Liver is the largest gland found in the body and is most complex organ. The weight of normal liver in adult man is 1.6 Kg. It consists of two lobes, right and left, which are covered with peritoneal membrane, which keeps it in position. Histologically, liver is formed of many pentagonal or hexagonal lobules separated by a sheath of connective tissue fibers called Glisson's capsule. It contains numerous interlobular blood vessels and interlobular bile ducts.

Every year about 18000 people are reported to die due to liver Cirrhosis caused by hepatitis. Though liver diseases are among the important diseases affecting mankind no remedy is available to majority of them at present.

Each hepatic lobule has a central or intralobular vein around which large number of hepatic cells are arranged in single row forming radical- hepatic cords. Cytoplasm of hepatic cell store glycogen granules and fats droplets. Between hepatic cells two types of channels the first channel is liver sinusoids whose walls have Kupffer cells which are phagocytic in nature and help to remove toxic material from the blood, and another type is bile capillaries which join to form bile duct. Bile duct open collectively in hepatic duct and deposits bile in the gall bladder.
Fig. 1.1: Situation of Liver

Fig. 1.2: Cells of Liver
Liver plays very important function in our body because it is not only endocrine gland but also acts as exocrine. Liver cells secrete bile, which changes the medium from acidic to alkaline. It plays an important role in metabolism of glucose by converting glucose into glycogen through glycogenesis and also by converting stored glycogen into glucose through glycogenolysis, another process is glyconeogenesis in which glucose is synthesized from amino acids or from fatty acids.

Liver also acts as depot of fats through lipogenesis and β-oxidation. It also helps in deamination of proteins and synthesizes albumin from amino acids.

It also helps in production of blood proteins like prothrombin and fibrinogen, which are essential for blood coagulation as well as heparin, which is anticoagulant. It helps in production of R.B.Cs. It provides heat to body through metabolic activities. It acts as storage house of vitamins like A, B₁₂ and D and inorganic substances like copper and iron. It produces urea through Ornithine cycle and therefore plays vital role in maintenance of internal environment of body. As mentioned earlier liver plays a vital role in our body and acts as important organ of body, so patients suffering from liver disease feel sick.

The main clinicopathological manifestations of liver are:

1. Jaundice
2. Cirrhosis of liver
3. Necrosis of liver
4. Hepatitis and other hepatic problems.
Jaundice is a colouration of the skin and sclerotics by bile pigment in the blood. Liver has the bilirubin as a bile pigment and jaundice may be the result of either excessive production or inadequate removal of the pigment. It is mainly of three types: -

(a) Obstructive jaundice (Post-hepatic)
(b) Hemolytic jaundice (Pre-hepatic)
(c) Hepatic jaundice (Liver cellular)

In obstructive jaundice, obstruction of common bile duct takes place due to which the pigment passes through liver cell and reabsorbed into the blood & passes in urine. The hemolytic jaundice occurs when excessive hemolysis is there and the bilirubin carried to the liver cannot be excreted entirely so some remains in the blood, also known as acholicuric jaundice. The other type is the hepatic jaundice also infections (viral) hepatitis or more accurately of liver necrosis. In this the first effect of disease of the hepatic cells, is an inability to excrete all the bilirubin, some of which therefore accumulates in the blood. With continued action of the virus, the hepatic cell becomes more and more swollen, so as to cause obstruction of the tiny bile capillaries. Cirrhosis of the liver is a progressive chronic destruction, diffuse in extent accompanied fibrosis retrogressive changes in the parenchymal cells and proliferation of remaining cells in the direction of regeneration. So the essence of cirrhosis is a disturbance of lobular architecture with the formation of regenerative nodules and connective tissues septa. Necrosis of liver cell can be divided into (a) diffused necrosis in which all the cell in group of lobules are affected as in acute yellow atrophy; (b) zonal necrosis in which only cell of a certain area in each lobule are
affected; (c) focal necrosis in which small area of no uniform distribution are affected as in sever bacterial infections such as streptococcal and typhoid.

The characteristic reaction of liver cells to an injurious agent is necrosis. This may be as hepatic necrosis or hepatitis. On an etiological basis we can distinguish hepatitis as viral, toxic and deficiency hepatitis or necrosis.

**VIRAL HEPATITIS**

This is an acute diffuse hepatic necrosis, which occurs, in sporadic and epidemic form. The sporadic form is mild where as the epidemic form is common among the troops of all armies of World War II.

There are two hepato-tropic viruses “Virus A” or virus of infections hepatitis (IH) and “Virus B” virus of serum hepatitis (SH). In such cases liver looses weight and liver becomes extremely soft and capsule is wrinkled because of rapid shrinkage. It is also realized that viral damage of organs other than the liver may be present. In those patients who recover, repeated biopsies show regenerating, liver cells, growing along to form new columns were as in absence of regeneration of cells, cirrhosis may occur and the patient frequently will have a number of recurring attacks of jaundice epigastric pain, vomiting and fever.

