn. (Nyctaginaceae)- *Punarnava*

Pharmacological study- The methanolic and chloroform extracts of the roots and aerial parts exhibited antihepatotoxic activity against carbon tetrachloride intoxication in rats.[12] 50 percent ethanolic extract on country made liquor induced hepatotoxicity in albino rats showed hepatoprotective effect evidenced by changes in serum alanine aminotransferase(ALT), triglycerides, cholesterol and total lipid levels in both serum and tissues. Histopathological studies showed marked reduction in fat deposits in animals receiving *B. diffusa* along with country made liquor.[13]

5. *Curcuma longa* Linn. (Zingiberaceae)- *Haridra*

Pharmacological study- Hepatoprotective effect of turmeric extract on carbon tetrachloride induced liver damage in rats revealed considerable reduction in serum bilirubin, cholesterol, aspertate, aminotransferase and alkaline phosphatase elevated by carbon tetrachloride.[14,15] Curcumin has been reported to strongly inhibit cytochrome 450IA in liver, an isozyme involved in the bioactivation of several toxins including benzo[α]pyrene.[16]

Pharmacokinetics- Pharmacokinetic study in rats indicates that the absorption of pure curcumin from gastrointestinal tract is about 60-65 percent after administration of a single oral dose of 400 mg/kg. About 40 percent of the administered dose was recovered unchanged in the faeces over a period of 5d with a peak after 3 d. Free curcumin was not detected in urine but excretion of glucuronic acid sulphate conjugates was observed from day 1 to day 7, suggesting an entero hepatic circulation.[17,18]

6. *Cyperus rotundus* (Cyperaceae)- *Musta*

Pharmacological study- Methanol extract of rhizome at a dose of 670 mg/kg administered to mouse orally is active in CCl_4 treated mice. Dried tuber also showed marked hepatoprotective activity against CCl_4 induced hepatotoxicity. [19] The ethyl acetate extract at an oral dose of 100 mg/kg exhibited a significant protective effect by lowering serum levels of glutamic oxaloacetic transaminase, glutamic pyruvic transaminase, alkaline phosphatase and total bilirubin.[20]

7. *Eclipta alba* (Linn.) Linn. (Asteraceae)- *Bhringaraja*

Pharmacological study- In vitro immune-activation of surface antigen of hepatitis B virus (HBsAg) by *E. alba* has been reported. [21,22] Liquid extract of fresh leaves shown hepatoprotective properties against acute carbon tetrachloride induced liver damage in guinea pigs.[23] Ethanol:Water (1:1) extract significantly reversed the carbon tetrachloride induced inhibition of the hepatic microsomal drug metabolizing enzyme amidopyrine *N*-demethylase and membrane bound glucose 6- phosphatase.[24]

Clinical trial- *E. alba* powder 50mg/kg with honey in three divided doses for a period of 1-5 wk recovered fully in 80 percent of children of Hepatitis taken for study and 100 percent cure in patients of infective hepatitis was observed in different studies. [25, 26]

8. *Embelia ribes* (Myrsinaceae)- *Vidanga*

Pharmacological study- Embelin orally (25 mg/kg) from day 1 to day 15, peroxidative damage was minimal in both liver and serum along with effectively inducing the antioxidant potential in CCl_4-treated male wistar rats. The biochemical results were compared with the standard drug silymarin – a combination of flavonolignans of *Silybum marianum* and histology of liver sections.[27]

9. *Emblica officinalis* Gaertn.(Euphorbiaceae)- *Amalaki*

Pharmacological study- Fruit extract shown to counteract metal ion toxicity and also does hepatoprotection against CCl_4 induced liver toxicity in rats. [28] Also fruit extract in dose of 100-200 mg\kg increased cell variability of rat hepatocytes being treated with

paracetamol (2g). Results indicate that the drug have the ability to rectify hepatic damage or toxicity.[29]

10. *Glycyrrhiza glabra* Linn. (Fabaceae)- *Yashtimadhu*

Pharmacological study- Glycyrrhiza flavonoids provided protection to hepatocytes exposed to carbon tetrachloride and galactosamine in mice. Anti-lipid peroxidation effect as the central mechanism contributing to its protective action against CCl_4 induced hepatotoxicity was pointed in this work.[30,31,32]

