CHAPTER - 2

LITERATURE REVIEW

ON

CICHERIUM INTYBUS LINN.
Cichorium intybus Linn.

(Asteraceae)

*Cichorium intybus* Linn., family Asteraceae, is commonly known as chicory and used in Indian System of Medicine as cardiotonic, anti-inflammatory, digestive, stomachic, liver tonic and diuretic. The phytoconstituents are mainly distributed in the whole plant but main constituents are present in the root. These are sesquiterpene lactones: lactucin, 8-deoxylactucin, lactopircin, cichoriolide A, B, and C. *C. intybus* is a major component of hepato-herbal formulations such as: Liv-52, Acilvan, Hepex, Livokin and Vimliv. Presently, it is a crop of choice for future genetic manipulation and the valuable phytochemicals may lead to metabolic engineering of secondary pathways. *C. intybus* is also used extensively in coffee blends as a vegetable and in value-added healthcare products (Chopra *et al.*, 1956; Anonymous, 1992; Zafar *et al.*, 1998; Bais *et al.*, 2001 and Prajapati *et al.*, 2003).

**Taxonomical classification**

Kingdom: Plantae; Subkingdom: Tracheobionta; Superdivision: Spermatophyta; Division: Magnoliophyta; Class: Magnoliopsida; Subclass: Asteridae; Order: Asterales; Family: Asteraceae; Genus: Cichorium.

**Vernacular names**

Sanskrit – Kasni; Hindi – Kasni; English – Chicory; Bengali – Kasni; Chinese – Ku-T’ Sail; German – Zichorie; Unani – Kasni; Arabian – Hindaba; Persian – Kasani; Gujarati – Kasni; Tamil – Kashmiri keerai; Telugu – Kasni-vittulu; Jammu – Kashni, Lishkan; Punjabi – Gul, hand, kasni, suchal (Anonymous, 1992; Pullaiah, 2002).

**Part used**

Seeds, roots and flowers (Singh *et al.*, 2005).

**Varieties**

There are two varieties of *C. intybus* – a cultivated sweet variety and the wild bitter variety (Kirtikar *et al.*, 1999).
Botanical features

*C. intybus* is an erect perennial herb 80-90 cm in height with a fleshy tap root up to 75 cm in length. Stem are angled or grooved with spreading branches, 1-1.5 m tall and glabrous. Leaves are broadly oblong, lanceolate, crowded at the base, forming a rosette arranged spirally on the stem. The upper leaves are cordate and amplexicaul; the lower leaves are 7.5-15 cm long and pinnatifed. Roots are brownish yellow outside and white inside, with thin bark. The root is well developed; the central part is mature and contains a portion of xylem including numerous vessels. Flower heads are bright blue in colour, solitary, terminal, often clustered and the axillary flowers are arranged along stout, erect, green, nearly leafless, spreading stem. Fruits are dry, indehiscent, 3 mm long, 2 mm broad and crowned with a ring of 0.5 mm long pappus which is usually white but sometimes half white and half straw-coloured. Mature fruits are brownish black as well as mottled, whereas those which are fully mature are pale. The seeds inside the fruits are 2.5 mm long, ovoid, with pointed apex, brownish tip and white plano-convex cotyledons (Bais *et al.*, 2001).

Geographical distribution

The plant is native to the temperate parts of the World and is found wild in Punjab and Andhra Pradesh regions. It is also cultivated in Bihar, Maharashtra, Gujarat, Tamil Nadu, Himachal Pradesh, Orissa and Kerala. The major producing countries of chicory are the United Kingdom, Belgium, Europe, France, Netherlands, Germany, Switzerland and South Africa (Prajapati *et al.*, 2003).

