"The art of healing comes from nature, not from the physician. Therefore the physician must start from nature, with an open mind".

-Paracelsus
2. REVIEW OF LITERATURE

2.1 Significance of medicinal plants

Since the beginning of human civilization, medicinal plants have been used for their therapeutic value to heal and cure diseases, and to improve health and well being. The plant-based traditional medicine systems continue to play an essential role in health care, with about 80% of the World’s inhabitants relying mainly on traditional medicines for their primary health care (Owolabi et al. 2007). India and China are two of the largest countries in Asia, which have the richest arrays of registered and relatively well-known medicinal plants (Raven 1998). The Indian subcontinent is well known for its diversity of medicinal plants, forest products and the age-old healthcare traditions. There is an urgent need to authenticate these traditional values using modern scientific knowledge (Wu, Y. 1988; Kala & Prakash 2006).

The present review highlights the floristic, ethnombotanical, cytomorphological, phytochemical analysis and bioactivities of some North Indian medicinal plants, with particular stress on members of family Asteraceae.

2.2 Historical background of Indian medicinal plants

The history of the use of plants in medicine can be traced back to the ancient civilizations. The earliest written record of the preparation and use of medicines from plants is in the ‘Rig-Veda’and‘Atharva Veda’, which are the earliest scriptures of the Hindus (4500-1600 BC). Such works were followed by the monumental contributions like Charak Samhita (1000-800 BC), Sushrut Samhita (800-700 BC) and Vagbhatta’s Astanga Hridaya. Early Roman writings also had a great influence on the development of western medicine, especially the works of Dioscorides who compiled information on more than 600 species of plants with medicinal value in De Materia Medica. It is estimated that 25% of prescriptions written in the U.S. contain plant-derived ingredients (close to 50% if fungal products are included) and even greater percentage are based on semi synthetic or wholly synthetic ingredients, originally isolated from plants (Levetin & McMahon 2003). While western medicine system
strayed away from herbalism, 75% to 90% of rural population of the remaining World still relies only on herbal medicine for their health care.

2.3 Literature of medicinal plants of India

In India, of the 17,000 species of higher plants, 7500 are known for their medicinal uses (Shiva 1996). This is the highest proportion of plants known for their medicinal purposes in any country of the World. Ayurveda, the oldest medical system in Indian sub-continent, has alone reported approximately 2000 medicinal plant species, followed by Siddha and Unani. The Charak Samhita, an age-old written document on herbal therapy, reports on the production of 340 herbal drugs and their indigenous uses (Prajapati et al. 2003). Currently, approximately 25% of drugs are derived from plants, and many others are synthetic analogues built on prototype compounds isolated from plant species in modern pharmacopoeia (Rao et al. 2004).

Khare (2004) presented an overview of the current status of herbal drugs in India. Some of the recent works on medicinal plants with respect to their description, phenology, part used, medicinal uses, history, chemical composition, modern therapeutical uses, cultivation, conservation, etc. are given by Pullaiah (2006), Kala (2000), Sood et al. (2001), Singh & Lal (2008) and Adhikari et al. (2010).

2.4 Literature of medicinal plants of Himalaya

Study of medicinally important plants has been carried out with the help of various regional floras of Himalayan region and their ethnobotanical aspects. The important contributions on distribution and use of medicinal plants in different areas of Himachal Pradesh are by Kirtikar & Basu (1933), Chopra et al. (1956), Jain (1968), Aswal & Mehrotra (1994), Maheshwari (1996), Saklani & Jain (1996), Jain & Mudgal (1999), Sood et al. (2001), Kala (2002), Uniyal & Shiva (2005), Pullaiah (2006), Ekka & Dixit (2007), Adhikari et al. (2010), etc. Some workers have studied medicinal and aromatic plants of Himalayas such as: Artemisia maritima (Jain 1989), Astragalus thomsonianus, Chaerophyllum villosum, Corydalis moorcroftiana, Crepis flexuosa (Kala 2000), Ephedra regeliana, Erigeron borealis, Gentiana moorcroftiana (Kirtikar & Basu 1991), Lactuca rapunculoides, Pedicularis punctate (Singh & Lal 2008), Rumex orientalis, Saussurea glanduligera, Scorzonera divaricata, Sedum tibeticum, Tanacetum falconeri (Sood et al. 2001), Taraxacum officinale (Aswal &
Mehrotra 1994), etc. Some botanists have published papers and floras on Himachal Pradesh including various medicinal plants, such as: Aswal & Mehrotra (1979, 1980a, b, 1981, 1983a, b, 1984, 1985a, b), Kala & Prakash (2006), Singh & Lal (2008), Dangwal et al. (2011), Dhaliwal & Sharma (1999), Kaur & Sharma (2004), etc. so as to provide necessary information about the present status of these medicinal and aromatic plants in the Himalayas.

2.5 Literature of medicinal plants of Lahaul-Spiti


2.6 Ethnobotanical literature of medicinal plants of Himalaya and Lahaul-Spiti

Ethno-botanical information (plant name, part used, mode of prescription, ailment treated, etc.) on plants of Himalaya used in traditional remedies was published by various workers such as: Jain (1989), Cotton (1996), Kala (2000), Gurib-Fakim (2006) etc.

Information on ethnobotany of higher plants from Cold Desert of Western Himalayas was given by some workers such as: Uniyal et al. (1973), Aswal & Mehrotra (1994), Jain (1996), Kala (2000), Sood et al. (2001) and Singh & Lal (2008).
Some workers published books and papers on ethnobotany of medicinal plants such as: Methods and Approaches in Ethnobotany (Jain 1989), Dictionary of Indian Folk Medicine and Ethnobotany (Jain 1991), Ethnobotany in Human Welfare (Jain 1996), Ethnobotany in South Asia (Maheshwari 1996), Cross-cultural Ethnobotany of North East India (Saklani & Jain 1996) and A Handbook of Ethnobotany (Jain & Mudgal 1999) and research papers by Singh & Lal (2008) and Dangwal et al. (2011).

2.7. Cytological studies

The chromosomal studies in flowering plants started at the end of 19th century by a German cytologist Strasburger in 1882 who for the first time counted chromosomes in orchids (cf. Federov 1969). The information on chromosome number of flowering plants of the World and India are compiled in the form of Chromosome Numbers of Flowering plants and Index to Plant Chromosome Numbers (Darlington & Wylie 1955; Federov 1969; Love & Love 1975; Goldblatt & Johnson 1986-2003), and Chromosome Atlases of India (Kumar & Subramanian 1986), IOPB/ IAPT and SOCGI chromosome data number reports published in Taxon and various journals and website of Missouri Botanical Garden. (http://www.tropics.org/Project/IPCN).