Clinical trial- Glycyrrhizin protected the liver apparently through its membrane stabilization effect and also decreases the increased plasma levels of aminotransferase(AST) and alanine aminotransferace (ALT) in patients with chronic hepatitis or during inflammation.[33,34,35] Glycyrrhizin is showed statistically significant improvement in acute and chronic cases of hepatitis in a randomized controlled clinical trial in 88 patients. [36]

Pharmacokinetics- The pharmacokinetic behavior of glycyrrhizin was examined in D-galactosamine intoxicated (GAL) rats. After oral administration, glycyrrhizin is metabolized predominantly in the liver and removed from the body via the bile. Better absorption and higher plasma concentration might be achieved by administering glycyrrhizin alone rather than in licorice extract. Significantly lower concentration of glycyrrhizin was found in bile samples from rats treated with licorice extract compared to pure glycyrrhizin. [3, 38]

11. *Luffa echinata* Roxb (Cucurbitaceae)- *Devadali*

Pharmacological study- Aqueous extract of *L.echinata* fruits significantly lowered the serum bilirubin level in chlorpromazine induced jaundice in rats. The alcoholic extract showed definite protection against carbon tetrachloride induced liver injury in rats. [39]

Clinical trial- Single administration of drops squeezed from watersoaked dry fruits into the nostrils significantly reduced bilirubin and SGPT levels within 3 to 7 days with substancial relief in clinical symptoms like anorexia and malaise. [40]

12. *Phyllanthus amarus* Schum. & Thonn. (Euphorbiaceae)- *Bhumyamalaki*

Pharmacological study- Methanolic extract of leaf significantly increased the levels of glutathione (GSH), superoxide dismutase (SOD), and catalase (CAT) in the liver which were markedly reduced due to ethanol-induced oxidative damage. Lipid peroxidation was also significantly reduced by the administration of drug.[41] Drug is also reported for having anti-HBV activities, [42] inhibition of HBV enhancer I resulting suppression of HBV messenger ribonucleic acid (mRNA) synthesis [43] and decrease serum levels of woodchuck hepatitis surface antigen and DNA polymerase in animals chronically infected with woodchuck hepatitis virus.[44,45]

Clinical trial- *P. amarus* powder administered in capsule form (600mg/d) showed 59 percent of the treated subjects to lose HBsAg at the first follow up visit and remained cleared for several months after the end of the treatment. [46] Chronic HBV carriers treated with 750 mg/day of *P.amarus* for 3 months revealed loss of HBsAg which remained negative nine months after treatment was discontinued. [47]

13. *Picrorhiza kurroa* Royle ex Benth. (Scrophulariaceae) – *Katuki*

Pharmacological study- *P.kurroa* has shown hydrocholeretic effect in rats and dogs,[48] antinecrotic effect in carbon tetrachloride-induced damage in rats and rabbits,[49] reduces fatty infiltration and lipid deposits in galactosamine-induced liver damage,[50] reduces paracetamol induced hepatic damage,[51] scavenging of superoxide anions and inhibition of lipid peroxidation and antiviral effect on vaccinia viruses.[52]

Clinical trial- A double blind study with placebo control showed total clearance of bile salts, bile pigments, serum bilirubin from the blood when patients treated with 500 mg dose of powder twice daily.[53] Decoction given orally thrice a day for four weeks to patients of infective hepatitis reported significant improvement with respect to serum bilirubin, serum alkaline phosphatase, SGOT, SGPT, serum total protein, serum albumin in drug treated group of patients with no side or toxic effects during study.[54]

14. *Piper longum* Linn. (Piperaceae)- *Pippali*

Pharmacological study - Following treatment with *Piper longum* milk extract (200 mg/day p.o. for 21 days), a significant hepatoprotective effect was observed in CCl4

induced hepatic damage as evident from decreased level of serum enzymes, total bilirubin and direct bilirubin. The hepatoprotective effect of *Piper longum* is comparable to the standard drug silymarin (25 mg/kg/day p.o. for 21 days).[55]