Agrotechnology

Chicory is a hardy plant and can tolerate extreme temperatures during its vegetative and reproductive phases of growth. Chicory thrives well under a mild climate, it requires a well distributed rainfall but can be cultivated under careful irrigation. For successful seed germination, chicory needs a minimum temperature of 21 °C and for good plant growth, a moderate and uniform temperature, with the optimum at 18-24 °C. The chicory plant needs chilling for about 90 days to break dormancy from vegetative to reproductive phase. The plant grows best in cool weather and calcareous and light soils, pH 4.5-8.3;
deep fertile loams with a slight excess of clay gave a high yields and good quality roots. The seeds are sown broad case (3-5 kg/ha) on well prepared field in the month of October-November and the crop is ready for coffee blending in March. At Kalpa (in Himachal Pradesh), the seeds are sown in the month of June-July and roots are ready by November. These are left as such under thick snow and replanted in March. Farmyard manure of well-rotted compost at the rate of 20-25 t/ha and an adequate supply of soil humus is required for increased yields of chicory crop. Chicory has a high requirement of potash (60-100 kg/ha) and nitrogen (60-160 kg/ha) for both root and seed crops, it also requires (60-120 kg/ha) of phosphoric acid for its full growth and development. After sowing, the whole area is irrigated up to 5 cm below the ridge level, once the plants are established, irrigation can be reduced. On the hills, chicory can be grown after wheat or potato. In the lighter soils, the crop is generally ready for lifting 120-135 days after sowing, while it may take nearly a fortnight more in heavier soils. In Tamil Nadu under irrigated conditions, the crop yields about 37.5 t, exceptional yields of even up to 50 t/ha can be expected on well cultivated and manured land (Anonymous, 1992).

**Traditional uses**

The cultivated chicory plant is used in Indian System of Medicine as a liver tonic, curative in acne, ophthalmia and inflamed throat. The plant is bitter, acrid, thermogenic, anti-inflammatory, appetizer, digestive, diarrhea, stomachic, cholagogue, cardiotonic, depurative, diuretic, emmenagogue, febrifuge, alexeteric and tonic. It is useful in vitiated conditions of kapha and pitta, cephalalgia, hepatomegaly, inflammations, anorexia, dyspepsia, flatulence, colic, gout, burning sensation, allergic conditions of skin, insomnia, jaundice, skin disease, leprosy, chronic and bilious fevers, vomiting, asthma and general debility (Anonymous, 1992; Prajapati et al., 2003).

The leaves of young plants are used as pot-herbs and cooked like spinach. Leaves of older plants, when blanched, were used like celery.

*C. intybus* roots are boiled and eaten with butter. Roots are also roasted and used to add a bitter, mellow taste to coffee and tea or used as a substitute for coffee (Ara et al., 2002).
Root of chicory is used in jaundice, liver enlargement, gout, rheumatism also used as vegetable. Seeds of chicory are carminative, agglutinating and cholagogue (Zafar et al., 1998).

Phytochemical work
Chicoric acid (dicaffeyltartaric acid) was isolated from chicory and its structure was determined and confirmed by synthesis of the optically active and racemic modifications from caffeic acid chloride cyclic carbonate and D(-)-, L(+)-, and meso-tartaric acids, respectively (Scarpati et al., 1958).

Qualitative and quantitative changes in the monosaccharides and oligosaccharides contents of chicory were evaluated by paper chromatography during roasting. Glucose and fructose increased between 100-160 °C, then decreased gradually (Nedelkovists et al., 1961).

Coumarins: cichoriin, esculin, 6,7-dihydroxycoumarin, umbelliferone, and scopoletin were isolated from racemes of C. intybus (Dem'yanenko et al., 1971).

Hydroxycinnamic acids were separated from the aerial parts of C. intybus plant. These substances were identified as caffeic, chlorogenic, neochlorogenic acids, 3-feruloyl- and 3-p-coumaroylquininic acids and dicaffeyltartaric acid (Dem'yanenko et al., 1972).

Flavonoids: apigenin, luteolin 7-O-β-D-glucopyranoside, quercitrin, hyperin and apigenin7-O-L- arabinoside were isolated from shoots of C. intybus (Dem'yanenko et al., 1973).

The highest content of esculetin and its glycosides was found in the flowers and leaves of C. intybus. Preliminary hydrolysis of the glycosidic material doubled the yield of the substance (Dem'yanenko et al., 1974).