The first chromosome report from India appeared 28 years later in 1910 when Johnson reported the chromosome count of 2n=32 in Piper betle (cf. Darlington & Wylie 1955). Though large number of medicinal species have been worked out cytologically, here the cytological review mainly covers members of family Asteraceae.

2.7.1 At World level

Chromosome information is now available for large number of species of family Asteraceae at the World level. Cytological data, including chromosome numbers, phylogeny, base number for all the 13 tribes of the family have been given by different workers in the two volumes of the book Biology and Chemistry of Compositae by Heywood et al. (1977a, b). Overall chromosomal picture at the World level covering 7900 species is compiled by Solbrig (1977). Some of the important workers at the World level who have contributed towards the cytology of the family are: Turner & Ellison (1960), Turner & Flyr (1966), Turner et al. (1961a, b, 1962, 1967, 1973), Powell & King (1969a, b), Powell & Sikes (1970), Powell et al. (1974),

Some of the cytological literature on the family is available from cytological survey of the floras of different regions. Most of the chromosomal data is based on male meiosis. Some of the important works in karyotypic analysis are of Arano (1965, 1970), Arano & Nakamura (1964), Huziwara (1959, 65), Moore & Frankton (1962). Arano (1965) analyzed the karyotype of 170 species covering 6 tribes. Stebbins et al. (1953) on the basis of karyotype studies pointed out certain evolutionary trends operative in the tribe Cichorieae.

Some of the workers have derived evolutionary lines on the basis of cytological data at the tribal level. Some of the workers who have concentrated on particular tribes are: Astereae (Raven et al. 1960; Solbrig et al. 1964, 1969; Huziwara 1965; Anderson et al. 1974), Cynareae (Moore & Frankton 1962; Arano 1965; Dittrich 1977; Morton 1977), Calenduleae and Arctoteae (Norlindh 1977a,b), Eupatorieae (King et al. 1976; Robinson & King 1977), Heliantheae (Payne et al. 1964; Solbrig et al. 1972; Stussy 1977), Helenieae (Powell et al. 1975), Inuleae (Merxmiller et al. 1977), Lactuceae (Babcock 1947; Stebbins et al. 1953; Edmonds et al. 1974; Tomb 1977; Tomb et al. 1978; Panero & Funk 2008) Mutisieae (Cabrera 1977) and Senecioneae (Ornduff et al. 1963, 1967; Afzelius 1967; Nordenstam 1977). Besides, there are large number of other workers who have concentrated on individual genera or species such as: Sheidai et al. (2009) studied the chromosome numbers in 8 species of Achillea from Iran. Mancuso et al. (2007) made cytotaxonomic studies in 6 species of Vernonia in order to check the validity of genus. Torrel & Valles (2001) made cytological analysis in genus Artemisia from Armenia and Iran. Tabur et al. (2012) recently studied the same genus from Turkey and reported B-chromosomes in Artemisia incana.

On the basis of available data, some of the workers who have made comments on the phylogeny and evolutionary trends in the family are Stebbins et al. (1953), Cronquist (1955), Huziwara (1959), Carlquist (1976), Wagenitz (1976), Mehra (1977), Gupta & Gill (1987), Watanabe et al. (1995). Origin of low chromosome
number by chromosomal rearrangements from higher numbers confirmed in many Compositeae such as *Crepis* (Tobgy 1943), *Aster* spp. \(x=5\) and \(x=8\) from \(x=9\) (Huziwara 1962), *Chaenactis fremontii* and *C.stevioides* \((x=5)\) from \(x=6\) (Kyhos 1965).

Recently, Meng *et al.* (2010) made karyotypic studies in *Anaphalis* from China and showed that polyploidy plays an important role in chromosome evolution in genus. Martin *et al.* (2012) studied the karyotypes of 13 taxa of the tribe Lactuceae from Turkey.

**2.7.2. At India level**

First chromosomal report on the Indian Asteraceae is of *Carthamus tinctorius* \(2n=24\) by Patel & Narayan (1935). Major work on the cytology of the family has come from Department of Botany, Punjab University, Chandigarh, Calcutta University, Calcutta, Punjabi University, Patiala, besides some work from University at Jammu and Srinagar. Cytological work in India gained some momentum in early sixties. Many of these workers have studied the Asteraceae from different geographical areas. Complete data on the cytological studies in Indian Asteraceae is presented in Annexure-I. Here mention may be made on some of the prominent workers such as by Mehra *et al.* (1965), Mehra & Remanandan (1974, 1975, 1976), Remanandan & Mehra (1974) from North and South India, Gupta & Gill (1983, 1984, 1989) from North and Central India. Mehra (1977) on the basis of comprehensive cytological data has discussed phylogeny and interrelationships of different tribes. Gupta & Gill (1987) has reviewed total available cytological data on Indian Asteraceae. They have worked out cytological frequency, polyploidy, aneuploidy, different chromosome numbers, karyotypic symmetry, base number, etc. and their role in speciation. Gupta *et al.* (1989) made cytological analysis on 40 wild species of Western Himalayas and studied B-chromosomes, intra- and inter-specific polyploidy, meiotic abnormalities, etc. Cytological studies were carried out by Sharma & Sarkar (1967, 68), Banerjee & Sharma (1974), Bhattacharya & Sharma (1970), Chatterjee & Sharma (1969), Subramanyam & Kamble (1966, 1967, 1971) from East and West India; Mathew & Mathew (1975 a, b, 1976, 1978, 1982, 1983, 1988), Josh & Mathew (1995) from South India. Cytological studies of family Asteraceae at genus level was made by Banerjee (1974) who studied chromosome numbers in cultivated genus *Tagetes* with different horticulture varieties of *T.erecta* and *T. patula* from East India.
Mathew & Mathew (1982) studied detailed karyomorphology of 8 species of genus *Vernonia* and 9 species of genus *Blumea* (Mathew & Mathew 1975a). Various workers such as: Khoshoo & Sobti (1958), Koul (1964), Kaul & Bakshi (1984) studied the chromosome counts in several species of Indian *Artemisia* from Western Himalayas.

Presently, lot of new work on the family Asteraceae has been published in Department of Botany, Punjabi University Patiala, by Gupta et al. (2009, 2010), Kaur et al. (2010), Malik et al. (2010), Bala & Gupta (2011), Bala et al (2010, 2011).