15. Plumbago zeylanica Linn. (Plumbaginaceae)-*Chitraka*

Pharmacological study- Hepatoprotective activity of methanolic extract of the roots in the dose of 500mg/kg was carried out. Activities of pure plumbagin and plumbagin free methanolic extract were compared in rats intoxicated with carbon tetrachloride inorder to ascertain the antihepatitoxic activity of the methanolic extract was due to plumbagin or due to the constituents other than plumbagin. There was no significant effect on biochemical parameters elevated by $_{CCL4}$ intoxication by plumbagin or plumbagin free methanolic extract. But methanolic extract with traces of plumbagin showed significant protection against CCl_4 hepatic injury in rats. [56] Petroleum ether extract of root showed significant reduction in the serum markers elevated in rats treated with paracetamol indicating the effect of plant extract in restoring the normal functional ability of the hepatocytes.[57]

16. *Swertia chirayita* Karst. (Gentianaceae) –*Kiratatikta*

Pharmacological study- Treatment with *S.chirayita* and carbon tetrachloride caused improvement at both the biochemical and histopathological parameters versus carbon tetrachloride treatment alone.[58] The methanolic extract found to be active against CCl_4, galactosamine and paracetamol induced liver toxicity in experimental rats and on fractionation into butanol-soluble and chloroform- soluble fractions, the anti hepatotoxicity was traced and found to be more profound in chloroform- soluble fraction.[59]

17. *Tephrosia purpurea* Linn. (Fabaceae)- *Sharapunkha*

Pharmacological study- Drug exhibited potent hepatoprotective effect against CCl_4 induced acute and chronic liver damage. It inhibited triglyceride accumulation in hepatic cells and protects liver against increased hydroxyproline content. It also has anticholestatic property. [60] Dried ethanolic extract of *Tephrosia purpurea* was studied

for its efficacy using both acute (D-galactosamine) and chronic models CCl4 of experimentally induced hepatotoxicity. In vitro studies exploiting trypan blue exclusion assay revealed that the alcoholic extract exerted a significant hydroxyl radical scavenging activity.[61]

18.*Terminalia belerica* Roxb. (Combretaceae)- *Vibhitaki*

Pharmacological study- Treatment with T. bellerica extract (200, 400 and 800 mg/kg, p.o.) and gallic acid (50, 100 and 200 mg/kg, p.o.) showed dose-dependent recovery in the biochemical parameters like serum transaminase, serum alkaline phosphatase, glutathione, adenosine triphosphatase and succinic dehydrogenase against carbon tetrachloride intoxication in albino rats. The effect was more pronounced with gallic acid.[62]

19. *Tinospora cordifolia* (Willd.) Miers ex Hook.f. & Thoms. (Menispermaceae)- *Guduchi*

Pharmacological study- Ethanolic extract of *T. cordifolia* stem exhibits hepatoprotective effect in carbon tetrachloride induced hepatotoxicity in mice, rats and rabbits. [63] Drug also showed significant improvement in Kupffer cell function. [64]

Clinical trial –*T. cordifolia* has been shown to have hepatoprotective and immunomodulatory properties, on surgical outcome in patients with malignant obstructive jaundice. Group containing *T. cordifolia* along with conventional management has shown phagocytic and killing capacities of neutrophils normalized which was not seen in group receiving only conventional management. [65,66]

20. *Terminalia chebula* Retz. (Combretaceae)-*Hareetaki*

Pharmacological study- An aqueous extract of fruit of *T. chebula* on the *tert*-butyl hydroperoxide (*t*-BHP)- induced oxidative injury observed in cultured rat primary hepatocytes and rat liver significantly reversed the *t*-BHP-induced cell cytotoxicity and lactate dehydrogenase leakage. In addition, extract exhibited *in vitro* ferric-reducing antioxidant activity and 2,2-diphenyl-1-picryhydrazyl free radical-scavenging activities. Histopathologic examination of the rat livers showed that TCE reduced the incidence of

liver lesions, including hepatocyte swelling and neutrophilic infiltration, and repaired necrosis induced by *t*-BHP. Based on the results described above, we speculate that TCE has the potential to play a role in the hepatic prevention of oxidative damage in living systems. [67]

