Chapter-6

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The liver is the largest organ of the body, which regulates many important metabolic functions\textsuperscript{135}. Various components like globulin, albumin, clotting factors, bile, and transport proteins are synthesized in the liver and are involved in detoxification of compounds\textsuperscript{136}. From the intestinal tract, toxins are absorbed and easily enter the liver to cause various hepatic diseases. Despite extensive research, no modern medicines are available to cure liver diseases, which many times become fatal\textsuperscript{137}. Many herbal preparations of plant origin are being used in treatment of hepatic diseases but, only few natural drugs are available for the treatment and this necessitate the evaluation of herbs for their possible antioxidant and hepatoprotective effects\textsuperscript{135}.

In this study, an attempt has been made to evaluate pharmacognostical, phytochemical parameters besides evaluating antioxidant and hepatoprotective activity of the roots of \textit{Ecbolium viride} (Forssk.) Alston and \textit{Rhyncosia beddomei} Baker leaves. The identification of plant material taxonomically and pharmacognostically is important to provide pharmacognostical standards and to avoid adulterated or spurious drugs.

\textit{Ecbolium viride} (Forssk.) Alston is an angiospermic dicot plant; the plant is a shrub growing upto 2.5m height. The leaves are elliptic-ovate to ovate. The lamina is thin and coriaceous; leaf apex is gradually acute.
Spikes are terminal and axillary. Bracts and bracteoles are leafy. Calyx: 5 sepals imbricate; petals: 5 lobed, bluish green. 2 -lipped, upper lip two lobed, lower lip three lobed and spreading. Stamens: 2, attached at the base of the upper lip; Anthers - two lobed lobes unequal. Ovary: Bicarpellary syncarpous, 2-ovuled; Fruits- 2 seeded Capsules; seeds circular flat\textsuperscript{138, 139}. The matured root measures about 5-8 cm long with darkish brown externally, with fissured and yellowish wood.

The roots of the plant were selected in the present study; since, in ethnomedicinal practices the traditional healers use \textit{Ecbolium viride} (Forssk.) Alston roots in the treatment of various ailments like jaundice, rheumatism, and menorrhagia\textsuperscript{71}. Identification of the selected plant and drug has been done by taxonomical, morphological and microscopical characters.

Microscopical characters like the presence of crushed cork surface, cystolith in sec.cortical parenchyma cells, air chambers in the middle sec. cortical zone, fibers, tracheids, vessels and pith helps in evolving pharmacopoeial parameters and also in the identification of drug. Macerate of roots is a key to identify the different cells present in different tissues of root. Macerate study revealed the presence of cork cells, thin walled cortical parenchyma, cystolith and other cell inclusions, fibres of different size, tracheids, vessels of different size and shapes.

\textit{Ecbolium viride} (Forssk.) Alston root exhibited some special diagnostic characters like crushed cork, air chambers, cystolith and also the
measurement of various cells of T.s and macerate (Cork, air chambers, vessels etc) helps in identification and also to differentiate from other species.

*Rhyncosia beddomei* Baker is an erect shrub with canescent branches. Leaflets oblong or oblong lanceolate, acute, subcoriaceous, thinly persistently argenteo, canescent above, densely so beneath, the veins conspicuously raised the end one short stalked. Flowers are in copious cymes from the axiles of reduced leaves; pedicles much shorter than calyx. Calyx is thinly silky, Corolla bright yellow; pod-1- seeded oblong, thinly canescent\textsuperscript{84}.

Leaves of *Rhynchosia beddomei* Baker were used as an abortifacient, antibacterial, antifungal, in the treatment of diabetes, liver disorders and traditionally for wounds, cuts, boils and rheumatic pains by adivasi tribes\textsuperscript{71, 86}. Hence, the leaves of the plant were selected in the present study. Identification of the selected plant and drug has been done by taxonomical, morphological and microscopical characters.

Microscopical study showed upper epidermis and lower epidermis with some rectangular epidermal cells, trichomes of different types (covering and glandular) emerging on both upper & lower epidermis. Stomata are anomocytic mainly found on the lower epidermis. Mesophyll region showed columnar palisade cells and spongy parenchyma and some of the spongy parenchyma cells found to contain yellow content. U-shaped vascular bundle is present in midrib region enclosed by
sclerenchymatous sheath. The ground tissue found to contain collenchymatous cells with yellow cell content. Both glandular and non-glandular trichomes are found in the lamina, they are unicellular. Macerate and powder studies showed the presence of vermiform trichomes, thin layered parenchyma cells, fibres with tapering ends, xylem vessels of spiral and reticulate thickenings.