Reducing sugars, sucrose and inulin in chicory root were determined by HPLC (High-Performance Liquid Chromatography) (Wight et al., 1983).
Lactucin, a bitter principle was isolated from chicory roots and determined by High-Performance Liquid Chromatographic method (Leclercq, 1984).

Cichoriin was isolated from chicory inflorescences by extraction with low molecular weight alcohol (methanol). The crude cichoriin contained traces of esculin. Cichoriin 60% (free from esculin) was obtained on recrystallisation with methanol or water (Mrugasiewicz et al., 1984).

Cyanidin (unmethylated aglycones) with small amounts of dephinidine were found in all cultivars of C. intybus (Cappelletti et al., 1984).

Cyanidin 3-0-β-(6-0-malonyl)−D-glucopyranoside: a major anthocyanin was isolated from red leaves of chicory and identified by spectroscopic methods (Bridle et al., 1984).

Sesquiterpene lactones like 8-deoxylactucin, lactucin and lactupicrin were isolated from C. intybus (Pyrek, 1985).

Sesquiterpene lactones and the major phenolics were determined in the chicory plant at different times during the growing season. The levels of the sesquiterpene lactones (lactucin, lactupicrin and 8-deoxylactucin) and the hydroxycoumarin cichoriin were found to be highest in the most actively growing regions of the plant. These sesquiterpene lactones secreted in the latex provide a significant barrier to herbivory in chicory (Sarah et al., 1985).

Cichoralexin, a sesquiterpenoid phytoalexin was isolated from C. intybus. Its structure has been elucidated by UV, 1H NMR, 13C NMR and mass spectroscopy (Kenji et al., 1990).

The new sesquiterpene lactones named 11 (S), 13- dihydrolactupicrin along with other known sesquiterpene were isolated from fresh root of chicory and identified by spectroscopic methods. The extraction procedure and HPLC analysis of sesquiterpene lactones in chicory were improved (Teris et al., 1990).
The fresh roots on analysis gave the following values: moisture, 77.0; fat, 0.6; cellulose, inulin and fibre, 9.0; gummy matter, 7.5; glucose, 1.1; bitter extractives, 4.0; and ash, 0.8%. There was considerable destruction of inulin during the roasting process and the resulting product contains increased proportion of reducing sugars together with dextrin and caramel. Roasted chicory gave a characteristic odour and contains acetic, lactic, pyruvic, pyromucic, palmitic and tartaric acids, while raw chicory contains only citric and tartaric acids. The volatile constituents identified include acetaldehyde, acetone, diacetylene, β-diketopentane, furfuraldehyde, maltol, furan and methyl and furfuryl alcohols (Anonymous, 1992).

The dry leaves on analysis gave the following values: crude protein, 12.20; crude fiber, 16.76; nitrogen free extract, 46.70; calcium, 1.99; phosphorus, 0.40; silica, 2.78% and vitamin B\textsubscript{2}, 1360 μg/100g. Mature and immature leaves contained 75.4 and 105.95 mg/100g vitamin C, respectively. Leaves contain three sesquiterpene lactones: lactucin, 8-deoxy lactucin and lactupicrin. Leaves also contain coumarins, esculetin and cichoriin (Anonymous, 1992).

Fructan, fructan fructosyl transferase was purified from chicory roots by a combination of ammonium sulfate precipitation, concanavalin-A affinity chromatography and anion and cation exchange chromatography. This protocol produced 60 fold purification and a specific activity of 14.5 μmol (mg protein min\textsuperscript{-1}). The mass of the enzyme was 69 kDa as estimated by gel filtration, the enzyme was a heterodimer. The purified enzyme exhibited β-fructosidase activity, especially at higher temperatures and lower substrate concentrations (Wim et al., 1996).

The major fatty acid present in the polar lipids of chicory leaves and flowering stalks was linoleic (33-62%) followed by palmitic (24-36%); changes in the fatty acid composition were observed after harvest in both leaves and flowering stalk. The most pronounced changes occurred in the younger leaves within the first 4 days of postharvest. Floral stalks and leaves showed a decrease in total fatty acid content and saturated to unsaturated fatty acid ratios with time (Evelin et al., 1996).
Magnolialide (eedesmanolides) and artesin were isolated from the roots of *C. intybus*. Their structures were confirmed by HMBC and NOESY NMR spectral interpretation as 1 beta-hyroxyeudesma-4,13-dien-6,12-olide and 11-beta, 13-dihydro derivative, respectively (Park *et al.*, 2000).