21. *Trichosanthes dioica* Roxb (Cucurbitaceae)- *Patola*

Pharmacological study- Ethanolic and Aqueous extracts of TD at different doses (100, 200 and 400 mg/kg) and silymarin (100 mg/kg) were administered orally for 10 days. TD-200e showed decrease in the levels of AST ($p<0.01$), ALT, TB, ALP and increase in TP ($p<0.05$). TD-200a showed significant decrease in the levels of AST, ALT, TB, ALP and increase in TP levels. The groups treated with 400 mg/kg aqueous and ethanolic extract showed significant ($p<0.01$) reduction in AST, ALT, ALP, TB and increase in TP level. The pretreatment with TD extracts showed profound histopathological protection to liver cells as evident from histopathological studies.[68]

TABLE 1: SUMMARY OF PHARMACOLOGICALLY ACTIVE HEPATOPROTECTIVE DRUGS.

No.	Drug	Botanical name	Plat part/ Active principle	Dosage form	Experimental model	Mechanism
1	*Bhunimba*	*Andrographis paniculata*	Leaf	Aqueous extract	CCl_4 and alcohol induced liver damage in rats	Increased biliary flow and liver weight.
2	*Nimba*	*Azardirachta indica*	Leaf, Tender leaves	Aq.extract, fresh juice	Paracetamol induced hepatotoxicity in rats	Anti oxidant activity
3	*Daruharidra*	*Berberis aristata*	Berberine	_	CCL_4- intoxicated mice	Free radical scavenging and attenuation of oxidative\nitrosative stress, as well as to the inhibition of inflammatory response

						in the liver.
4	*Punarnava*	*Boerhavia diffusa*	Roots, Aerial parts	Methanolic and chloroform extracts	CCl_4 intoxication in rats	Reduction in serum alanine aminotransferases, triglycerides, cholesterol and total lipid levels in both serum and tissues, marked reduction in fat deposits.
				50 percent ethanolic extract	Country made liquor induced hepatotoxicity.	
5	*Haridra*	*Curcuma longa*	Rhizome \ Curcumin	Crude extract	CCl_4 induced liver damage in rats.	Reduction in serum bilirubin, cholesterol, aspertate, aminotransferase and alkaline phosphatase.
6	*Musta*	*Cyperus rotundus*	Rhizome	Methanol extract	CCl_4 induced hepatotoxicity in mice.	Lowered serum levels of glutamic oxaloacetic transaminase, glutamic pyruvic transaminase, alkaline phosphatase and total bilirubin.
7	*Bhringaraja*	*Eclipta alba*	Leaves	Ethanol:Water (1:1) extract	CCl_4induced liver damage in guinea pigs.	Reversed the toxicant induced inhibition of the hepatic microsomal drug metabolizing enzyme amidopyrine *N*-demethylase and membrane bound glucose 6- phosphatase
8	*Vidanga*	*Embelia ribes*	Embelin	_	CCl_4-treated male Wistar rats	Embelin prevents formation of preneoplastic foci in rats.

9	*Amalaki*	*Emblica officinalis*	Fruit	Water extract	CCl_4 induced liver toxicity in rats.	Decreased lipid peroxidation in liver tissue and glutamate pyruvate transminase (GPT) and alkaline phosphatase (ALP) in serum. Also inhibited fibrotic changes.
					Paracetamol induced hepatic damage in Wistar albino rats.	
10	*Yashtimadhu*	*Glycyrrhiza glabra*	Glycyrrhiza flavonoid	–	CCl_4 induced hepatotoxicity in mice	Anti-lipid peroxidation effect.
11	*Devadali*	*Luffa echinata*	Fruit	Aqueous extract	Chlorpromazine induced jaundice in rats.	Lowers the serum bilirubin level.
				Alcoholic extract	CCl_4induced liver injury in rats.	Inhibits lipid peroxidation and shown hydroxyl radical scavenging activity.
12	*Bhumyamalaki*	*Phyllanthus amarus*	Leaf	Methanolic extract	Ethanol-induced oxidative damage in wister albino rats.	Reduces rate of lipid peroxidation, increases antioxidant defence mechanism.
13	*Katuki*	*Picrorhiza kurroa*	Root	Alchoholic extract	D-galactosamine induced hepatitis in rats, CCl_4 induced damage in rats and rabbits.	Prevented decrease in the levels of protein and glycoprotein and in the activities of superoxide dismutase and catalase.
14	*Chitraka*	*Plumbago*	Root	Methanolic	CCl_4 induced hepatic	Functional improvement of