Leaves of *Rhynchosia beddomei* Baker exhibited some special diagnostic characters like vermiform trichomes, cells of different region with yellow content, spiral and reticulate vessels and also the measurement of various cells of T.s and macerate (trichomes, collenchyma cells, vessels etc) helps in identification and also to differentiate from other species.

Various physical constants were determined in the present study. Moisture content of drug should be determined as the amount of active constituents is expressed in percentage based on air dried material. Ash content represents inorganic salts naturally occurring in crude drugs or adhering to it or deliberately crude drugs are mixed with sand, soil, chalk powder, calcium oxalate or other drugs with inorganic content. Total ash usually consists of carbonates, silica, phosphates and silicates. Ash value is an important criterion to evaluate crude drugs for their identity or purity. Adhering sand and dirt may be determined by acid insoluble ash. Extractive values represent the quality of the drug since; it indicates the amount of chemical constituents present in the drugs.
Moisture content and total ash values of *Ecbolium viride* (Forssk.) Alston and *Rhynchosia beddomei* Baker were found to be 8.2%, 9.4% and 6.6%, 2.6% respectively. The alcohol soluble extractive value of *Ecbolium viride* (Forssk.) Alston and *Rhynchosia beddomei* Baker were found to be 15.2% w/w and 23.9% w/w respectively and that of water soluble extractive value were found to be 6.4% w/w and, 11.2% w/w respectively.

Dried roots of *Ecbolium viride* (Forssk.) Alston and leaves of *Rhynchosia beddomei* Baker were coarsely powdered and subjected to extraction using various solvents (increasing order of polarity). Prepared extracts were screened by different chemical tests to obtain information on various phytoconstituents like alkaloids, carbohydrates, glycosides, phyto sterols, phenolic compounds, flavonoids, tannins, saponins, fixed oils and volatile oils. In case of *Ecbolium viride* (Forssk.) Alston, Pet.ether extract found to contain phytosterols, fixed oil and fats, benzene extract revealed the presence of phytosterols, chloroform extract showed alkaloids, methanol extract was found to contain carbohydrates, phytosterols, alkaloids, phenolic compounds, flavonoids and tannins; aqueous extract revealed phenolic compounds, flavonoids, carbohydrates and tannins. In case of *Rhynchosia beddomei* Baker, Pet. ether found to contain phytosterols, fixed oil and fats, benzene and chloroform extracts showed no phytoconstituents, methanol extract was found to contain carbohydrates, alkaloids, phenolic compounds, flavonoids and tannins; aqueous extract revealed carbohydrates, phenolic compounds, tannins,
gum and mucilage. Both MEEV and MERB showed better response for alkaloids, phenolic compounds, flavonoids and tannins. Hence, methanolic extract was selected to evaluate the activity.

Based on the results of phytochemical analysis, methanolic extract was selected for the isolation of phytoconstituents by employing column chromatography. The compound isolated from MEEV was identified as β-sitosterol by spectral analysis and that of MERB was identified as aconifine by spectral analysis.

β-Sitosterol is one of the phytosterol having chemical structure similar to that of cholesterol. Many plants like Pygeum africanum, Nigella sativa, Serenoa repens, soybeans etc found to contain β-sitosterol. It inhibits absorption of cholesterol in the intestine, when it is absorbed in the intestine; it is incorporated by lipoproteins into the cellular membrane. It also serves as dietary cholesterol in micelles due to structural similarity with cholesterol\(^{141,142}\).

Aconifine is the norditerpenoid alkaloid posse’s lycoctonine carbon skeleton previously isolated from the leaves and tubers of Aconitum karakolicum Rapaics and other species. There are two intramolecular O-H…O hydrogen bonds with five- and seven-membered pseudo-rings, respectively. Aconifine posses central nervous, cardiovascular, and respiratory system effects arising from the presence of benzyl ester and hydroxyl groups in their mol. structures\(^{143}\).
Both MEEV and MERB were subjected to screen antioxidant activity by using \textit{in vitro} antioxidant models like DPPH assay, nitric oxide, reducing power, hydrogen peroxide, superoxide anion scavenging and β-Carotene linolate model.

