2. REVIEW OF LITERATURE

Much interest in drug plants was evinced during the early period of civilization. The use of plants for curing various human ailments has prominently figured in ancient manuscripts such as ‘The Bible’, ‘The Rigvedas’, ‘The Iliad’, ‘The Odyssey’ and ‘The History of Herodotus’. The ancient Chinese were using drug plants more than six centuries ago. They were the pioneers in using plants as valuable source of medicine. There are numerous Sanskrit writings which explain the usage, collection and isolation of drugs from plants. The Assyrians, Babylonians and ancient Hebrews were all familiar with the use of plants as drugs. Some of Egyptian papyri, written as early as 1600 B.C., mention plants such as Cannabis, Opium and Cassia being used by the physicians. The Greeks were familiar with the works of Aristotle, Hippocrates, Pythagoras, and Theophrastus. However, even during highly developed civilization, the ‘supernatural power’ was still considered supreme in healing the sufferer of various diseases. During this period, only a few men were considered able to distinguish between valuable and harmful plants. The Romans were less interested in healing plants. However, in 77 B.C. Dioscorides wrote his great treatise, ‘De Materia Medica’, which dealt with nature and properties of all the medicinal substances known till that time. This treatise completely changed the history of science of healing and is held in high esteem even today.

The end of ‘Dark period’ was the beginning of the period of the herbalists and encyclopedists. The monasteries of northern Europe produced vast compendiums of true and false information regarding plants, stressing in particulars, on medicinal value and folklore. It was about this time that the curious “Doctrine of Signatures” came into existence, according to which, all plants possessed some natural signs, given by the Creator, which indicated the use for which they were intended. Thus a plant with heart-shaped leaves should be used for heart ailments and the one with liver like, 3-lobed leaves was designated for liver troubles and so on. Many of the common names of our plants owe their origin to this curious belief (Hill 1992).

Current knowledge of the properties and therapeutic uses of plants in India comes from numerous sources and is closely linked to the rich cultural diversity that characterizes the Indian subcontinent. Traditional Indian medicine includes both folk
medicine, an oral tradition that is purely empirical in nature, which exists in all communities and reflects the country’s broad ecological, ethnic and cultural diversity, and ‘codified’ traditional medicine systems (Ayurveda, Siddha and Unani), with strong theoretical foundations and a body of medical texts dating back to hundreds, or in some cases thousands, of years (Shankar 1996).

Of India’s codified medical traditions, the oldest and perhaps the best known outside south Asia, is Ayurveda, a Sanskrit term meaning ‘the knowledge (veda) of life (ayu). Ayurveda traces its origins to the Vedic ages (1500-800 BC). The Rigveda (1200-900 BC), the earliest scripture of the Hindus, and the later Atharva Veda, contain numerous references to the healing properties of plants such as Soma. Epics such as the Ramayana (ca. 10th century BC) also allude to the use of plants to heal the wounds of battle (Vyas 1967).

Despite the assertions of many scholars (including the authors of early Ayurvedic works) that Ayurvedic knowledge is derived mainly from the Vedas, there is strong evidence suggesting that the early ascetic communities (Jain, Ajivika and especially Buddhist) that developed in India from the 4th century BC onwards had a major role in the evolution of Ayurveda that is not generally recognized. In contrast to the medical concepts and treatments alluded to in Vedic texts, there are close similarities between early Buddhist texts and much later Ayurvedic texts in the lists of medicinally used herbs and minerals and descriptions of specific treatments (Wujastyk 1995). By the time of the reign of the Buddhist Emperor Ashoka (274–237 BC), the importance of plants in Indian medicine was officially recognized by the state and specific measures were taken by the state to promote forest conservation as well as the propagation of medicinal and other useful plants (Kapoor 1990; Patnaik 1993).