A new lactucopicrin derivative, eudesmanolide magnolialide and guaianolide ixerisoside D were reported for the first time from the chicory plant, along with the previously known chicory sesquiterpene lactones have been isolated and identified (Wanda *et al.*, 2001).

Four anthocyanins pigments were isolated from the blue perianth segments of *C. intybus*. The pigments were identified as delphinidin 3,5-di-O-(6-O-malonyl-β-D-glucoside) and dephinidin 3-O-(6-O-malonyl-β-D-glucoside)-5-O-β-D-glucoside and the known compounds were delphinidin 3-O-β-D-glucoside-5-O-(6-O-malonyl-β-D-glucoside) and delphinidin 3,5-di-O-β-D-glucoside. In addition 3-O-p-coumaroyl quinic acid has been also identified (Rikke *et al.*, 2002).

Inulin, sucrose, fructose, and glucose contents in tubers of *C. intybus* stored at different temperatures (-18, 4 and 18 °C) after harvesting were investigated. Inulin content in tubers decreased during storage, this decrease was associated with increase in glucose and fructose contents (Cabezas *et al.*, 2002).

A new seco-sterol, cichosterol has been isolated and characterized as 13,14-seco-stigma 5(6),14(15)-diene-3-β-ol and a rare sterol glycoside stigma 5(6)-ene-3-α-O-(β-D-glucopyranoside) from the seed of *C. intybus* (Bahar *et al.*, 2002).
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Literature Review

Sonchuside A (8)

Sonchuside C (9)

Cichorioside A (11)

Cichorioside B (12)

Cichorioside C (13)

Cichoriolide A (10)

Cichorioside A (11)

Esculetin (14)

Esculin (15)

Cyandin-3- O-beta-(6-O-malonyl)-D-glucopyranoside (16)
Pharmacological studies

Anticancer activity: Four new sesquiterpene lactones, cichoriolide A and cichoriosides A, B and C showed the cytotoxic activity in the L-5178 Y cultured cell system (Seto et al., 1988).

The tumor inhibitory effect of an ethanolic extract of chicory root was studied against Ehrlich ascites carcinoma in mice; significant results were obtained at doses from 300 to 700 mg/kg (Hazara et al., 2002).

Antihepatotoxicity activity: Oral pretreatment of Jigrine was studied on hepatic damage induced by paracetamol in rats. Biochemical parameters like serum transaminases GOT and GPT, serum bilirubin, plasma prothrombin time and tissue lipid peroxides were estimated to assess the liver function. Alcohol, CCl₄ and paracetamol treatment produced an increase in serum transaminases, bilirubin, plasma prothrombin time and tissue lipid peroxides in liver. These effects were progressively reduced by pretreatment doses of Jigrine. The activity of Jigrine was also compared with Liv-52, a known Ayurvedic hepatoprotective formulation (Kapur et al., 1994).

The natural root and root callus extracts of C. intybus were compared for their antihepatotoxic effects in Wistar strain of Albino rats against carbon tetrachloride induced hepatic damage. The increased levels of serum enzymes and bilirubin observed in rats treated with carbon tetrachloride were very much reduced in the animals treated with natural root and root callus extracts. These biochemical observations were supplemented by histopathological examination of liver sections. Results of this study revealed that C. intybus root callus extract could afford a better protection against CCl₄ induced hepatocellular damage as compared to the natural root extract (Zafar et al., 1998).