### 2.8. PHYTOPHARMACOLOGICAL EVALUATION

Phytopharmacological Evaluation includes

(i) Phytochemical studies and

(ii) Pharmacological activities (*in vitro*/ *in vivo*)

#### 2.8.1 PHYTOCHEMICAL STUDIES

Phytochemistry is the study of phytochemicals. These chemicals are derived from plants. In a narrower sense, the term is often used to describe the large number of secondary metabolic compounds found in plants. Many of these are known to provide protection against insect attacks and plant diseases. They also exhibit a number of protective functions for human consumers.

During 1970's, most chemical separations were carried out using a variety of techniques, including open-column chromatography, paper chromatography and thin-layer chromatography. However, these chromatographic techniques were insufficient for quantification of compounds and resolution between similar compounds. During this time, pressure liquid chromatography (HPLC) began to be used leading to reducing purification times of compounds being isolated by column chromatography.

High pressure liquid chromatography was developed in the mid-1970's. In the late 1970's, new methods including reverse phase liquid chromatography (RPC) allowed for improved separation between very similar compounds. After that new techniques like Hydrophilic Interaction Liquid Chromatography (HILC), Gas chromatography–mass spectrometry (GC-MS) and High Performance Thin Layer
Chromatography (HPTLC) improved the separation, identification, purification and quantification far above the previous techniques. The next major advancement was Ultra Performance Liquid Chromatography (UPLC). Wren & Tchelitchef (2006) and Vinay et al. (2012) reported several UPLC applications for the determination of chemical compounds in plants. Both these phytochemical techniques (HPLC and UPLC) have been extensively used in research work.

So two medicinally important plants were well reviewed and investigated on the basis of HPLC technique.

Large number of workers have investigated the phytochemistry of different medicinal plants. Some workers have discussed phytochemistry of some individual species. The significant contributions have been made towards chemical constituents of Himalayan medicinal plants by Bhatnagar et al. (1961). Comprehensive account of chemistry of medicinal plants has been provided by Agarwal & Kamboj (1977) including those of family Asteraceae.

Phytochemistry of some important medicinal plants of Asteraceae family has been discussed by some workers such as: Achillea millefolium (Baggio et al. 2002), Bidens pilosa (Kumar & Sinha 2003), Pluchea lanceolata (Chawla et al. 2006), Lagascea mollis (Alarcón et al. 2007), Stevia rebaudiana (Jaitak et al. 2008a), Eclipta alba (Saggoo et al. 2010), Artemisia parviflora (Sharma 2010), A. minor (Sharma et al. 2010) and Cynara scolymus (Naseer 2012).

Some members of family Asteraceae where chemical constituents were analysed are: Senecio graveolens where essential oil was obtained by GC-MS (Perez et al. 1999), stigmasterols were isolated from aerial parts of Warionia saharae by HPLC (Mezhoud et al. 2012).

The amount of phytochemicals is reported to vary in the different species of the same genus, besides shows lot of quantitative and qualitative difference at the intraspecific level, depending upon genetic constitution, geographical distribution, environmental factor, developmental stage of plant, plant part and agronomical conditions. Generally, the amount of these active phytochemicals is found to be more in the polyploids compared to the diploids.
Berkov (2001) reported the higher amount of alkaloids in the induced autopolyploids of *Datura stramonium* and *Hyoscyamus niger*. Greger (1979) and Eisenman & Strawe (2011) reported qualitative differences in phytochemicals among different cytotypes of *Artemisia dracunculus*. Some of these compounds were present in diploids (2x) and decaploids (10x) but were absent in tetraploids (4x) and octaploids (8x). Sharma *et al.* (2012) reported the similar differences in three cytotypes of *Syzygium cumini* (2x, 4x, 6x), three cytotypes of *Boerhaavia diffusa* (2x, 4x, 8x) where the percentage of ursolic acid is maximum in diploid cytotype (0.095%) which is followed by tetraploid (0.066%) and octaploid (0.032%) and *Achyranthes aspera* (2x, 4x, 6x) where the maximum percentage of active phytoconstituents, oleanolic acid is present in diploid cytotype (2.3%) which is followed by tetraploid (1.2%) and hexaploid (0.46%). Further, these workers reported the differences in active principles in different plant parts.

Amount of terpenes in diploids and polyploids of *Solidago gigantea* differ in local and invasive taxa (te Beest *et al.* 2012). Glycoalkaloids content lower in polyploids than diploids in *Solidago* sp. (Caruso 2010). Svehlitrova & Repcak (2008) reported that the amount of apigenin is more in 4x than 2x in *Chamomilla recutita*.


Different morphotypes of some of the species are found to have significant difference in the amount of phytochemicals such as *Withania somnifera* (Sharma *et al.* 2008b), *Echinacea purpurea* (Shalaby *et al.* 1997), *Ocimum sanctum* (Sharma 2012), etc.

Further, the amount of the secondary metabolites also varies with the agronomical conditions as has been reported in many species such as *Datura* spp. (Esendal *et al.* 2000), *Artemisia* spp. (Usha & Swamy 1998), *Tanacetum parthenium*, *Echinacea purpurea* and *E. pallida* (Qu *et al.* 2003).

The amount of phytochemicals show variations depending upon the stage of maturity of the taxa as has been reported in *Taxus baccata* (Nadeem *et al.* 2002).
The amount of alkaloids is found to differ in the different parts of \textit{Plantago major} (Prakash \textit{et al.} 2011b). Sharma (2012) reported that the amount of alkaloid scopolamine is maximum in leaf sample whereas that of hyoscyamine in seed samples of \textit{Datura metel}. Thus, relying on the right species for medicinal activities is not sufficient as the intraspecific variations may be highly significant. Further review on phytochemical investigations on two selected plants i.e., \textit{Taraxacum officinale} and \textit{Silybum marianum} is discussed in detail.

2.8.1.1 \textit{Taraxacum officinale} Wigg.