Ayurveda’s earliest works are believed to have been composed between the 10th and 4th centuries BC. Of these, ‘Materia Medica’ of Charaka (Charaka Samhita), and Sushruta (Sushruta Samhita) are perhaps the best known. Neither the ‘Charaka Samhita’ nor the ‘Sushruta Samhita’ is known in its original form, the oldest extant texts (palm-leaf manuscripts) of these works date from the second half of the first millennium A.D. and were apparently modified and supplemented by later authors. The oldest known manuscript of the Charaka Samhita, composed by Drdhabala in the 9th century AD,
describes the medicinal uses of 341 types of plants, and 177 and 64 medicinal substances of animal and mineral origin respectively. Later texts of importance to the development of Ayurveda include Vagbhata’s ‘Aṣṭaṅgaḥṛdaya Samhitā’ (ca. 600 A.D.), Madhavakara’s ‘Rugvinischcaya’ (early 14th century), and the Bhavamishra’s ‘Bhava-prakasha’ (16th century).

2.1 Botanical studies

Botany emerged as a scientific discipline to mitigate the human sufferings. This necessitated the plant exploration work all over the world. The scientific beginning of plant exploration work in India probably dates back to the year 1534 when Garcia da Orta settled in Goa (Burkill 1965). He was a great pharmacist from Portugal and in his garden, he mainly grew the plants which were used by the local physicians for the treatment of various diseases. His knowledge of plants is recorded in his book ‘Colloquies’ published in 1565. It was Heinrich Van Rheede, the Governor of Dutch Possession in Malabar in 1667 who made first real attempt to explore systematically the plant wealth of India. He was responsible for 794 excellent illustrations and descriptions of about 750 species (Manilal 1980) through the assistance of various workers from different walks of life, including scientists, plant collectors, artists, physicians, integrators etc. His monumental book, ‘Hortus Malabaricus’, published in 12 volumes from Amsterdam, became a very important contribution to Indian Botany. It is mainly on Rheede’s work that Linnaeus based the nomenclature of Indian plants in his ‘Species Plantarum’. In 1933, a voluminous work entitled ‘Indian Medicinal Plants’ by Kirtikar and Basu was published. Dymocks’s ‘Materia Medica of India’ and his comprehensive work ‘Pharmacographice Indice’, prepared in collaboration with Warden and Hooper, was published during 1899–91.

One of the most significant outcomes of all these collections is to be seen in Hooker’s ‘Flora of British India’ published in 7 volumes during 1872-1897. This pioneer work has formed the basis of all the later provincial or local Indian floras published till date. A comprehensive account of floristic studies in India, during the last four centuries is given by Burkill (1965). Watt produced a voluminous “Dictionary of Economic Plants of India” in 6 volumes (1889-96). The ‘Indian Materia Medica’ by K.M. Nadkarni
appeared in 1927. Chopra and Chopra produced a treatise on “Indigenous Drugs of India” in 1933. Dr. Chopra alongwith R.L. Bhadwer and S. Ghosh prepared a monograph on “Poisonous Plants of India” in 1965. Chopra et al. (1956 and 1958) published a “Glossary of Indian Medicinal Plants”. Council of Scientific and Industrial Research ((CSIR), New Delhi came out with a consolidated account and updated information on economic plants of India in several volumes in “Wealth of India”. Many regional flora and accounts of medicinal plants of India also appeared during the past few decades.

These are all outstanding works containing wealth of information on economic plants of India. However, all these previous works, although of immense value in their own time, have now become outdated in the light of present Rules of Nomenclature and other concepts of systematic botany. Consequently, there has been a spurt in the plant exploration activities in the country during the last three decades or so as is evidenced by the publication of a large number of regional/district floras. It has been stated that we are not utilizing our plant resources and the vast land fully and properly, and it is because of this reason that we do not have a complete inventory of our plant wealth (Vohra 1980). If the natural plant resources have to be studied and their fuller utilization for our people attempted, there has to be an urgency of purpose and rather a short time table. With this awareness among the public, in the professionals, government and scientific community, it is hoped that the writing of regional floras based on the extensive and intensive field exploratory work, will go a long way in contributing towards the completion of this aim. Botanical Survey of India (BSI) is already involved in the major programme of preparing the ‘Flora of India’ in 4 series, namely, the National Flora (Flora of India), State Flora Analysis, District and small regional Floras, and Miscellaneous Floras, not falling under the first three series. Understandably, the writing of the regional floras will go a long way in contributing towards the early completion of this aim.