The DPPH free radical, when it reacts with hydrogen donors reduced to a corresponding hydrazine. The purple colour of DPPH radical changes to yellow colour upon reaction with a hydrogen donor. This assay is based on discoloration, which is evaluated by adding antioxidant to an ethanolic or methanolic solution of DPPH. Antioxidants terminate chain reaction of free radicals by donating hydrogen to form a stable product, which prevent the propagation of further oxidation\textsuperscript{144, 145}. Both MEEV and MERB demonstrated dose dependant activity. MEEV showed potent free radical scavenging activity (78.25%) against DPPH radical with IC\textsubscript{50} value of 66 µg/ml and MERB also exhibited potent activity (80.25%) with IC\textsubscript{50} value of 29 µg/ml. Scavenging potential of different extracts is based on their individual hydrogen donating capacity.

Nitric oxide is a potent mediator of various physical processes such as platelet aggregation inhibition, smooth muscle relaxation etc \textsuperscript{146}. Antioxidant capacity is evaluated by measuring the potential of the substances to inhibit the nitric oxide radical generated from sodium nitroprusside. The amount of NO generated is measured by Griess reagent. Dose dependant activity was observed with MEEV and MERB with IC\textsubscript{50} value 70 µg/ml and 35 µg/ml respectively.
Investigation of Fe$^{3+}$- Fe$^{2+}$ transformation is used as a tool to measure the reducing ability of MEEV and MERB. The reducing capacity of substance may serve as a significant indicator of its antioxidant potential$^{147}$. MEEV upto 80 µg/ml has shown steady increase in reducing capacity, but there was sudden increase in activity at 100 µg/ml (IC$_{50}$ value 86µg/ml). However, MERB at different concentration has shown steady increase in activity and maximum of 83.20% at 100 µg/ml (IC$_{50}$ value 24 µg/ml).

Hydrogen peroxide oxidizes essential thiol (-SH) group of few enzymes directly leads to their inactivation. It exhibits toxic effects on cells by generating hydroxyl radical through the reaction with Fe$^{2+}$ and Cu$^{2+}$ ions$^{148}$. MEEV exhibited maximum activity at 250 µg/ml (71.42%) with IC$_{50}$ value of 165 µg/ml and MERB exhibited the maximum activity at 100 µg/ml (74.41%) with IC$_{50}$ value of 78 µg/ml.

Nitro blue tetrazolium dye (NBT) is used to deduct superoxide radical produced upon photo reduction of riboflavin. The superoxide ion reduces the NBT resulted in a chromophore with a maximum absorption at 560nm$^{109, 110}$. It was observed that the MEEV and MERB have demonstrated dose dependent increase in the superoxide anion scavenging activity. Ascorbic acid (100 µg/ml) has shown 97.11% activity. However, 500 µg/ml MEEV and 100 µg/ml MERB have shown maximum scavenging activity i.e. 64.19% and 79.25% with IC$_{50}$ values of 330 µg/ml and 66 µg/ml respectively.
In absence of an antioxidant, β-carotene looses its colour rapidly due to the formation of linoleic acid free radicals generated from coupled oxidation of β-carotene and linoleic acid. These radicals attack the β-carotene, which is highly unsaturated leads to its oxidation and subsequently loses its orange color; in presence of antioxidants β-carotene bleaching is hindered due to neutralization of the free radicals by anti oxidants \(^{149, 150}\). It was observed that MEEV and MERB have shown dose dependent antioxidant activity. BHT (100 \(\mu g/ml\)) has shown 95.22% activity. However, 500 \(\mu g/ml\) of MEEV and 250 \(\mu g/ml\) MERB have shown maximum scavenging activity i.e. 74.25 and 83.25% respectively.

The constituents like flavonoids, phenolic compounds, alkaloids known to possess potent antioxidant activity\(^ {151}\). Phytochemical analysis of MEEV and MERB indicated the presence of flavonoids, phenolic compounds, alkaloids and tannins. Hence, both the extracts exhibited significant \textit{in vitro} antioxidant activity. MERB exhibited significant activity against all the free radicals than MEEV may be due to higher phenolic content.

On the basis of the results of \textit{in vitro} antioxidant studies, MEEV and MERB were screened for an \textit{in vivo} antioxidant and hepatoprotective activities. Before screening for \textit{in vivo} antioxidant and hepatoprotective activity, MEEV and MERB were subjected to the acute toxicity studies according to OECD 423 guidelines. Both extracts showed no toxicity or
lethality up to 2000 mg/kg. Hence, 1/10th and 1/5th of higher dose were selected to carry out further studies.