2.8.1.1.1 Medicinal uses

\textit{T.officinale} is commonly known as blowball, canker wart, fairy clock, lion’s tooth, piss-in-bed, white endive and wild endive. In the Middle Ages, European physicians continued to use the leaves and roots of the yellow-flowering plant to treat diseases of the yellow bile (liver and gall bladder) and as a diuretic (Lewis 1977). In Ayurveda, the plant is known as dugdhpheni, as it is full of milky juice. The grounded roots are sometimes used as a substitute for chicory roots or coffee beans and oftenly used medicinally (Duke 1985). In addition to its medicinal uses, dandelion serves as a green salad. The leaves are an excellent source of calcium and potassium, in addition to vitamins A, B$_1$, B$_2$, C and D. This tea vitalizes and heals the liver and also helps the kidney function and leaves are vitally important in the prevention and treatment of pregnancy-related oedema, pre-eclampsia, and it can help restore a slow moving digestive tract (Blumenthal 1998). The flowers are sometimes fermented into wine. The German Commission E approves it to treat dyspepsia, liver and gallbladder complaints and appetite loss (Fleming 1998). It has long been used in folk medicine to treat hepatic disorders (Bylka \textit{et al.} 2010). Mahesh \textit{et al.} (2010) highlighted activity of dandelion water extract against D-galactosamine induced hepatitis in rats.

2.8.1.1.2. Chemical constituents

The products so obtained contain complex mixture of many medicinal plant metabolites, such as alkaloids, glycosides, terpenoids, flavonoids and lignins (Handa \textit{et al.} 2008). The products are in the form of decoctions, infusions, fluid extracts, tinctures, semisolid extracts or powdered extracts. Such preparations have been popularly called galenicals, named after Galen, the second century Greek physician.
In *T. officinale*, cichoric acid was isolated from dandelion leaves with the help of HPLC (Chkhikvishvili & Kharebava 2001). It is a potent inhibitor of the integrase of the type I human immunodeficiency virus (HIV-I) (Robinson *et al.* 1998). Dandelion’s active ingredients are found in both the roots and leaves. The leaves contain bitter sesquiterpene lactones such as taraxinic acid (Kuusi *et al.* 1985), and roots contain triterpenoids such as taraxasterol, taraxerol and cycloartenol, flavonoids and phenolic compounds (Kashiwada *et al.* 2001). Williams *et al.* (1996) isolated three flavonoid glycosides: luteolin 7-glucoside and two luteolin 7-diglucosides from dandelion flowers and leaves together with free luteolin and chrysoeriol in the flower tissue. Schutz *et al.* (2006) reported high potassium content in the herb (4.5%), which shows diuretic effect. Budzianowski (1996) isolated coumarins, caffeoyltartaric acid and methyl esters from dandelion leaves. Dandelion leaves contain higher polyphenol contents than the roots (Williams *et al.* 1996). The flowers contain triterpenes (arnidiol, faradiol, β-amyrin), β-sitosterol, and carotenoids (Mele´ndez-Martinez *et al.* 2011). The gas chromatography–mass spectrometry (GC–MS) analysis of essential oil obtained by hydrodistillation from the flower of *T. officinale* revealed the presence of 25 compounds with 1,3-dimethylbenzene, 1,2-dimethylbenzene, 1-ethyl-3-methylbenzene, heneicosane and tricosane as the main components which play role as attractants and pheromones of some insects (Bylka *et al.* 2010). Phenolic acids and flavonoids were extracted from a dandelion root and herb juice and characterized by high-performance liquid chromatography/electrospray ionization mass spectrometry (Schutz *et al.* 2006).

The drug Taraxaci radix cum herba contains: sesquiterpene lactones, triterpenes, phytosterols, carbohydrates, phenolic acids and flavonoids (Bradley 1992; Williams *et al.* 1996). Comparative quantitative chemical analysis in different parts of plants revealed that total hydroxycinnamic acid derivatives and flavonoids had the highest values in leaves and flowers (Newall *et al.* 1996).

### 2.8.1.1.3. Biological activities

Some workers showed biological activities in some members of family Asteraceae such as: Candan *et al.* (2003) showed inhibitory effect of essential oils of *Achillea millefolium* against *Staphylococcus* spp. This inhibitory effect is dose-dependent and there is a reduction in growth by increasing the concentration of the
extract in the culture media. Triterpenoids, flavonoids, coumarines, quinones, volatile oil, carotenoids and amino acids were extracted from *Calendula officinalis* and these chemical compounds possess multiple pharmacological activities such as anti-HIV, cytotoxic, anti-inflammatory, hepatoprotective, spasmylytic and spasmodogenic (Muley *et al.* 2009). Different type of biological activities of *Eclipta alba* have been studied such as antimicrobial (Khanna & Kannabiran 2008, Saggoo *et al.* 2010), antiviral (Dhar *et al.* 1968), antifungal (Yasman *et al.* 2008), antihepatitis-B (Jayaram *et al.* 1987). Antimicrobial activity of *E. alba* is reported to be due to wedelolactones (Dalal *et al.* 2009). Phototoxic compounds in stems and leaves of young plants of *Vernonia patens* were confirmed by TLC. These compounds were in smaller amount in younger than in adult plants of this species. Stems and leaves of the plant also showed anti-inflammatory activity and bactericide potential. The plant also showed phototoxic activity against *Bacillus subtilis* and *Escherichia coli* (Wat *et al.* 1980).

Anticancer activity of some mixed formulations of some composites (*Ageratum conyzoides, Eclipta alba, Spilanthes acmella, Vernonia cinerea*) has been studied by Har *et al.* (1972). Antioxidant activity of different fractions of leaves of *Erigeron annuus* reported by Jeong *et al.* (2011).

Several pharmacological activities of *T. officinale* are shown by various workers such as: Colle *et al.* (2012) showed hepatoprotective activity of *T. officinale* leaf extract against APAP-induced hepatotoxicity. The plant was able to decrease thiobarbituric acid-reactive substance levels induced by 200 mg/kg APAP (p.o.), as well as prevent the decrease in sulfhydryl levels caused by APAP treatment. Furthermore, histopathological alterations, as well as the increased levels of serum aspartate and alanine aminotransferases caused by APAP, were prevented by *T. officinale* (0.1 and 0.5 mg/mL). Awortwe *et al.* (2011) showed anticholinergic effect of the *T. officinale* leaves extract in ovalbumin (OA)-sensitized guinea-pig trachea. The result showed significant antagonistic effect on contraction of trachea to both acetylcholine (35.10 ± 0.04) and OA (18.6 ± 1.5). Also, the extract reduced monocytes (0.62 ± 0.23), lymphocytes (3.4 ± 0.59) and neutrophils (3.65 ± 0.20) counts in OA-sensitized guinea-pigs.

Dandelion extracts are used for medicinal purposes because of its choleretic, diuretic, antioxidant, anti-inflammatory and hepatoprotective properties (Wichtl &
Bisset 1994; Schütz et al. 2006). The plant shows diverse pharmacological properties, including antioxidant and hepatoprotective activity (Mahesh et al. 2010).