Efforts to document traditional medical knowledge and systematically explore the flora of India during the past two centuries have added much to our understanding of the uses and efficacy of medicinal plants. In addition to translations of numerous classical Sanskrit and Tamil texts on Ayurveda and Siddha, and Arabic and Persian texts on Unani, late 19th century botanical surveys and works on economic and medicinal botany by Hooker (1872-1897), Watt (1889-1896) and Dymock et al. (1889-1891) have set the
stage for a revival of interest in (and respect for) Indian medicine in the 20th century. During the past century, a number of standard reference works have been published that survey in great detail the traditional uses of medicinal plants. These include Kirtikar and Basu’s ‘Indian Medicinal Plants’ (1933), Nadkarni’s ‘Indian Materia Medica’ (1927); Chopra and Chopra ‘Indigenous Drugs of India’ (1933); Dastur’s (1962) account of ‘Medicinal Plants of India and Pakistan’; Jain’s ‘Dictionary of Indian Folk Medicine and Ethnobotany’ (1991); Jain and Filipps’ (1991) ‘Medicinal Plants of India’; and more recent compendia published by the Indian Council for Industrial Research, as well as general articles and other publications by anthropologists and ethnobotanists. In India, there are over 2000 plants credited with medicinal properties and only a few of these are cultivated, while a majority grows in the wild (Kirtikar and Basu 1933; Chopra et al. 1958). The biological activity of many plants has been studied at Central Drug Research Institute, Lucknow and Regional Research laboratories of CSIR. The National Chemical Laboratory, Pune, the Central Council for Research in Ayurveda and Sidh (CCRAS), various universities and medical institutions are also engaged in biochemical screening.

As a result of these efforts, the medicinal flora of India has become better known. Chopra and Handa (1961) and later Jain (1994) have reviewed the status of research on ethnobotany and medicinal plants in India. Numerous research papers continue to appear periodically on the diversity of medicinal plants of various regions of India. In itself, it is but a stupendous task to refer to all these publications. A few works on the medicinal plants of the different geographic regions of India include the accounts of the medicinal plants of Darjeeling and Sikkim Himalayas by Biwas (1956); Garhwal Hills by Gupta (1960), Naithani (1973), Nautiyal (1981), Dhasmana (1986a,b), Uniyal (1989) and Ghildyal et al. (2008a,b); Ethnobotanical accounts of Kumaon Himalaya by Pandey et al. (1999), Pangtey and Rawat (1987) and Pangtey et al. (1989); ‘Medicinal Plants of Kashmir and Ladakh’ by Kaul (1997); ‘Medicinal and Aromatic Plants of Himachal Pradesh’ by Chauhan (1999); accounts of medicinal plants of Uttarakhand (Uttaranchal) by Purohit (1997), Chandola (2005) and Shah (2006, 2007); medicinal plant resources of Nanda-Devi Biosphere Reserve in the central Himalaya by Nautiyal et al. (2001); ethnobiological accounts of Nilgiri hills by Rajan and Mukherjee (2002); ethnomedicinal knowledge of plants used by Kunabi tribe of Karnataka in India by Harsha et al. (2002);
traditional use of medicinal plants by the Jaintia tribes in north Cachar hills district of Assam by Albert and Kuldip (2006); useful medicinal plants of Uttar Pradesh and Uttarakhand by Prakash and Singh (2006); traditional aboriginal knowledge of medicinal plants in the Vellinangui holly hills of south India by Ragupathy et al. (2008); and a few others.

2.2 Ethnobotanical studies

Ethnobotany is the study of different uses of plants in day to day life of the ethnic communities. The importance of medicinal plants in traditional healthcare practices, providing clues to new areas of research and in biodiversity conservation is now well recognized. However, information on the uses of plants for medicine is lacking from many areas of the country. In what follows, studies conducted in different parts of India and other countries during the 21st century, on the diversity of plant resources that are used by local people for curing various ailments, are briefly reviewed.