**TOXIC HEPATITIS**

Necrosis of liver may be caused by drugs (chloroform, cincopehn) by poisons (phosphorous, mercury) and by substances used in technical and manufacturing processes (CCl₄, tetrachloroethane, trinitrotoluene).
The action these substances can be observed both in man and in experimental animals. The effect depends both on size and length of dose applied. The necrosis is zonal in type, central or peripheral depending on the poison, when large doses are given at short intervals the necrosis is more massive and may be followed by cirrhosis.

Fig. 1.3: Zones of liver showing effect of chemicals

DEFICIENCY HEPATITIS

Lack of lipotropic factors in the diet, especially cholin and the sulfur containing amino acid, methionine and cystine results in an extreme degree of fatty infiltration of the liver followed by necrosis prolonged administration of low protein diet deficient in these essential amino acids also results in necrosis. These substances together with vitamin B serve to protect the liver against the poison mentioned above and also against viral infections. The two main examples of deficiency hepatitis are Kwashiorkor and alcoholism.
Kwashiorkor is term meaning 'Red boy'. The striking lesion in the liver is an extreme degree of fatty infiltration with ensuring cirrhosis a picture closely resembling that of alcoholic cirrhosis in man.

Alcoholism has been known for many years to be associated with liver disease particularly cirrhosis. The diet has poor contents of protein, vitamins etc. even more the alcohol provides high caloric values to body and so takes the place of food. There is believed to be choline deficiency in alcoholic cirrhosis. It is now evident that alcohol can be directly poisonous to the liver.

Since mankind has cured many disease by creating and synthesizing drugs. But there is fact that modern medicine does not have suitable answer for many conditions such as arthritis, asthma and over all includes the liver disorders\textsuperscript{13}.

This fact develops interest of mankind towards herbal drugs\textsuperscript{14-17}, so doctors and scientists are interested in drugs with plants origin which have protective, effect on liver particularly from harmful effect of alcohol, drugs and viruses, as liver diseases are among the important diseases affecting mankind. That is why the development of traditional system of medicines is catching up.

**PLANTS WITH HEPATOPROTECTIVE PROPERTY**

People living in remote area depend on traditional healers. The integrated system of medicine based on natural products may yield most effective and cheap package for health. This proofs that plants are very important part of our life.
From the time immemorial plants are known to us and are being used since then based on the considerable knowledge about plants. It is true that very few people are concerned about the plants. Plants feed us, clothe us and protect us from the elements. Nevertheless plants are essential to human and animal life. They form bottom layer of a set of building block without bottom layer all the higher levels of life would topple over.

In today’s life, plants are used in each and every step. It is not necessary that only those plants, which are growing in our garden, are useful but also plants growing, as weeds in croplands and forests may also be useful since one man’s weed is another’s medicine.

Plants are wonderful chemists, a trait that benefits not only themselves but also humans. Since good health is considered to be an equilibrium of physical, mental, spiritual and social well being plants play a vital role in human health as they are used in treatment of different remedies\textsuperscript{18-20}.

India unquestionably occupies topmost position in the herbal drugs. It is one of the fore most countries exporting plants drugs or their derivatives and active principles. This is not at all surprising, as the systematized use of herbal drug in India has been practiced from almost the very beginning of civilization.

According to Indian mythology, Lord Brahma composed the “Ayurveda” the knowledge of life or the system of Indian medicine even before creating universe.

When illness and disease got rampan on earth, the sages learnt the science of healing from Lord Indra and recorded in scriptures. The
Rigveda mentioned 67 herbal drugs. The Yajurveda mentioned 81 and Atharveda gave 290 drugs. Ayurveda has provided a rationale basis for treatment of various alignments based on the medicinal properties of selected plants as described in Ayurveda texts. Although the religions social and medical treaties of India “Charak Samhita” written in 1st century and another script “Susrutes Samhita” also gives knowledge about plants used for treatment of disease. Later during the Buddhist period considerable progress was made and medicinal plants were cultivated.

Plants still constitute one of the major raw-material for drugs for treating various alignment of human beings, and knowledge of medicinal plants has mostly been inherited traditionally which is also used house holds.