Lee et al. (2012) examined the anti-fatigue and immune-enhancing effects of *T. officinale* in mice by performing a forced swimming test (FST) and *in vitro* by using peritoneal macrophages, respectively. The results showed that the plant improves fatigue-related indicators and immunological parameters in mice.

The dandelion extracts or individual compounds extracted from dandelion leaves and roots demonstrated also antiinflammatory, anticarcinogenic, antioxidative, antiangiogenic and antinociceptive activities through inhibition of NO production and COX-2 expression (Jeon et al. 2008). The infusion of dandelion root, rich in oligofructans, stimulated *in vitro* the growth of 14 strains of bifidobacteria (Trojanova´ et al. 2004). The dandelion root and herb can be used internally for the treatment of loss of appetite and dyspepsia, such as feeling of fullness and flatulence, for irrigation of the urinary tract, especially in cases of inflammation and renal stone, and in rheumatism disorders (Schu¨tz et al. 2006).

### 2.8.1.2. *Silybum marianum* (L.)Gaertn.

#### 2.8.1.2.1 Medicinal uses

*S. marianum* is commonly known as Milk thistle, Ladys thistle, Holly thistle, Marian thistle. It is widely used in Europe for hepatic and biliary disorders, and also protect against nephrotoxicity as well. It protects the liver from several hepatotoxins, including *Amanita* mushrooms, acetaminophen and alcohol. The leaves of the plant are eaten in fresh salads and as a spinach substitute and the stalks eaten like asparagus. Ripe milk thistle seeds are used in Europe in the treatment of various hepatobiliary problems, such as hepatitis, cirrhosis, gallstones, and jaundice, as well as for kidney ailments. It is used to treat hepatitis and biliary disease, lower cholesterol, and even improve psoriasis (Deak et al. 1990)

#### 2.8.1.2.2. Chemical constituents

A simple, accurate and sensitive HPLC method was developed for estimation of silybin by Kuki et al. (2012).
The seeds of milk thistle contain 70-80% silymarin flavonolignans and 20-30% of chemically undefined fraction, composed of mostly polymeric and oxidized polyphenolic compounds (Dixit et al. 2007).

Flavonolignans are the active constituents in the dried seeds of milk thistle and are collectively known as silymarin (Wagner et al. 1974). Flora et al. (1998) reviewed the history, properties and the clinical effects of the plant. Shah et al. (2011) from Pakistan reported that the flavonoids are in high quantity (21%) in blue flowering and less (19%) in the white flowering plant of *S. marianum*.

The qualitative and quantitative data obtained by HPLC (High Performance Liquid Chromatography) and HPCE (High Performance Capillary Electrophoresis) showed the extract of dried fruits of *S. marianum* contains flavonoid silymarin and HPLC allowed the good separation between SBN and ISBN (Quaglia et al. 1999). Alikaridis et al. (2000) reported successful production of flavonolignans from the cultivated transformed and untransformed root cultures of *S. marianum*. Minakhmetov et al. (2001) separated flavonoids using reverse-phase HPLC with isocratic elution by CH$_3$CN-H$_2$O over Separon SGX C$_{18}$.

Hammouda et al. (1993) showed that when *S. marianum* was cultivated under different agricultural conditions, highest content of silymarin was obtained upon nitrogen fertilization with 100, 150 kg/feddan (1 feddan = 4200 m$^2$) and a 60% water regime without fertilization when compared to the content of silymarin in wild plants. Hasanloo et al. (2005) analysed the content of silymarin in the dried fruits of *S. marianum* collected from different environmental conditions of Iran by TLC and HPLC and compared with those from Hungarian fruits. Highest amount of silymarin content was found in fruits of Boranjan (south west of Iran) and Rudbarak (north of Iran) (27.1 and 24.6 mg/g dry wt.), while the content of silymarin in fruits of plants grown under green house effect was much lower (3.3 mg/g dry Wt.) than the content of silymarin in fruits of other areas and Hungarian fruits (22.7 mg/g dry Wt.).

Geneva et al. (2008) showed that the combined application of the foliar fertilizer with MD 148/II at a concentration of 1.10 M affected most positively growth, number of plant lateral shoots and flower heads per plant. These changes were associated with altered flowering rate, enhanced seed ripening and increased
yield. The accumulation of flavonoids and silymarin compounds in the seeds was also positively influenced.

Hassan El-Mallah (2003) exhibited characteristic lipid profiles from seed oil of *S. marianum* (fatty acids, TAGs, tocopherols, whole sterols, free and acylated sterols and sterylglucosides) using capillary GLC and HPLC. The oil is rich in linoleic acid (53.3%) and oleic acid (21.3%). Five major triacylglycerols containing linoleic acyls were detected by HPLC using FID detector.

2.8.1.2.3. Biological activities

Silymarin is used for the treatment of many liver disorders characterized by degenerative necrosis and functional impairment (Lecomte 1975). It is capable to antagonize the toxin of mushroom *Amanita phalloides* (Desplaces et al. 1975) and provides hepatoprotection against poisoning by paladin (Choppin & Desplaces 1978), galactosamine (Barbarino et al. 1981), thioacetamide (Schriewer et al. 1973), halothane (Siegers et al. 1983) and carbon tetrachloride (Mourelle et al. 1989).

Das et al. (2008) reported milk thistle’s benefit effects in gastrointestinal disorders and its antitumoral activities and other applications of silymarin are antioxidant, antiinflammatory agent, nephroprotector, radiation and skin protector. Kumar et al. (2011) reported certain phytoconstituents such as silybin A, silybin B, isosilybin A, isosilybin B, silychristin, silydianin, kaempferol 3-O-α-rhamnoside-7-O-β-galacturonide, apigenin 7-O-β-glucuronide, taxifolin and quercetin, and also showed pharmacological activities of the plant as it is used as anti-diabetic, hepatoprotective, hypocholesterolaemic, antihypertensive, antiinflammatory, anticancer, and as an antioxidant. Seeds of the plant are also used as an anti-spasmodic, neuroprotective, anti-viral, immunomodulant, cardioprotective, demulcent and antihaemorrhagic. The plant also serves as a galactagogue and used in the treatment of uterine disorders.