HD-30 a polyherbal hepatoprotective formulation, containing Solanum nigrum, Cichorium intybus, Picrorrhiza kurroa, Tephrosia purpurea and Andrographis paniculata was evaluated for its protective effect against diverse hepatotoxic agents. Treatment with HD-30 led to significant amelioration of toxin-induced changes in the biochemical parameters (Mitra et al., 1998; 1999).
Aqueous or butanol extracts of Liv-52 stimulated the activity of aminopyrine N-demethylase and aniline hydroxylase while the petroleum-ether extract stimulated the activity of cytochrome oxidase, succinate dehydrogenase and total ATPase in the mitochondrial fraction, when added to the post-mitochondrial fraction of liver of normal and CCl₄-treated rats; chloroform extract, inhibited the activities of lysosomal acid phosphatase, acid ribonuclease and cathepsin B in total liver homogenate (Bardhan et al., 1985).

The methanolic fraction and a phenolic compound of seed of C. intybus were found to posses a potent antihepatotoxic activity comparable to the standared drug silymarin. The results were supported by biochemical parameters and histopathological studies of the liver (Bahar et al., 2003).

Antioxidant activity: The enzymic antioxidants (catalase, peroxidase, superoxide dismutase and polyphenol oxidase) and non-enzymic antioxidants (ascorbate, tocopherol, total carotenoids, reduced glutathion and flavonoids) and lipid peroxidation were assessed in the leaves of the C. intybus. It was found that the leaves possessed considerable amount of antioxidants. They were also found to inhibit lipid peroxidation to a significant extent, revealed their importance for use in the preparation of antioxidant formulations (Saroja et al., 2001).

Hepatoprotective effect of Hepatomed, an Ayurvedic drug containing water extract of six medicinal plants viz., Picrorhiza kurroa, Eclipta alba, Adhatoda vasica, Solanum nigrum and Cichorium intybus showed significant reduction in the level of malondialdehyde (MDA) induced by 1.5 mM cumene hydroperoxide (CHP). Oral treatment of drug upto 3 ml/100g body weight for 15 days did not show any rise in serum GOT and GPT. The results suggested that Hepatomed is a strong hepatoprotective Ayurvedic medicine with no detectable adverse effects (Sharma et al., 1995).

Plant extracts of Solanum nigrum and Cichorium intybus in the reaction mixture containing calfthymus DNA and free radical generating system protect DNA against oxidative damaged to its deoxyribose sugar moiety. Hepatoprotective effect of these crude plant extracts may be due to their ability to suppress the oxidative degradation of DNA in the tissue debris (Sarwat et al., 1995).
Liv-52, treatment prevents ethanol induced increase in the activity of the enzyme \( \gamma \)-glutamyl transpeptidase and has protective effects on the activity of superoxide dismutase and the levels of glutathione. Hepatoprotective nature of Liv-52 which might be attributed to its ability to inhibit lipid peroxidation (Sandhir et al., 1999).

The water extract of \textit{C. intybus} showed a remarkable antioxidative effect on low density lipoprotein (LDL), and inhibitory effects on the production of thiobarbituric acid reactive substance and the degradation of fatty acids in LDL (Kim et al., 2001).

Benzene and acetone crude extract of \textit{C. intybus} plant showed the potential antioxidant activity, which was measured by ferric thiocyanate (FTC) and compared with thiobarbituric acid (TBA) method (Aquil et al., 2003).

\textbf{Antidiabetic activity:} The antidiabetic activity was examined on streptozotocin-induced diabetic rats with methanol extract. Methanolic extract gave a significant reduction of blood glucose levels in 1\textsuperscript{st} week and 3\textsuperscript{rd} week of the study (Yim et al., 1999).

\textbf{Anti-inflammatory activity:} The intraperitoneal LD\textsubscript{50} dose of chicory root in mice was found to be 8.9 g/kg and 9.3 g/kg within 19/20 confidence limits for aqueous and alcoholic soxhlet extracts, respectively. In a clinical trial significant reduction of gingival inflammation index (0.2 mm weekly) was observed when patients suffering from pyorrhoea massaged the inflamed/bleeding gums with alcoholic dried extracts of chicory root (250 mg) (Patel et al., 1985).

Methanol extract of the root of \textit{C. intybus} was investigated for anti-inflammatory activity against carrageenin induced rat’s hind paw edema. Significant inhibitory effects were observed at the dose of 1,000 mg/kg and were compared with aspirin as a control (Yim et al., 1999).