In modern medicine plants occupy very significant place as raw material for some important drugs. Although in modern days synthetic drugs and antibiotics are very common and brought revolution in disease control. Because of convenience of dose in contrast narrow spectrum of activity, of synthetic drugs are out of reach to millions of people. So many scientists and pharmacologists are working in this field to make the drugs cheaper and more effective against diseases without any side effects. And this is possible when a natural source is used as a raw material for which medicinal plants are cultivated in fields, commercially for extraction of active constituents used in modern medicine. There is worldwide perception that herbal drug are safe and effective alternative to modern medicine.
In the field of hepatoprotectives, some plants species have been already discovered which possess the protective property against hepatotoxicity, which encourage for studying different plants in order to discover new constituents. The work already done in the field is briefly described:-

**Plants From Solanaceae Family:**

*Solanum capsicatrum* from which capsimin and isocapsimin were isolated are steroidal - alkaloids by nature and are mainly isolated from roots of plants and show protective activity against CCl₄ induced hepatic damages.

Plant from the same family is *Withania somnifera* commonly known as “Asgand” in Hindi, from this plant, a constituent withraferin-A having hepatoprotective activity against CCl₄ has been extracted. Another plant *Lycium chinense* has shown protective effect against hepatotoxicity.

**Plants From Compositae Family:**

*Silybium manianum* a well known hepatoprotective plant whose main active principle is flavanoidal in nature where as another plant from same family is *Artemisia capillaries* whose buds extract protect liver from CCl₄ liver toxicity having active constituent of flavanoid nature.

The genus Santolina from Astraceae is widely used in traditional medicine and has hepatoprotective activity against liver toxicity.