Madani et al. (2008) showed protective effects of polyphenolic extracts of *Silybum marianum* on thioacetamide-induced hepatotoxicity in rat. The extracts were injected to the rats, at a dose of 25 mg/ kg body weight together with thioacetamide at a dose of 50 mg/ kg body weight. To assess the affectivity of extracts, against thioacetamide, the activity of aminotransferases (SGOT and SGPT), alkaline
phosphatase, bilirubin, Na and K were measured. Significant decrease in the activity of aminotransferases, alkaline phosphatase and bilirubin was observed in the groups treated with extracts and thioacetamide compared with the group that was treated only with thioacetamide.

Silymarin has clinical applications in alcoholic liver diseases, liver cirrhosis, viral hepatitis, toxic and drug induced liver diseases, psoriasis, and in neuroprotective and neurotropic activity and though it does not have antiviral properties against hepatitis virus, it promotes protein synthesis, helps in regenerating liver tissue, controls inflammation, enhances glucoronidation and protects against glutathione depletion (Vladimir & Walterova 2005).

2.8.2. PHARMACOLOGICAL ACTIVITIES *(in vitro / in vivo)*

In pharmacology, biological activity or pharmacological activity describes the beneficial or adverse effects of a drug on living matter. Activity is generally dosage-dependent and it is not uncommon to have effects ranging from beneficial to adverse for one substance when going from low to high doses. As presently two biological activities i.e., antimicrobial and hepatoprotective have been studied for two species, the review of literature on these two aspects with particular reference to presently studied species is discussed further.

2.8.2.1. Antimicrobial activity

Bacterial diseases are a type of infectious diseases caused by pathogenic bacteria. It is notable that majority of bacteria are non pathogenic and are not harmful to human health. Some bacteria are even helpful and necessary for the good health. Millions of bacteria normally live in the intestine, on the skin and the genitalia. Bacterial diseases results when the harmful bacteria get into a body area, multiply their and thrash the body’s defensive mechanism.

Pathogenic bacteria can invade in the body through various routes like inhalation into nose and lungs, ingestion in food or through sexual contact. Once bacteria enters the body, the immune system of the body recognizes the bacteria as foreign intruder and tries to kill or stop them from multiplying. However, even a healthy immune system is not always able to stop the bacteria from reproducing and
spreading. As a result bacteria thrive in the body and emit toxins which damage cells and tissues that consequently results in the symptoms of bacterial disease.

General symptoms of bacterial diseases include fever, chills, headache, nausea and vomiting. Bacterial infections if untreated can lead to serious and life threatening complications such as sepsis, kidney and liver failure, toxic shock and even death. Infectious diseases are a leading cause of mortality Worldwide (Bajpai et al. 2005).

2.8.2.1. Effect of antibiotics

Antibiotic resistance has become a global concern in recent years. This problem is of great significance, especially in the developing countries, because infectious diseases are one of the major causes of mortality in these countries.

Aromatic and medicinal plants are sources of diverse nutrient and non-nutrient molecules, many of which display antioxidant and antimicrobial properties which can protect the human body against both cellular oxidation reactions and pathogens. Thus it is important to characterize different types of medicinal plants for their antioxidant and antimicrobial potential (Mothana & Lindequist 2005; Wojdylo et al. 2007).

2.8.2.1.2. Need for plant based drugs

For many years, control of bacterial infections by inhibiting microbial growth has been a primary approach of antimicrobial chemotherapy. So commercial antimicrobial drugs have been commonly employed as treatment of infectious diseases for many years. However, in recent years the indiscriminate use of these antibiotics has developed multiple resistances and side effects, therefore, more natural antimicrobial substances from plants are desired (Saleem et al. 2010). A large number of herbs possess antimicrobial activity (Mothana & Lindequist 2005) and some active components of these have become a potential source of new antiinfective agents (Agunu et al. 2005).

Due to the vast potentiality of plants as source for antimicrobial drugs, large number of Asteraceae plants have been used to investigate the antimicrobial properties by various workers. Candan et al. (2003) investigated in vitro antimicrobial and antioxidant activities of the essential oil and methanol extracts of Achillea millefolium subsp. millefolium. Essential oil showed antimicrobial activity against
Streptococcus pneumoniae, Clostridium perfringens, Candida albicans, Mycobacterium smegmatis, Acinetobacter lwoffii and Candida krusei while water-insoluble parts of the methanolic extracts exhibited slight or no activity. Ooi et al. (2006) reported three antimicrobial agents, namely 3,4-dicaffeoylquinic acid, 3,5-dicaffeoylquinic acid and luteolin-7-O-glucoside which were purified and chemically characterized from the ethanol extract of Youngia japonica. The two dicaffeoylquinic acids showed antiviral activity against respiratory syncytial virus (RSV) cultured in HEp-2 cells with 50% inhibitory concentration in vitro. Luteolin-7-O-glucoside together with the two dicaffeoylquinic acids also showed some antibacterial activity towards the causal agents of food-borne disease, namely Vibrio cholerae and Vibrio parahaemolyticus at the concentration of 2 mg/ml.

Phytochemical screening revealed the presence of flavonoids, tannins, alkaloids, steroids/triterpenes and cardiac glycosides in Vernonia blumeoides with a concentration-dependent activity against Staphylococcus aureus, Salmonella typhi, Candida albicans and Penicillium citrinum. It however showed no activity against Proteus vulgaris, Klebsiella pneumoniae and Escherichia coli. So the plant shows various therapeutic properties due to the presence of various phytochemical constituents (Ibrahim et al. 2011).

Antimicrobial activity of 9 plants such as: Artemisia vulgaris, Eclipta alba, Glossocardia bosvallea, Mikania micrantha, Spilanthes uliginosa, Vernonia cinerea, Vicoa indica, Wedelia chinensis and Wedelia trilobata against different Gram +ve and Gram –ve bacterias was studied by Bajpai et al. (2005).

Six organic solvent extracts of Artemisia nilagirica showed inhibitory activity for gram-positive and gram-negative bacteria except for Klebsiella pneumoniae, Enterococcus faecalis and Staphylococcus aureus. The hexane extract was found to be effective against all phytopathogens with low MIC of 32 µg/ml and the methanol extract exhibited a higher inhibition activity against Escherichia coli, Yersinia enterocolitica, Salmonella typhi, Enterobacter aerogenes, Proteus vulgaris, Pseudomonas aeruginosa (32µg/ml), Bacillus subtilis (64µg/ml) and Shigella flexneri (128µg/ml) (Ahameethunisa & Hopper 2010). Naphade et al. (2009) reported antioxidant activity of aqueous, chloroform and methanol extract of the aerial parts of plants of Tricholepis glaberrima by the Ferric Thiocyanate (FTC) method and
Thiobarbituric Acid (TBA) method. Methanolic extract showed higher antioxidant activity than the chloroform and aqueous extract. The results showed that the plant parts of *T. glaberrima* are a potential source of natural antioxidants and the strong antioxidant activity of these extracts is useful in the treatment of malaria, acquired immunodeficiency syndrome, heart disease, stroke, arteriosclerosis, diabetes, and cancer.