\textbf{Powder of \textit{C. intybus}} was used in the form of vaginal tablets, the drug are used as haemostatic, astringent, anti-inflammatory and analgesic in Unani System of Medicine (Suhail et al., 2000).
Antimalarial activity: Aqueous root extracts of *C. intybus* is a light-sensitive plant remedy for malaria. Preparative isolation and bioassay against HB-3 clone of strain Honduras-I of *Plasmodium falciparum* identified the previously known light-sensitive sesquiterpene lactones Lactucin and Lactucopicrin to be antimalarial compound (Theodore *et at.*, 2004).

Antimicrobial activity: *In vitro* sensitivity tests with alcoholic extracts of roots of *C. intybus*, on micro-organism of inflamed gingival showed significant antimicrobial activity. The extract was found to be less potent than some common antibiotics (Patel *et al.*, 1981).

Cardiovascular disorders: The alcoholic extracts of kasani caused bradycardia in normal and hypodynamic heart of frog, and elicited a fall in blood pressure with a corresponding increase in respiratory rates in dogs (Panday, 1985).

Immunostimulant effect: *C. intybus* ethanolic extract does not have a direct mitogenic effect on human lymphocytes or thymocytes. It showed a complete inhibitory effect on the proliferation of lymphocytes in the presence of phytohemagglutinin (PHA) at the concentration of 10 μg/ml. Thus, *in vitro* study revealed that ethanolic extract enhanced the proliferation of lymphocytes after stimulation with the allogenic cell (Amirghofran *et at.*, 2000).

Diuretic effect: Oral administration of chicory extract (1 ml of 10% extract/kg bw, for 28 days), decreased the activity of oxalate synthesizing enzymes and increased urine output in the extract treated rats (Santhosh *et at.*, 2000).

Sexual disorders: Histological changes in the testes of mice fed on chicory (*C. intybus*) have been studied. Mice were fed on 8.7 g/kg and 4.3 g/kg chicory as an aqueous suspension for ten days. A definite impairment of spermatogenesis in the mice fed on 8.7 g chicory/kg was revealed (Roy *et at.*, 1983).
Plant tissue culture work

The accumulation of phenolamides in tissue of *C. intybus* appears to be closely linked to floral induction. It begins very early in young buds under continuous light and in calli that bear these buds (Martin *et al.*, 1984).

High concentrations of auxin in the presence of cytokinin, casein hydrolysate and vitamins resulted in the production of voluminous, unorganised calli on small explants of *C. intybus* (Vasseur *et al.*, 1984).

The exogenous glucose inhibits the development of buds on *C. intybus* root explants cultured in vitro. The numbers of neoformed meristems were decreased and the growth of all or part of them was reduced (Backoula *et al.*, 1985).

Hairy root cultures established with *Agrobacterium rhizogenes* LMG 150 of an Indian cultivar of chicory produced esculin, a dihydroxycoumarin monoglucoside used as skin protectant and a marker in microbiological media. Maximum biomass of $6.2 \pm 0.425 \text{ g/culture}$ of transformed roots were obtained in full strength MS medium with 3% sucrose on 28$^{th}$ day. Esculin production was linked to growth and 100 g fresh weight of transformed roots gave a maximum of 13.93 mg, corresponding to a ~ 13 fold increase as compared to that in 30 days old non-transformed roots (0.72 mg), during the same period (George *et al.*, 1999).

Regeneration of plantlets from the leaf explants of *C. intybus*, excised leaf segments from the in vitro grown seedling were cultured on a modified MS medium supplemented with various growth regulators. Differentiation of shoot buds was obtained via callus on the MS medium supplemented with 2.0 $\mu$M indole-3-acetic acid and 5.0 $\mu$M 6-furfury laminopurine. Five or more shoots regenerated from each callus. Regeneration occurred through both somatic embryogenesis and organogenesis. Root formation in excised shoots was induced with 0.2 $\mu$M indole-3-butyric acid (Rehman *et al.*, 2001).
AIMS AND OBJECTIVE

Medicinal plants are widely used in the formulation of herbal based healthcare products. In Indian Traditional Systems of Medicine, the whole plant or the parts of plant are used as raw materials. The use of genuine and authentic plant material is essential for quality drugs in Traditional Systems of Medicine.