		zeylanica		extract	injury in rats.	hepatocytes may be by an accelerated regeneration of parenchymal cells. Early improvement in the secretary mechanism of the hepatic cell.
				Petroleum ether extract	Paracetamol induced liver toxicity in rats.	
15	*Kiratatikta*	*Swertia chirayita*	Whole plant	Methanolic extract	CCl_4 induced hepatotoxicity and hepatocytic necrosis in rats.	Decreased serum aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase activities and bilirubin level.
16	*Sharapunkha*	*Tephrosia purpurea*	Aerial parts	Ethanolic extract	CCl_4 induced acute and chronic liver damage in rats.	Inhibited triglyceride accumulation in hepatic cells and protects liver against increased hydroxyproline content.
17	*Guduchi*	*Tinospora cordifolia*	Stem	Ethanolic extract	CCl_4 induced hepatotoxicity in mice, rats and rabbits	Modulation of Kupffer cell activity.
18	*Hareetaki*	*Terminalia chebula*	Fruit	Aqueous extract	*tert*-butyl hydroperoxide (*t*-BHP)-induced oxidative injury	Reversed *t*-BHP-induced cell cytotoxicity and lactate dehydrogenase leakage, reduced the incidence of liver lesions, including hepatocyte swelling and neutrophilic infiltration and repaired necrosis induced by *t*-BHP.

19	*Vibhitaki*	*Terminalia belerica*	Fruit	Water extract	CCl_4 intoxication in albino rats	Recovery in the biochemical parameters like serum transaminase, serum alkaline phosphatase, glutathione, adenosine triphosphatase and succinic dehydrogenase.
20	*Patola*	*Trichosanthes dioica*	Whole plant	Ethanolic and Aqueous extracts	Ferrous sulphate-induced liver injury	Reduction in AST, ALT, ALP, TB and increase in TP level.
21	*Pippali*	*Piper longum*	Fruit and root	milk extract	CCl4 induced hepatic damage	Decreased level of serum enzymes, total bilirubin and direct bilirubin.

TABLE 2: SUMMARY OF HEPATOPROTECTIVE DRUGS WITH PROVEN CLINICAL EFFICACY.

Sl no	Drugs	Botanical name	Part used	Form	Dose and duration	Remarks
1	*Bhunimba*	*Andrographis paniculata*	Leaf	Decoction	60 ml/day	Serum bilirubin, alkaline phosphatase and serum transferase were highly significant.
2	*Bhringaraja*	*Eclipta alba*	Plant	Powder	50mg/kg with honey for 1-5 wk	100 percent cure in patients of infective hepatitis.
3	*Yashtimadhu*	*Glycyrrhiza glabra*	Glycyrrhizin	4mg\day	4 weeks	Prevents development of hepatocellular carcinoma in chronic hepatitis C.
5	*Devadali*	*Luffa*	Water soaked dry	Juice	Drops	Reduced bilirubin and

		echinata	fruits		(once)	SGPT levels
6	*Bhumyamalaki*	*Phyllanthus amarus*	Wholeplant	Powder	Capsule form (600 mg/day) 750 mg/ day for 3 months	Loss of HBsAg which remained negative nine months after treatment.
7	*Katuki*	*Picrorhiza kurroa*	Root	Decoction	500 mg dose of twice daily for four weeks	Significant improvement in serum bilirubin, serum alkaline phosphatase, SGOT, SGPT, serum total protein, serum albumin.
8	*Guduchi*	*Tinospora cordifolia*	Stem	Powder	16 mg/kg/day	Phagocytic and killing capacities of neutrophils normalized.