### 2.8.2.1.3. Antimicrobial activity of *T. officinale*

Sengul *et al.* (2009) studied that the methanolic extract of *T. officinale* had shown better antimicrobial activity as compared to aqueous extract. Some workers showed maximum antimicrobial activity in herbal extract of dandelion (Williams *et al.* 1996), roots show better results than whole plant (Trojanová *et al.* 2004), leaves and roots show antimicrobial activity against Gram +ve bacteria (Woods-Panzaru *et al.* 2009). Sudha & Vinodhini (2011) showed that seeds of dandelion show maximum antimicrobial activity as compared to leaves. According to Jaca & Kambizi (2011) leaves showed better antimicrobial activity than flowers. Whole plant shows antimicrobial activity against Gram+ve bacteria (Sharafzadeh 2011).

### 2.8.2.1.4. Antimicrobial activity of *S. marianum*

Antimicrobial activity of *S. marianum* showed that ethanol extract is more effective than hot water extract (Hassan *et al.* 2009). Various parts of the plant showed antimicrobial activity such as: ethanol extract of seeds showed better antimicrobial activity than methanol extract (Iqbal & Hamayun 2006), methanol extract of whole plant shows better antimicrobial activity as compared to ethanol extract (Ahmad & Beg 2001; Voravuthikuncha *et al.* 2004; Buwa & Staden 2006; Sofia *et al.* 2007; Shah *et al.* 2011). Keskin *et al.* (2010) showed that leaf and flower extract of *S. marianum* showed anticandidal activity on various micro-organisms.

### 2.8.2.2. Hepatoprotective activity

The liver is the largest organ in the body, contributing about 2 per cent of the total body weight, or about 1.5 kg in the average adult human. It is involved with almost all the biochemical pathways to growth, fight against disease, nutrient supply, energy provisions and reproduction (Ward & Daly 1999). The basic functional unit in liver is lobule, which is a cylindrical structure, several millimetres in length and 0.8 to
2 millimeters in diameter. The human liver contains 50,000 to 100,000 individual lobules. The lobule itself is composed principally of many liver cellular plates that radiate from the central vein like spokes in a wheel. Each hepatic plate is usually two cells thick, and between the adjacent cells lie small bile canaliculi that empty into bile ducts in the fibrous septa separating the adjacent liver lobules. In the septa are small portal venules that receive their blood mainly from the venous outflow of the gastrointestinal tract by way of the portal vein. From these venules, blood flows into flat, branching hepatic sinusoids that lie between the hepatic plates and then into the central vein. Thus, the hepatic cells are exposed continuously to portal venous blood. Hepatic arterioles are also present in the interlobular septa. These arterioles supply arterial blood to the septal tissues between the adjacent lobules, and many of the small arterioles also empty directly into the hepatic sinusoids. In addition to the hepatic cells, the venous sinusoids are lined by two other type of cells: (1) typical endothelial cells and (2) large Kupffer cells (also called reticuloendothelial cells), which are resident macrophages that line the sinusoids and are capable of phagocytizing bacteria and other foreign matter in the hepatic sinus blood. The endothelial lining of the sinusoids has extremely large pores, some of which are almost 1 micrometer in diameter. Beneath this lining, lying between the endothelial cells and the hepatic cells, are narrow tissue spaces called the spaces of Disse, also known as the peri-sinusoidal spaces. The millions of spaces of Disse connect with lymphatic vessels in the interlobular septa. Therefore, excess fluid in these spaces is removed through the lymphatics. Because of the large pores in the endothelium, substances in the plasma move freely into the spaces of Disse. Even large portions of the plasma proteins diffuse freely into these spaces.

Numerous industrial compounds and therapeutic agents have been found to injure the liver. Consequently, the use of such chemicals has been eliminated or restricted. For example, carbon tetrachloride was commonly used in unventilated garages for degreasing automobile engines. Plastic industry workers without any protective equipment crawled down into giant vats coated with residue containing vinyl chloride (Kramer 1974). Now exposures to the potent hepatotoxins carbon tetrachloride and vinyl chloride are tightly regulated. However, each year new chemicals are found to damage the liver, such as the drugs Rezulin (troglitazone), prescribed for type 2 diabetes, and Rimadyl (carprofen), prescribed for dogs with
arthritis. Usage of Rezulin in clinical medicine and Rimadyl in veterinary medicine was recently withdrawn or restricted based on reports of hepatic damage in more than 100 humans and over 8000 dogs, respectively. During the 3-year period before the serious and sometimes fatal hepatotoxicity associated with their use was generally recognized, these two drugs were widely prescribed to over 800,000 humans and more than 4 million dogs. Initially promising drugs have been withdrawn during clinical trials when their hepatotoxicity became manifested after weeks or months of exposure. The 1993 clinical trial of fialuridine as a therapy for chronic viral hepatitis was suddenly terminated when some of the participating patients died of liver failure (McKenzie et al. 1995). Humans and animals continue to ingest hepatotoxins in foods, teas, and contaminated water. The serious problem of chemically induced liver damage has inspired excellent monographs (Zimmerman & Seef 1970; Williams 1998).

2.8.2.2.1. Cause of liver damage

The risk of liver intoxication has recently increased by the higher exposure to environmental toxins, pesticides and frequent use of chemotherapeutics which can eventually lead to various liver ailments like hepatitis, cirrhosis and alcoholic liver disease (Sharma et al. 1991). Drug induced liver injury is a major health problem that challenges not only health care professionals but also the pharmaceutical industry and drug regulatory agencies.

2.8.2.2.2. Drugs causing hepatic disorder

Different types of drugs cause various type of hepatic disorder such as acetaminophen, Cu, dimethylformamide and ethanol ecstasy cause hepatocyte death, CCl₄, fialuridine, valproic acid cause fatty liver, diclofenac, halothane, tienilic acid cause Immune-mediated response, canalicular cholestasis due to chlorpromazine, Mn and phalloidin.