A number of antihepatotoxic compounds were isolated from many plant species, which are given below in table 1.1.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the plant</th>
<th>Part of Plant</th>
<th>Compounds</th>
<th>Structure</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Solanum capicastrum</em> (Solanaceae)</td>
<td>Roots</td>
<td>- Capsimine&lt;br&gt;- Isocapsicastrine</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>2.</td>
<td><em>Withania sominifera</em> (Solanaceae)</td>
<td>Leaves</td>
<td>- Withaferin-A</td>
<td>3</td>
<td>27, 28</td>
</tr>
<tr>
<td>3.</td>
<td><em>Lycium chinense</em> (Saururaceae)</td>
<td>Ripe fruits</td>
<td>- Cerebroside (1)&lt;br&gt;- Cerebroside (2)</td>
<td>4</td>
<td>29-32</td>
</tr>
<tr>
<td>4.</td>
<td><em>Silybum manumum</em> (Compositae)</td>
<td>Aarial part</td>
<td>- Silybin&lt;br&gt;- Silymarin</td>
<td>6</td>
<td>33-38</td>
</tr>
<tr>
<td>5.</td>
<td><em>Santolina canescens</em> (Astraceae)</td>
<td>Flowers leaves</td>
<td>- Santolin-di-acetylene</td>
<td>8</td>
<td>39</td>
</tr>
<tr>
<td>6.</td>
<td><em>Cassia tora</em> (Caseaepliniaceae)</td>
<td>Seeds</td>
<td>- Nor-rubrofusarin-6-β-glycoside&lt;br&gt;- Rubrofusarin-6-β-glycoside&lt;br&gt;- 6-[(α-apiofurano syl (1→6)O-β-D-glucopyranosyl)]&lt;br&gt;- Oxyl rubrofusarin</td>
<td>9, 10, 11</td>
<td>40-43</td>
</tr>
<tr>
<td>7.</td>
<td><em>Glycyrrhiza uraiensis</em> (Leguminosae)</td>
<td>Aerial part</td>
<td>- Glycyrrhizin</td>
<td>12</td>
<td>44-47</td>
</tr>
<tr>
<td>8.</td>
<td><em>Canarium album</em> (Burseraceae)</td>
<td>Whole plant</td>
<td>- Urs-12-ene-3-α-16-β-diol&lt;br&gt;- Oleane-12-ene-3α-16-β-diol</td>
<td>13, 14</td>
<td>48-49</td>
</tr>
<tr>
<td>9.</td>
<td><em>Artemisia capillaries</em> (Compositae)</td>
<td>Aerial part</td>
<td>- Capillarisin&lt;br&gt;- Quercetin</td>
<td>15, 16</td>
<td>50</td>
</tr>
<tr>
<td>S.No.</td>
<td>Name of the plant</td>
<td>Part of Plant</td>
<td>Compounds</td>
<td>Structure</td>
<td>Reference</td>
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<tr>
<td>10.</td>
<td>Anthocephalus cadambin</td>
<td>Bark</td>
<td>- Cadambin</td>
<td>17</td>
<td>51, 52</td>
</tr>
<tr>
<td></td>
<td>(Rubiaceae)</td>
<td></td>
<td>- 3-α-dihydro cadambin</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Buddleja species</td>
<td>Whole plant</td>
<td>- 7p methoxy cinna moyl accubin</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>(Buddleja)</td>
<td></td>
<td>- 7p methoxy cinna moyl catalposide</td>
<td>20</td>
<td></td>
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<tr>
<td>12.</td>
<td>Andrographis paniculata</td>
<td>Leaf</td>
<td>- Andrographolide</td>
<td>21</td>
<td>54, 55</td>
</tr>
<tr>
<td></td>
<td>(Nees.) (Acanthaceae)</td>
<td></td>
<td>- Andrographaside</td>
<td>22</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Neo-andrographolide</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Curculige orchoides</td>
<td>Rhizome</td>
<td>- Curculigenin A</td>
<td>24</td>
<td>56-60</td>
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<tr>
<td></td>
<td>(Amaryllidaceae)</td>
<td></td>
<td>- Curculigol</td>
<td>25</td>
<td></td>
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<tr>
<td></td>
<td>(Compositae)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Lyfts echinata</td>
<td></td>
<td>- Epigenin</td>
<td>27</td>
<td>64-66</td>
</tr>
<tr>
<td>16.</td>
<td>Schisandra chinensis</td>
<td>Dry fruits</td>
<td>- Gomisin A</td>
<td>28</td>
<td>67-68</td>
</tr>
<tr>
<td>17.</td>
<td>Combretum uadrangular</td>
<td>Seeds</td>
<td>- Quadransode-I</td>
<td>29</td>
<td>69-74</td>
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<tr>
<td></td>
<td>(Combretaceae)</td>
<td></td>
<td>- Quadransode-II</td>
<td>30</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>- Quadransode-III</td>
<td>31</td>
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<td></td>
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<td>- Quadransode-IV</td>
<td>32</td>
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<td></td>
<td></td>
<td></td>
<td>- Quadransode-V</td>
<td>33</td>
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<td></td>
<td></td>
<td></td>
<td>- Quadransode-VI</td>
<td>34</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- 2α-3β-23-trihydroxy urs-12-19-dien-28 oic acid</td>
<td>35</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- β-D-glucopyra-nosyl ester</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>- Gallocatechin</td>
<td>36</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Epicatechin</td>
<td>37</td>
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<tr>
<td>S.No.</td>
<td>Name of the plant</td>
<td>Part of Plant</td>
<td>Compounds</td>
<td>Structure</td>
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<tr>
<td>18.</td>
<td><em>Saururus chinensis</em></td>
<td>Aerial part</td>
<td>- Sauchinone</td>
<td>38</td>
<td>75-78</td>
</tr>
<tr>
<td></td>
<td>(Lour.) (Saururaceae)</td>
<td></td>
<td>- Sauchinone-A</td>
<td>39</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- 1-episauchinone</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td><em>Baccharistimera</em> (Less.)</td>
<td>Whole plant</td>
<td>- Quercetin</td>
<td>41</td>
<td>79-82</td>
</tr>
<tr>
<td></td>
<td>(Compositae)</td>
<td></td>
<td>- Luteolin</td>
<td>42</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Nepetin</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Apigenin</td>
<td>44</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Hispidulin</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td><em>Picrorhiza kurrooa</em></td>
<td>Roots</td>
<td>- Iridoid glycoside veronicoside</td>
<td>46</td>
<td>83-91</td>
</tr>
<tr>
<td></td>
<td>(Benth.) (Scrophulariaceae)</td>
<td></td>
<td>- Minecoside</td>
<td>47</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- 6-feruloylcatapol</td>
<td>48</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>- Piecein</td>
<td>49</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Androsin</td>
<td>50</td>
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</table>
A deep sweep in the available literature on hepatoprotective plants with hepatoprotective activity has revealed that there are number of compounds which have been isolated from different parts of plants of different families as above and as such there exists enough justification to stimulate curiosity to carry out further systematic phytochemical analysis investigation with a view to isolate and identify hepatoprotective compound by using modern spectroscopic technique and so the following plants were selected and identified by the author for the present study in view of its significant hepatoprotective activity were:

1. *Andrographis paniculata* (Nees.) (N.O. Acanthaceae)
2. *Anthecephalus cadamba* (N.O. Rubiceae)

*Andrographis paniculata* (Nees.):

The plant is commonly known as “Kalmegh” in Hindi and belongs to family Acanthaceae. It is distributed in plains of North India.

The plant possesses several medicinal properties. It forms principle ingredient of a household medicine Alui and is extensively used in Bengal. The juice of the leaves with certain spices such as Cardamom, Cloves, Cinnamon etc. is dried in sun and made into little globules which are prescribed for infants to relieve griping irregular stool and loss of appetite.\textsuperscript{92-95}

This plant is very useful in debility and for treatment of dysentery and dyspepsia. The roots and the leaves are febrifuge, stomaczhache, tonic alternative and anthelmintic.
Photograph 1: PLANT ANDROGRAPHIS PANICULATA (NEES.)
Green leaves with leave of India birthwort and the fresh inner root bark of country sarsaparilla is used by hakims as a tonic syphilitic cachexia and foul syphilitic ulcers. It is used as antidote for venom of cobra.