In the present study, in vivo antioxidant activity was evaluated in CCl₄ and paracetamol treated rats. Since, SOD, Catalase, reduced glutathione (GSH) were considered as inbuilt antioxidant substances which prevent lipid peroxidation. Hence, estimation of SOD, Catalase, GSH and extent of lipid peroxidation were considered as parameters for screening in-vivo antioxidant properties.

Lipid peroxidation is an autocatalytic destructive process occurs in hepatic damage. Lipids are most susceptible towards free radical attack than protein, carbohydrates, nucleotides etc, and this leads to generation of lipid free radicals. These radicals attack poly unsaturated fatty acids (PUFA), either directly or through the formation of ROS. It is generally measured as MDA since; it is the end product of lipid peroxidation. Enhanced levels of MDA in CCl₄ and paracetamol intoxicated rats indicate the inability of antioxidant defence mechanisms to protect the body from excessive free radicals. Treatment with silymarin 100 mg/kg, MEEV and MERB significantly reduced the MDA levels.

The body is able to prevent the damage induced by free radicals with the help of antioxidant enzymes like catalase, SOD, peroxidase, GST and GPX. The imbalance between ROS and antioxidant enzymes leads to oxidative stress, in turn responsible for the development of various
diseases. Catalase is an enzymatic haemoprotein decomposes hydrogen peroxide to water and oxygen, thus protecting the production of hydroxyl radicals and its toxic effect on all the major biomolecules in particular PUFA\textsuperscript{155, 156}. SOD is a metallo protein acts as an antioxidant by lowering or inhibiting the production of superoxide anion radical\textsuperscript{157}. Decreased levels of SOD and catalase in CCl\textsubscript{4} and paracetamol animals may be due to the cross linking with MDA leads to enhanced lipid peroxidation\textsuperscript{158}. Catalase and SOD levels decreased significantly in liver of CCl\textsubscript{4} and paracetamol treated animals compare to normal group. Both MEEV and MERB significantly elevated the levels of catalase levels in CCl\textsubscript{4} treated rats at 400 mg/kg. However, the levels did not increase to any significant extent at 200mg/kg. In paracetamol treated animals MEEV and MERB at both the doses (200 and 400 mg/kg) elevated the catalase levels significantly (p<0.001). MERB significantly elevated the levels of SOD in CCl\textsubscript{4} and paracetamol treated rats at 200 and 400 mg/kg. MEEV significantly elevated the levels of SOD levels in CCl\textsubscript{4} and paracetamol treated rats at 400 mg/kg. However, 200 mg/kg elevated the levels moderately (p< 0.01).

GSH is a non-enzymatic biological antioxidant plays an important role in many cellular functions, such as destruction of H\textsubscript{2}O\textsubscript{2}, free radicals, detoxification of foreign compounds etc \textsuperscript{159, 160}. It also regulates gene expression and apopsis\textsuperscript{161}. Depletion of GSH made cells susceptible to various aggressions and severe depletion leads to liver injury\textsuperscript{162}. It
effectively scavenges free radicals and other ROS directly and indirectly through enzymatic reactions\textsuperscript{163}. In the present study, significant reduction of GSH levels was observed in toxicant group animals. The treatment with MERB (200 mg and 400 mg) and MEEV at 400 mg/kg have brought back the levels of GSH considerabally.

Hepatoprotective activity of MEEV and MERB was evaluated in CCl\textsubscript{4}, Paracetamol and ethanol treated rats. The activity was assessed by measuring serum marker enzymes, bilirubin, triglycerides, total proteins and histopathological changes in the liver. Enhanced levels of these marker enzymes, triglycerides, bilirubin and reduced levels of total proteins are an indication of liver damage.