DISCUSSION AND CONCLUSION

There are various conditions in clinical practice where one can find modern medical agents inadequate either from efficacy or safety or compliance point of view. Common such refractory conditions encountered in the practice of internal medicine are liver disorders, arthritis, diabetes, obesity, cancer etc.

In the world medical history *Charaka samhita* for the first time recorded about the observations made by Acharyas of Ayurveda with regard to the pigmenting substance (stercobilinogen) which is responsible for the color of faecal matter while discussing about the recovery signs of jaundice.[69] *Charaka* has advocated the drugs namely *Katuki* (*Picrorhiza kurroa*), *Haridra* (*Curcuma longa*), *Triphala* (Three myrobalans), *Guduchi* (*Tinospora cordifolia*), *Daruharidra* (*Berberis aristata*) and *Nimba* (*Azardirachta indica*) as prime drugs for the management of jaundice (*Kamala*).[70] Later works like Nighantus and other texts have added the herbs like *Vasa* (*A.vasika*), *Bhumyamalaki* (*P.amarus*),

Kumari (*Aloe vera*), *Devadali* (*L.echinata*), *Bhunimba* (*A. paniculata*)[71] to the formulations indicated in the management of liver disorders.

Involvement of liver in *pitta* dominating disorders is well known. For eg. Symptoms of *Udara* especially *Pittodara* and *Yakritdalyodara*, *Kamala, Kumbhakamala, Haleemaka* etc shows liver is affected in these conditions. The drugs mentioned in the classical texts which have proven hepatoprotective activity are *pittahara* mainly.

Drug like *Tamalaki* or *Bhumyamalaki* (*P. amarus*) has not included in the chapter explaining treatment of *Kamala* by *Acharyas* like Charaka and Sushrutha but it is indicated in *pitta* predominant *jwara, gulma, kasa* etc and formulations containing *Tamalaki* is been considered in treating *Kamala, Haleemaka, Pandu*, Jwara etc. This is being noted and documented by Yogaratnakara (a 17th century work), who brought the drug into main stream of treatment of liver disorders which paved the way for various researches and successful management of jaundice.

Eventhough *Katuki* (*P. kurroa*) is included in formulations of *Kamala* treatment, it is Yadavji Trivikramji Acharya who made the drug popular for the management of K*amala*. Since then most of the practitioners of Ayurveda started prescribing *Arogyavardhini Rasa*, which was originally formulated by Rasavagbhta for the management of *Kushta* (skin disorders). Recent researches have also confirmed hepatoprotective and choleretic activities of *Katuki*.

The drugs mentioned in Ayurveda not only prevent liver damage but can also reverse the damage occurred as evidenced by the above studies through different modes of action along with anti oxidant property and immune stimulation. It can also be noted that drugs like *Daruharidra* and *Bhunimba* having *Bhedana* action enhance excretion of bilirubin relieving obstructive jaundice. It is also seen that research which combined ancient Ayurvedic healing principles with the dialysis procedures of modern medicine in an immunologic setting has given fruitful result in controlling viral Hepatitis B disease. [72]

A critical analysis of the research studies clearly indicates that whole drug is preferred to its isolated active principle. Hepatoprotective activity of *P. zeylanica* was demonstrated

only when drug was administered as a whole. The liver protective and curative effect of *A. paniculata* extract compared to isolated andrgrapholide also supports this observation. Administration of drug through nasal mucus membrane in the management of jaundice as suggested by Ayurveda was ridiculed by western scientists. But clinical research carried out at Pune medical college [38] confirmed that the drug administered as nasal drops brings down the elevated serum bilirubin level significantly which revalidates the claim recorded in the Ayurvedic classics.

The research organizations like CCRAS, ICMR have conducted meticulous studies and produced evidence based data of hepatoprotective herbs and other herbal formulations mentioned in the classics of Ayurveda. These findings lend support to establish that the age old Ayurvedic health practices are comprehensive and more suitable to address the contemporary healthcare problems.

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