*Anthocepalus Cadamba:*

The plant is commonly known as “Kadamb” in Hindi and Bengali. It belongs to family Rubiaceae. It is distributed in India especially in the plains. It grows best in deep moist alluvial sites and often in the secondary forests along the riverbanks.\(^{96-98}\)

The bark of the plant is used as tonic and astringent and also as antidote in snakebite. The decoction of leaves is used as gargle in cases of aphthite and stomatitis.

It is much more used in Indonesia and China for preparation of essential oil from flowers. The bark is pungent bitter sweet, saline, aphrodisiac, cooling indigestible, galachagogue and astringent to the bowels.

It is, vulnerary alexiteric good in uterine complaints, blood disease it cure in stringency “Vata” “Kapha” and useful biliousness burning sensation. The fruit is heating aphrodisiad and causes bilious when ripe. The sprouts are acid aphrodisiac stomachache, cure leprosy and dysentery.

The decoction of the leaves is used as gargle in case of aphthae and stomatits. In some other parts the bark is considered as tonic.

Charaka prescribed the bark for treatment of snake-bite, but the bark is not antidote to snake- tonic.
Photograph 2: PLANT ANTHOCEPHALUS CADAMBA
MODERN METHODS OF PLANTS ANALYSIS

The separation techniques such as paper column and thin layer chromatography coupled with modern spectroscopic techniques\textsuperscript{99-124} of UV, IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, and mass spectroscopy have proved to be boost for the organic chemist and have been utilized for the isolation and structural elucidation of various complex organic molecules such as flavonoids, steroids, terpenoids and alkaloids etc.

\textit{A brief account of some of them is given below:}

1. A simple isolation method for the major catechins in green tea using high-speed countercurrent chromatography.\textsuperscript{99}

2. UV guided isolation of verrucines A and B. Novel Quinazolines from \textit{Penicillium verrucosum} structurally related to Anacine from \textit{Penicillium aurantiogriseum}.\textsuperscript{100}

3. UV guided isolation of Alantrypinone a Novel Penicillium Alkaloid.\textsuperscript{101}

4. Fractional Protocol for the isolation of polypeptides from plant biomass.\textsuperscript{102}

5. Application of HPLC with online-coupled UV/MS-biochemical detection for isolation of an Acetylcholinesterase inhibitor from Narcissus 'sir Winston Churchill'.\textsuperscript{103}

6. Isolation of the pharmacologically active sapinon ginsenoside Rb 1 from Ginseng by Immuno-affinity column chromatography.\textsuperscript{104}

7. A HPLC determination of Andrographolide in \textit{Andrographis paniculata}.\textsuperscript{105}
8. Development of HPLC method for vasicine and vasicinone in *Adhatoda vasica* (Nees).\(^\text{106}\)

9. Volatile components of *Arbutus unedo* L. fruits of GC MS.\(^\text{107}\)

10. Use of on-flow LC/\(^1\)H-NMR for the study of an antioxidant fraction from *Orophia contracebra* and isolation of a polyacetylene lignans and a tocopherol derivative.\(^\text{108}\)

11. Combination of LC-MS and LC-NMR as tools for the structure determination of natural products.\(^\text{109}\)

12. Isolation and characterization of two new alkaloids norpandamarilactonine-A and B from *Pandanus amaryllizolius* by spectroscopic and synthetics methods.\(^\text{110}\)

13. X-ray crystals structure of woodinine and conformational analysis by semiempirical and \(^1\)H-NMR methods.\(^\text{111}\)

14. Structure elucidation of secalosides A and B by NMR spectroscopy.\(^\text{112}\)

15. Low-level long-Range \(^1\)H - 15N - Heteronuclear shift correlation at natural abundance using sub micro NMR techniques.\(^\text{113}\)

16. A comparison of inverse-detected hetero nuclear NMR performance: conventional vs. cryogenic microprobe performance.\(^\text{114}\)

17. Higher order and substitute chemical shift effects in the proton NMR of glycoside.\(^\text{115}\)
18. NMR spectroscopy, X-ray crystallographic and molecular modeling studies on a new pyranone from *Haloxylon salicornicum*.\(^{116}\)

19. A new 2D-TLC bioautography method for the discovery of novel antifungal agent to control plant pathogens.\(^{117}\)

20. Revision of the structure of fagaridine based on the comparison of UV and NMR data of synthetic compounds.\(^{118}\)

21. Isolation of diterpenoid alkaloids from herb and flowers of *Aconitum napellus vulgare* and electrophoresis ion trap multiple MS study of these alkaloids.\(^{119}\)