CCl\textsubscript{4} is one of the halogenated alkane widely used to induce hepatotoxicity. The postulated mechanism suggested that it metabolized to trichloro methyl free radical (CCl\textsubscript{3}) by the action of cytochromes, which in turn binds to cellular molecules result in impairement of lipid metabolism with steatosis. This free radical is unreactive initially, but capable of reacting with mol oxygen to form highly reactive trichloromethyl peroxo radical (CCl\textsubscript{3}OO\textsuperscript{-}). This radical attacks and destroys PUFA of phospholipids leading to lipid peroxidation, in turn, causes homeostasis due to changes in permeability of plasma membrane and mitochondria\textsuperscript{42, 43}. 
Liver mass increased considerably with the administration of CCl₄ in the toxicant group. This indicates the extent of damage caused to hepatocellular parenchyma. The liver weight decreased on treatment with MEEV, but the results were non-significant when compared with the positive control. However, MERB significantly decreased liver wt at 400 mg/kg (p< 0.01). Silymarin showed little effect on liver weight (p< 0.05).

Damage to the cell membrane of hepatocytes result in leakage of enzymes such as SGPT, SGOT and ALP into blood from cytosol, in turn leads to loss of functional integrity of of liver\textsuperscript{164, 165}.

Serum glutamate pyruvate transaminase (SGPT) is also called as Alanine transaminase (ALT) is commonly found in liver and to certain extent in serum and various body tissues. It catalyzes the transfer of amino group from alanine to α-ketoglutarate and results in formation of pyruvate and glutamate. High levels of ALT often suggest the existence of liver damage and other diseases like viral hepatitis, diabetes, bile duct problems. Hence, it is commonly used to screen liver problems\textsuperscript{166, 167}. Serum glutamate oxaloacetate transaminase (SGOT) is also called as Aspartate transaminase (AST) or aspartate aminotransferase (ASAT) is mainly found in the liver, heart, brain and RBC. It catalyzes the conversion of aspartate and α-ketoglutarate to oxaloacetate and glutamate. Both ALT and AST is commonly measured to determine the liver health. ALT is a more specific indicator than AST since; AST may be
elevated in other conditions, such as pancreatitis, myocardial, acute hemolytic anemia, acute renal disease and trauma\textsuperscript{168}. The elevated levels of these enzymes were observed in toxicant animals. The levels of SGPT and SGOT significantly reduced with MEEV (p<0.01 for 200 mg/kg and p<0.001 for 400 mg/kg). However, effect of MERB was extremely significant (p<0.001) and comparable with that of standard silymarin.

Alkaline phosphatase (ALP), as the name suggests it is highly effective in an alkaline environment\textsuperscript{169}. ALP is commonly found in sinusoids and endothelium, an enhanced serum level of ALP is a common symptom of hepatobiliary diseases\textsuperscript{170}. Levels are also found to be elevated in people with untreated celiac disease\textsuperscript{171}. ALP levels increased by 2.5 fold in toxicant group and treatment with MEEV and MERB reduced the levels significantly.

The synthesis of plasma albumin, fibrinogen and other serum proteins associated with liver. Studies reveal that, in hepatotoxicant animals proteins will be synthesized continuously even after simultaneous administration of toxicants. The metabolic dysfunction may occur due to site specific oxidative damage in some susceptible amino acids\textsuperscript{172}. Serum protein levels decreased by 3 fold in the positive control animals compare to normal group. Both MEEV and MERB exhibited significant activity by enhancing the total proteins levels.

Bilirubin (hematoidin) is formed from normal heme catabolism as yellow breakdown product. It is excreted in bile and urine and enhanced
levels may indicate certain diseases. It imparts background straw-yellow color to urine (urobilin a breakdown product of bilirubin imparts the color)\textsuperscript{173}. CCl\textsubscript{4} intoxication enhanced the levels of serum bilirubin by 5 folds. Serum bilirubin levels in MEEV and MERB treated animals were significantly restored, it may be due to the inhibitory effects of the plant extracts on Cytochrome P450 and/or promotion of its glucoronidation\textsuperscript{174}.

A triglyceride (TG) is an ester derived from glycerol and three fatty acids. They are the main constituents of vegetable oil (more unsaturated) and animal fats (more saturated). In humans, the presence of high TG concentration in blood correlates with the consumption of starchy and other high carbohydrate foods. They are a major component of human skin oils\textsuperscript{175, 176}. CCl\textsubscript{4} significantly enhanced the levels of TG in positive control group compared to normal group. There was two and half a fold increase in serum triglyceride levels in the positive control group. However, both MEEV and MERB showed moderate effect at 200 mg/kg and almost brought back to normal level at 400mg/kg (\(p<0.001\)). The effect at 400 mg/kg was comparable with that of standard silymarin. Hepatoprotective activity of MEEV and MERB was further supported by histopathological studies. CCl\textsubscript{4} treated group (positive control) revealed loss of normal liver architecture with fibrosis, congested sinusoids, ballooning degeneration, lymphocytic infiltration, hemorrhage and centrilobular necrosis (Fatty liver). However, MEEV and MERB treated groups showed dose dependant improved liver architecture with regeneration of
hepatocytes, moderate lymphocytic infiltration and light ballooning degeneration.