Chloroquine and isoniazid are inducing hepatotoxicity in World. The rate of hepatotoxicity has been reported to be much higher in developing countries like India (8%-30%) compared to that in advanced countries (2%-3%) with a similar dose schedule (Sharma 2004). Developing countries and population with HIV infection suffer disproportionately (Anonymous 2006). Many compounds, including clinically
useful drugs, can cause cellular damage through metabolic activation of the compound to highly reactive substances such as free radicals. One such environmental toxicant is carbon tetrachloride (CCl₄) and is widely used in different animals to induce liver damage.

### 2.8.2.2.3. Hepatoprotective activity of some plants

Hepatoprotective activities of ethanolic and aqueous extracts of *Aegle marmelos* were examined against carbon tetrachloride induced liver damage in mice using silymarin as control. Enzyme activities of Serum Glutamate Oxaloacetate Transaminase (SGOT), Serum Glutamate Pyruvate Transaminase (SGPT) and Alkaline Phosphatase (ALP) were analyzed and the results indicate that ethanolic and aqueous leaf extracts of *A. marmelos* had moderate activity over carbon tetrachloride treatment as compared to control (Kalaivani *et al.* 2009).

Chandan *et al.* (1991) showed an alcoholic extract of whole plant *Boerhaavia diffusa* given orally exhibited hepatoprotective activity against experimentally induced carbon tetrachloride hepatotoxicity in rats and mice. The extract also produced an increase in normal bile flow in rats, suggesting a strong choleretic activity. The extract does not show any signs of toxicity up to an oral dose of 2 g/kg in mice.

Administration of picroliv, a standardized fraction of alcoholic extent of *Picrorhiza kurroa* (3-12 mg/kg/day for two weeks) simultaneously with *Plasmodium berghei* infection showed significant protection against hepatic damage in *Mastomys natalensis* (Chander 1990). Further many workers have showed hepatoprotective activity of some plants such as: *Curcuma longa* (Kapoor 1990), *Boerhaavia diffusa* (Vaidya *et al.* 2009), *Ginkgo biloba* (Shenoy *et al.* 2001), *Azadirachta indica* (Chattopadhyay & Bandyopadhyay 2005), *Ficus carica* (Krishna *et al.* 2007), *Rhoicissus tridentate* (Opoku *et al.* 2007), *Solanum nigrum* (Chang-Chi *et al.* 2008), *Sargassum polycystum* (Meena *et al.* 2008), *Lepidium sativum* (Afaf *et al.* 2008) and *Rheum emodi* (Akhtar *et al.* 2009).

### 2.8.2.2.4. Hepatoprotective activity of some composites

Some composites show hepatoprotective activity such as: *Eclipta alba*, commonly known as Bhringraj. The hepatoprotective activity of the leaf of this herb
has been demonstrated by Singh et al. (1993). Jamshidzadeh et al. (2006) investigated the effects of different concentrations of the hydroalcoholic extract of dried powdered leaves of *Cichorium intybus* on CCl₄-induced hepatotoxicity in vivo in rats and CCl₄-induced cytotoxicity in isolated rat hepatocytes. The results showed that the *C. intybus* extract could protect the liver from CCl₄-induced damages with doses of 50 and 100 mg/kg, but concentrations higher than 200 mg/kg were less effective. Some other composites with hepatoprotective activity are *Tridax procumbens* (Ravikumar et al. 2005), *Launaea intybacea* (Pokharkar et al. 2007), *Calendula officinalis* (Muley et al. 2009), *Sphaeranthus indicus* (Varsha et al. 2010), etc.

### 2.8.2.2.5. Hepatoprotective activity of *T. officinale*

According to the earlier reports Mahesh et al. (2010) revealed that out of sesquiterpene lactones and the ethanolic extract, obtained from roots of *T. officinale*, sesquiterpene lactones showed a protective effect against CCl₄-induced hepatotoxicity in mice. Kashaw et al. (2011) suggested that dandelion could be used as a potential therapeutic material for treating chemically induced or viral hepatitis. The plant has also been used to enhance bile flow and to improve both hepatitis and jaundice. Some workers showed hepatoprotective activity in different parts of the plant such as: whole plant showed better hepatoprotective activity against CCl₄ (Rudenskaya et al. 1998; Kisiel & Barszcz 2000; Tabassum et al. 2010), flowers showed hepatoprotective activity against three experimentally induced hepatotoxicity models in rats (Singh et al. 2008). Water extract showed hepatoprotective activity of the methanol extract in paracetamol induced hepatotoxic rats. Alteration in the levels of biochemical markers of hepatic damage like SGOT, SGPT, ALP and lipid peroxides were tested in both paracetamol treated and untreated groups (Bourdi et al. 2002; Singh et al. 2008), root extract with hepatoprotective effect of ethyl acetate, ethanol and aqueous extracts at various concentrations was assessed in galactosamine and LPS induced mice model systems (Thyagarajan et al. 2002; Stickel & Schuppan 2007; Tabassum et al. 2010). Colle et al. (2012) showed hepatoprotective activity of *T. officinale* leaf extract against APAP-induced hepatotoxicity where the increased levels of serum aspartate and alanine aminotransferases caused by APAP, were prevented by *T. officinale* (0.1 and 0.5mg/mL).
2.8.2.2.6. Hepatoprotective activity of *Silybum marianum*

Administration of silymarin extracted and isolated from the seeds of milk thistle is effective in the treatment of both acute and chronic hepatitis, lowering the elevated serum level of bilirubin, AST and ALT in liver (Akhtar *et al.* 2009). Madani *et al.* (2008) investigated protective effects of polyphenolic extracts of *Silybum marianum* on thioacetamide-induced hepatotoxicity in rat. Some workers showed hepatoprotective activity in different parts of the plants such as: 50% ethanol extract of whole plant (100 & 250mg/100g body weight) was found to protect the mice from hepatotoxic action of paracetamol as evidenced by significant reduction in the elevated serum transaminase levels (Wagner *et al.* 1974; Sonnenbichler & Zetl 1986; Saller *et al.* 2001; Wellington & Jarvis 2001; Das *et al.* 2008; Singh *et al.* 2008). Seeds show the significant variations in the biochemical parameters. The level of TBARS in ethanol intoxicated rats increased two fold when compared with the control animals. The levels of GSH, SOD and CAT decreased significantly in the ethanol intoxicated rats (Wagner *et al.* 1968; Das *et al.* 2008; Madani *et al.* 2008). Madani *et al.* (2008) showed protective effects of polyphenolic extracts of *S. marianum* on thioacetamide-induced hepatotoxicity in rat. Significant decrease in the activity of aminotransferases, alkaline phosphatase and bilirubin was observed in the groups treated with extracts and thioacetamide compared with the group that was treated only with thioacetamide.