The major criticism being faced by Traditional Systems of Medicine is inadequate scientific validation and standards of plant material employed by the manufacturer in the herbal formulations. Thus there is a strong need in promoting standardization of quality parameters of important medicinal herbs.

Next to botanical authentication, chemical and biochemical composition of the material should be investigated. Physico-chemical parameters give an idea about quality of herbs and are helpful in standardizing the crude drugs. The effect of the herbal drug is not due to its natural origin but rather due to its pharmacological characteristics of dose levels of the active constituents. Hence, the chemical analysis of the constituents is the most important part of the standardization.

In order to utilize phytochemical constituents of herbs as viable quality markers, it is necessary that they are isolated, identified and quantified in the formulation. The analytical data will help immensely in standardization of herbal drugs.

Fingerprint profile by HPTLC is one of the most powerful tools to link the botanical identity to the chemical constituent profile of the plant. In combination with the microscopic investigations, the fingerprint profile provides the means for a convenient identity check. It can also be used to detect adulterants in raw materials. From the constituent profile, a number of marker compounds can be chosen which might be used to further describe the quality of the drug in the herbal preparations. It gives a rough fingerprint which may serve as a reference for quick quality control approval.
Cichorium intybus is an important medicinal plant used in traditional systems of medicine (Anonymous, 1992). It is an integral ingredient of many hepatoprotective formulations available in the market (Handa et al., 1986). Antioxidant, antimalarial, hepatoprotective and cytoprotective activities of C. intybus have been also reported recently (Aquil et al., 2003; Theodore et al., 2004; Saroja et al., 2003; Hazara et al., 2002).

The extensive literature survey of the plant revealed that there is a lot of variation regarding the concentration of the active constituents present in different parts of the drug. Leaves, stems, and roots contains the sesquiterpene but roots of C. intybus showed the maximum concentration of sesquiterpene lactones like lactucin, 8-deoxylactucin, lactopicrin, cichoriolide A, B and C (Bais et al., 2001). It was found that extensive work had been done on seeds, moreover no systematic pharmacognostic work and quantification of the phytoconstituents has been carried out on the leaves, stem and root of C. intybus. There were no reports available on the standardization of the leaves and stem of the crude drug.

Keeping in view the strong need to promote standardization of quality parameters of important medicinal herbs, it was thought worthwhile to conduct following studies on leaves, stems and roots of C. intybus

- **Standardization and quality control of C. intybus leaves, stems and roots**
  1. Botanical evaluation of the crude drug by
     a) Macroscopic evaluation
     b) Microscopic evaluation
     c) Foreign organic matter
  2. Physicochemical evaluation of the crude drug by determination of
     a) Extractive values
     b) Loss on drying
     c) Ash values
d) Bitterness value  
e) Foaming index  
f) Swelling index  
g) Behaviors of crude powder with different reagents  
h) Fluorescence analysis  
i) pH determination  
j) Microbial contamination determination

3. Preliminary phytochemical screening of the crude drug to detect the presence of primary/secondary metabolites.

4. HPTLC fingerprint profile of various crude drug extracts.

5. Quantitative determination of  
a) Total phenolic content  
b) Total flavonoid content  
c) Resin content

6. Heavy Metal Analysis in the crude drug.

7. Quantitative determination of umbelliferon and esculetin by HPTLC in the crude drug.

• **Extraction, isolation and characterization of phytoconstituents**

Extraction and isolation of phytoconstituents from the roots of *C. intybus*; structural elucidation of phytoconstituents carried out by spectral data analyses and chemical reaction.

• **Hepatoprotective Activity**

The alcoholic, hydroalcoholic and aqueous extracts of leaves, roots and compounds isolated from roots of *C. intybus* has been evaluated for its hepatoprotective activity on the basis of biochemical studies in serum and histopathological studies of liver tissues.
References