22. Encapsulation of podands by cyclodextrins: A spectrophotometric study.\(^{120}\)

23. \(^1\)H-NMR spectral study of some 4-hydroxy-2, 6-diphenylpiperidines and a systematic analysis of \(^1\)H-chemical shifts in some piperidines and 3, 7 diazabicyclo [3.3.1] nonane derivative.\(^{121}\)

24. \(^1\)H-NMR and \(^13\)C-NMR spectral study of substituent effects in 4-substituted 2', 6', dimethyl diphenyl sulphones.\(^{122}\)

25. A rapid and facile method for the dereliction of purified natural products.\(^{123}\)

26. Submicro inverse-detection gradient NMR: A powerful new way of conducting structure Elucidation studies with <0.05 µ mol samples.\(^{124}\)
PROBLEMS TAKEN AND WORK DONE

From the time immemorial human beings have been depended on plants as a source of food and medicine. Many plant species have been investigated for their biologically active constituents; but there are still many plants, which were investigated incompletely when the modern spectroscopic techniques were inadequately available and so further phytochemical work is warranted in the same field.

Normally the patients suffering from liver disease are likely to have been treated with drugs in large quantity of synthetic drugs but number of medicinal preparation have been advocated in traditional systems of medicine especially in Ayurvedas as they offer significant relief. Such medicines which of used, in treatment of hepatitis as they possess hepatoprotective activity are known hepatoprotectives.

The liver disease are major problems of India especially in Urban or remote areas, due to unhygienic living mode and the drugs available in market are so costly that they are out of reach of such people. So there is a need to search and develop a drug, which is easily available, more potential, less toxic and with cheaper cost which are affordable by common man. This is possible when we move towards nature and investigate the flora of Indian subcontinent.

The medicinal properties of plants depend on the presence of one or more physiological active compounds. Therefore it becomes necessary to isolate the physiologically active principles from plants in pure form and study their exact composition and finally establish their structure in order to reveal the secrecy of therapeutic values of the plants.
The phytochemical investigations on *Andrographis paniculata* (Nees.) and *Anthocephalus cadamba*, for the presence of active constituent against hepatotoxicity and its application as biologically active constituent are described below:-

1. **Isolation and study of the flavone glycoside (SU-I):** 5, 4'-dihydroxy flavone-7-O-L-α-L-arabinopyranosyl (1→4)-O-β-D-glucopyranoside from the aerial part of *Andrographis paniculata* (Nees).

This chapter deals with the isolation and structural studies of flavone glycoside SU-I (yield 0.084%) molecular formula C_{26}H_{30}O_{14}, m.p. 210–211°C and [M^+] = 566 (FAB-MS) which was obtained by column chromatography from the acetone: methanol soluble fraction of concentrated ethanolic extract of the aerial part of *Andrographis paniculata* (Nees.). It displayed significant IR bands $\nu_{\text{max}}^\text{IR}$ cm⁻¹: 3429.8 cm⁻¹ (-OH group), 2928.7 cm⁻¹ (-C-H stretching vibration), 1728.0 cm⁻¹ (> C =O), 1663.0 cm⁻¹ (α-β unsaturated C = O), and 1524.2 cm⁻¹ (-C-O-C stretching vibration). While in it's ¹H-NMR signals were observed at (DMSO d₆ 300 MHz): δ 6.52 (s, 1H, H-3), δ 6.79 (d=2.5, 1H, H-6), δ 7.49 (d=2.5,1H, H-8), δ 7.40 (d=2.5, 1H, H-2', H-6'), and δ 7.20 (d=2.0, 1H, H-3', H-5'), δ 5.08 (d=7.2, 1H, H-1''), δ 3.28-3.34 (m, 4H, protons of glucose), δ 4.28 (d=6.2, 1H, H-1''), δ 4.68 (m, 3H, protons of arabinose). [M^+] (FAB-MS) showed peaks at 566, 433, 270, 242, 153, 124.

On acid hydrolysis the compound SU-I gave an aglycone, 5, 7, 4'-trihydroxy flavone. The sugar(s) obtained after acid hydrolysis were identified as L-arabinose and D-glucose by (Co-PC and TLC).
Compound SU-I was characterized as; 5, 4'-dihydroxy flavone 7-O-[α-L-arabinopyranosyl (1→4)-O-β-D-glucopyranoside] on the basis of different colour reactions, chemical degradations and spectral studies.

\[\text{SU-I}\]

2. **Isolation and study of the Triterpenoidal saponin SU-II: 3-O-[α-L-rhamnopyranosyl (1→4)-O-β-D-glucopyranosid]-Olean-12-ene-16-β-ol-28-oic acid from the Aerial part of *Andrographis paniculata* (Nees).**

This chapter incorporates the isolation and structural studies of the triterpenoidal-saponin SU-II [yield 0.0302%] molecular formula C_{42}H_{68}O_{13}, m.p. 189-191°C and [M^+] = 780 (FAB-MS) was obtained by column chromatography from the chloroform soluble fraction of concentrated ethanolic extract of the aerial part of *Andrographis paniculata* (Nees.).