2.2.1 Ethnobotanical studies in India

Jain (1994) reviewed the status of research on ethnobotany and medicinal plants in India. The author opined that despite the existence of a vast ethnobotanical knowledge in India; the study has been intensified since 1950 and has resulted in the publication of 10 books and over 300 papers. A dictionary of folk medicine and ethnobotany containing 2532 plants has been compiled as a result of four decades of work. The author further revealed that India harbors about 45,000 plant species and many thousands have medicinal properties. Indigenous system uses about 500 plant species and about 2000 Indian plant species find frequent mention in the medicinal plant literature.

Kala et al. (2006) provided insights into the challenges and opportunities of developing medicinal plant sector in Northern India. The study revealed that Northern India is a rich repository of medicinal plants and biodiversity, which can be used at different levels to develop the medicinal plants sector. An ethnobotanical study was conducted by Kala (2005) on Apatani tribe of Arunachal Pradesh. A total of 158 medicinal plant species were recorded, Asteraceae was found to be the most dominant family of medicinal plants, followed by Zinziberaceae, Solanaceae, Lamiaceae and Araceae.
An ethnobotanical survey was carried out by Ayyanar and Ignacimuthu (2005) among the ethnic groups in South Western Ghats of India. A total of 54 plant species belonging to 26 families were documented which were mostly used to cure skin diseases, poison bites, wounds and rheumatism. A similar study was carried out by Jain et al. (2005) in Sita Mata Wildlife Sanctuary of Chittorgarh and Udaipur district of Rajasthan. Two hundred and forty three genera belonging to 76 families were reported to be used by tribes for curing various ailments. Uniyal et al. (2006) reported 35 plant species that were commonly used by local people for curing various diseases among the tribal communities of Chho Bhangal in Western Himalaya.

Muthu et al. (2006) collected information from traditional healers on the use of medicinal plants in Kancheepuram district of Tamil Nadu. The investigations revealed that the traditional healers used 85 species of plants distributed in 76 genera belonging to 41 families to treat various diseases. Studies claimed that many people in the district continue to depend on medicinal plants at least for the treatment of primary healthcare. A case study among the Sanowal Kacharis of Dibrugarh, Assam was carried out by Das et al. (2008a). In this study an attempt was made to find out the beliefs and practices related to health care system among the people of the district.

An ethnobotanical study was conducted by Sajem and Gosai (2006) regarding the traditional use of medicinal plants by the Jaintia tribes in the North Cachar Hill district of Assam (India). Using structured questionnaires, the investigators documented 39 medicinal plants species belonging to 27 families and 35 genera. A distinct classification of above ground and underground plant parts used in curing various ailments was followed. The above ground parts like leaf, fruit and seeds accounted for curing 76.6% ailments and underground parts like roots, tubers, rhizomes, bulbs and pseudo-bulbs accounted for 23.4% only.

Verma et al. (2007) attempted to study the medicinal plants in an urban environment and explored the medicinal flora of Banaras Hindu University Campus, Varanasi in the Uttar Pradesh state of India. Though being one of the oldest inhabited cities of the world and one of the important sites of Hindu Pilgrimage, a little was known about the medicinal and general flora of Varanasi. They highlighted the traditional use of
72 medicinal plant species collected from the premises of the university. The study also revealed the uses of these plants by the local inhabitants.

Ragupathy et al. (2008) undertook a study on consensus of the ‘Malasars’ traditional aboriginal knowledge (TAK) of medicinal plants in the Velliangiri holy hills of South India. The study listed 95 plant species belonging to 50 families of medicinal and general health purposes. The consensus analysis revealed a high degree of agreement among the informants regarding the usage of a particular plant for different ailments. The community expressed concern over the younger generation not embracing TAK in the face of lucrative jobs in more developed urban areas.