Paracetamol is one of the well known analgesic and antipyretic drug, but overdose of the same known to produce centrilobular hepatic necrosis. More than 90% of the Paracetamol is excreted after undergoing glucoronidation/sulfation and a small amount undergoes metabolism by cytochrome P450 enzyme to form reactive intermediate N-acetyl-P-benzoquinone imine (NAPQI). This intermediate is readily detoxified by GSH, but saturation of glucoronidation/sulfation takes place when paracetamol is administered at higher doses. This leads to excessive production of NAPQI, which in turn deplete the GSH completely and binds to proteins to form adducts. These adduct cause impairment in the function of cellular proteins. Other proposed mechanism is overdose of paracetamol also leads to lipid peroxidation and pyridine nucleotide oxidation, which may induce liver damage\textsuperscript{44-46,177}.

In the present study, significant hepatic damage was observed in the toxicant group (paracetamol) animals as evidenced by the elevated levels of serum markers. The alteration in levels reflects the structural integrity of hepatocytes. An enhanced SGOT level is usually associated with increased levels of SGPT and conversion of amino acids to keto acids is effected by enhanced level of these enzymes. The treatment with MEEV and MERB significantly lowered the levels of SGPT and SGOT and
it suggests that extracts are able to protect the cell membrane integrity of liver.

Increased biliary pressure found to enhance the synthesis of ALP. Both MEEV and MERB significantly reduced the levels of ALP and bilirubin compare to positive control group. Improvement in the hepatic secretory mechanisms is an indication of effective control of ALP and bilirubin levels by extracts.

A reduction in the serum protein levels was observed in the toxicant animals, it may be due to decreased number of hepatocytes or reduced capacity of hepatocytes to synthesize proteins leads to increase in the liver weight. Both MEEV and MERB extract enhanced serum protein levels and reduced liver weight in their respective groups. Histopathological studies also supported the hepatoprotective effect of both plants. The liver section of toxicant animals showed degenerative changes, aggregates of mononuclear inflammatory cells with congested sinusoids. Treatment with extracts helped in regaining the normal hepatic architecture.

Ethanol was also used to induce the hepatotoxicity. Alcohol-induced liver injury found to enhance the production of ROS and lipid peroxidation. Many pathways have been suggested to explain the mechanism involved with alcohol induced hepatotoxicity such as, acetaldehyde production, neutrophil infiltration, apoptosis, hypoxia, increased liver fat and immunological mechanism. Reduction in the
levels of SGPT and SGOT reflects the stabilization of plasma membrane and the repair of hepatic tissue. An elevated level of liver wt, serum marker enzymes, total bilirubin, triglycerides and reduced levels of total proteins were observed in ethanol treated group. Both MEEV and MERB significantly altered the levels of all the parameters and almost brought back to the normal level at higher dose (400 mg/kg).

Many of the Phytoconstituents found in MEEV and MERB are reported to posses’s antioxidant and hepatoprotective activity. Phenolic compounds known to posses’ antioxidant and hepatoprotective activity. Antioxidant potentials of many drugs containing flavonoids, polyphenols and β-sitosterol are reported.

Both MEEV and MERB showed significant antioxidant and hepatoprotective activity. Possible mechanisms responsible for hepatoprotective effect maybe free radical scavenging and intercepting those radicals involved in the metabolism of CCl₄, paracetamol and alcohol. The extracts could have hindered their interaction with poly unsaturated fatty acids by trapping oxygen related radicals and abolishing the lipid peroxidation process. The histopathological changes associated the hepatoprotective activity of both the plants support the result of biochemical estimations.

Antioxidant principles from herbal resources provide enormous scope in correcting the imbalance between prooxidants and antioxidants through regular intake of a proper diet supplemented with antioxidants.
Thus, the antioxidant property of these plants can be related to the presence of constituents like flavonoids, polyphenols, sterols, tannins etc. and antioxidant property could have contributed to the hepatoprotective effect.