IR Bands were recorded at $\nu_{\text{max}}^{\text{KBr}}$ cm$^{-1}$: 3377.8 cm$^{-1}$ (-OH group), 2933.9 cm$^{-1}$ (CH$_3$ str.), 1233.0 cm$^{-1}$ (C-H str. vib.), 1629.6 cm$^{-1}$ (C-O str.), 1066.8 cm$^{-1}$ (Triterpene). $^1$H-NMR signals were observed at (DMSO d$_6$) : δ 0.95 (3H, s, H-23), δ 0.99 (3H, s, H-24), δ 0.89 (3H, s, H-24 ), δ 0.85 (3H, s, H-26), δ 1.10 (3H, s, H-27), δ 0.95 (3H, s, H-29), δ 0.88 (3H, s, H-30), δ 2.32 (1H, d, J=10.5, H-11), δ 5.32 (1H, d, J=3.0, H-12). [M+] peak at 780 (FAB-MS).
On acid hydrolysis SU-II gave an sapogenin which was identified as olean-12-ene-3-α-16-β-diol-28-oic acid (echinocystic acid) and the sugar (s) obtained after acid hydrolysis were identified as L-rhamnose and D-glucose by [Co-PC and TLC].

Compound SU-II was characterized as; 3-O-[α-L-rhamnopyranosyl (1→4)-O-β-D-glucopyranoside]-Olean-12-ene-16-β-ol-28-oic acid, on the basis of chemical degradation and spectral studies.

3. Isolation and study of the Flavone-glycoside SU-III: 5, 7, 4' trihydroxy flavone 3' (3'' methyl, but 2'' enyl) 3-O-β-D-glucopyranoside from fruits of Anthocephalus cadamba.

This chapter deals with the isolation and structural studies of flavonoid glycoside SU-III (yield 0.116%) m.f. C_{26}H_{28}O_{11}, m.p. 159-160°C and [M'] = 516 (FAB-MS) which was obtained by column chromatography of benzene soluble fraction of concentrated ethanolic
extract of the plant *Anthisephalus cadamba*. Its IR spectra was recorded at 

\[ \nu_{\text{max}}^{1\text{Br}} \text{ cm}^{-1} : 3550.3 \text{ cm}^{-1} (-\text{OH group}), 2920.2 \text{ cm}^{-1} (\text{C-H Str.}), 1730.3 \text{ cm}^{-1} (\alpha-\beta \text{ unsaturation}), 1685.2 \text{ cm}^{-1} (\text{Aromatic ring}), 1385.2 \text{ cm}^{-1} (\text{Gem-dimethyl}), 1216.5 \text{ cm}^{-1} (\text{C-O-C stretching vibration}), 860.2 \text{ (two adjacent protons in benzene).}

In its \(^{1}\text{H-}\text{NMR spectrum signals were observed at (DMSO d_{6} 300 MHz)}: \delta \; 6.80 \text{ (s, 1H, H-8)}, \delta \; 6.40 \text{ (s, 1H, H-3)}, \delta \; 7.83 \text{ (s,1H, H-6)}, \delta \; 7.99 \text{ (s, 1H, H-6')}, \delta \; 1.33 \text{ (s, 6H, Hz) prenyl.}

On acid hydrolysis the compound SU-III gave an aglycone 5, 7, 4'-trihydroxy- 3' (3'' Methyl but 2''-enyl) flavone. The sugar (s) obtained after acid hydrolysis was identified as D-glucose by (Co-PC and TLC).

Compound SU-III was characterized as: 5, 7, 4' trihydroxy flavone 3' (3'' methyl, but 2'' enyl) 3-O-\(\beta\)-D-glucopyranoside by various colour reactions and on the basis of chemical degradation and spectral studies.
4. Kaempferol 3-O-\(\alpha\)-L-rhamnopyranosyl (1→2)-O-\(\beta\)-D-glucopyranoside from fruits of Anthocephalus cadamba.

This chapter incorporates the isolation and structural studies of flavonoidal glycoside SU-IV (yield 0.21%) m.f. C_{27}H_{14}O_{15}, m.p. 238-239°C and [M\(^+\)] = 594 (FAB-MS) which was obtained by column chromatography of ethyl acetate soluble fraction of concentrated ethanolic extract of Anthocephalus cadamba.

IR bands were recorded at \(X_{\text{max}}\) 3350 cm\(^{-1}\) (-OH group); 2900 cm\(^{-1}\) (C-H str. vib.); 1600 cm\(^{-1}\) (Aromatic ring); 1650 cm\(^{-1}\) (\(\alpha\)-\(\beta\)-unsaturation); 1050 cm\(^{-1}\) (C-O-C str. vib.). \(^1\)H-NMR, signals were observed at (DMSO d_{6} 300 MHz): \(\delta\) 6.20 (s, 1H, H-6), \(\delta\) 6.20 (s, 1H, H-6), \(\delta\) 6.33 (s, 1H, H-8), \(\delta\) 7.45 (d, J = 7.5, 2H, H-2', H-6'), \(\delta\) 6.91 (d, J = 7.5, 2H, H-3', H-5'), \(\delta\) 5.44 (d, J = 2.0, 1H, C\(_1\) of glucose), \(\delta\) 6.22 (d, J = 2.0, 1H, C\(_1\) of rhamnose), \(\delta\) 4.69-5.35 (m, 6H, Proton of rhamnose), \(\delta\) 1.09 (d, J = 6.0, 3H, C\(_{11}\) of rhamnose). Mass spectra gave fragmentation m/e 594, 286, 285, 258, 153, 152, 134, 125, 124, 120.

On acid hydrolysis the compound SU-IV gave an aglycone 3, 5, 7, 4'-tetrahydroxy flavone (Kaempferol). The sugar(s) obtained after acid hydrolysis were identified as L-rhamnose and D-glucose by (CoPC and TLC).

Compound SU-IV was characterized as; Kaempferol 3-O-[-\(\alpha\)-L- rhamnopyranosyl (1→2)-O-\(\beta\)-D-glucopyranoside] by various colour reactions and on the basis of chemical degradation and spectral studies.
(B) Isolation and study of the bio-active flavonoidal constituent SU-V:
Quercetin 4'-O- (β-D-glucopyranosyl (1→4)-O-β-D-glucopyranoside)
from fruits of Anthecephalous cadamba.

This chapter describes the isolation and structural studies of a
flavonoidal glycoside SU-V (yield 0.523%) which was isolated from
fruits of Anthecephalous cadamba. It analysed for m.f. C_{27}H_{32}O_{17}, m.p. 212-
213°C, 3355.3 cm⁻¹ (-OH groups), 2922.0 cm⁻¹ (-C-H stretching), 1709.3
cm⁻¹ (>C = O stretching vibration), 1600.5 cm⁻¹, 1620.3 cm⁻¹ (Aromatic
ring system), 1320.0 cm⁻¹ (C-O-C bending vibration), 1232.3 cm⁻¹ (C-O-
C stretching vibration) and 890.3 cm⁻¹ (Two adjacent protons in benzene
ring); ^{1}H-NMR signals observed at (DMSO, d₆): δ 7.77 (s, 1H, H-2'), δ
7.58 (d, J = 8.0 Hz, 1H, H-6'), δ 6.85 (d, J = 8.0 Hz, 1H, H-5'), δ 6.67 (d, J =
2.0 Hz, 1H, H-8), δ 6.29 (d, J = 2.0 Hz, 1H, H-6) δ 5.30, (d, J = 7.0 Hz, 1H,
H-1", \( \delta 3.59 \) (m, 6H, Glycoside protons), \( \delta 3.99 \) (m, 6H, Glycoside protons) \([M^+] = 627, 302, 274, 153, 152, 151, 126 \) (FAB-MS).

On acid hydrolysis the compound SU-V gave an aglycone 3, 5, 7, 4', 3',pentahydroxy flavone (Quercetin). The sugar(s) obtained after acid hydrolysis were identified as D-glucose by (CoPC and TLC).

SU-V was identified as: Quercetin-4'-(\( \beta \)-glucopyranosyl (1→4))-O-\( \beta \)-D-glucopyranoside) by specific colour reaction, chemical degradation and spectral analysis.

![SU-V](image)

**[CI] HEPATOPROTECTIVE ACTIVITY:**

This chapter describes hepatoprotective activity (in vivo):-

**[I]** The extract of aerial part of *Andrographis paniculata* (Nees.) yielded compound SU-I and SU-II, which were tested for hepatoprotective activity against hepatotoxins CCl4, paracetamol, galactoseamine etc. Different assessment of liver function used during study were serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), total protein (T.protein) and bilirubin (Bil.) which showed that it has
significant hepatoprotective activity against hepatotoxins SU-I. It is more effective against hepatotoxicity induced by using CCl₄ as compared to SU-II.

The fruits extract of *Anthocepalus cadamba* yielded compound SU-III, SU-IV and SU-V. They also showed similar activity. SU-III and SU-V has shown hepatoprotective activity against CCl₄ more effectively than that of SU-IV.
REFERENCES