2.2.2 Ethnobotanical studies in other countries

Ahmad et al. (2006) provided an overview of the problems and their feasible solutions to the medicinal flora of the Thar Desert (Pakistan). Thar Desert occupies a vast area of 35126 sq.km in the Sindh Province and geographically located between 24-28° and 68-71° longitude. Earlier surveys of the medicinal flora of the area have shown more than 85 medicinal plants in traditional use for curing a number of ailments (Stewart, 1868; Awan, 1978; Nassir and Ali 1970-1995; Ali and Qaiser 1995-2005). They revealed that the area has a rich biodiversity and the communities of the area satisfy 95% of their health services by the local medicinal flora Cassia fistula, C. angustifolia, Cordia latifolia, Aloe barbedensis, Tribulus terrestris and Caesalpinia bonducella have been listed as the important medicinal plants of Thar Desert. They have also cautioned against the exposure of medicinal plants to anthropogenic impact.

Shah et al. (2006) carried out an ethnobotanical study in the mountainous region of District Musakhel and Barkhan of Bato Chistass on plants of 18 families that were found to cure different diseases. Leporatti and Impieri (2007) compiled ethnobotanical notes on some uses of medicinal plants in Atto Tirreno Cosentino area of Southern Italy. Information was gathered by mainly interviewing elderly native people, engaged in farming and stock raising activities and housewives. They listed 52 species of medicinal plants belonging to 35 families. Most of the species (15) were recorded to cure skin diseases, respiratory apparatus diseases (11 species), tooth-ache, decay (10 species) and 8 species were found effective in curing rheumatoid pains. Apart from human ailments
many veterinary diseases like sores, ulcers, taenia, dermatitis, gangrenous wounds of cattle and respiratory diseases are cured by these plant species.

Ogueke et al. (2007) demonstrated the anti-bacterial activities and toxicological potentials of crude ethanolic extracts of *Euphorbia hirta*. The investigators verified the biochemical basis of traditional medicinal uses of *E. hirta* in the treatment of boils, wounds and control of diarrhoea and dysentery. The leaf extract was obtained by maceration in ethanol and agar, diffusion method was employed to determine antibacterial activity on *Staphylococcus aureus*, *E. coli*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Bacillus subtilis* at different concentration. The results showed that the extracts inhibited the growth of the first three of the bacterial types but *S. typhi* remained unaffected. The study is significant from the traditional medicine system point of view and justification for the use of *E. hirta* for the above mentioned conditions.

Husain et al. (2007) carried out ethno-pharmacological review of the native traditional medicinal plants for brain disorders. The workers discussed some well known medicinal plants of Indian origin which are used in central nervous system (CNS) disorders since ancient times. They were of the opinion that the brain being much complex organ of our body and only a very few drugs are used for multifactorial ailments like Alzheimer’s disease. The focus of the study were reputed and effective. The plant species like *Withania somnifera*, *Bacopa monniera*, *Centella asiatica*, *Convolvulus pluricaulis*, *Embelica officinalis* and *Ocimum sanctum*. These plants had been discussed for their ability to combat intellect, which in original ayurveda are classified as ‘Medhya rasayanas’ meaning intellect and rejuvenation.

Gronhaug et al. (2008) conducted an ethnobotanical survey of six medicinal plants from Mali, West Africa. Nanying et al. (2008) carried out an ethnobotanical survey of Samburu district of Kenya by randomly sampling 100 interviewees comprising different age groups, occupations and levels of education. Data on plant use from the respondents yielded about 990 citations on the 56 plant species of medicinal importance. These plant species were used to cure 54 different animal and human diseases, including malaria, digestive disorders, respiratory syndromes, and getting rid of ectoparasites.

An ethnobotanical study was undertaken by Yinger et al. (2008) on plant knowledge and practice of the Oromo ethnic group, in the South Western Ethiopia. Data
were collected from 45 traditional healers which were randomly selected. This study revealed that about 67 ethnobotanical plant species were used by traditional healers to manage 51 different human ailments. There was almost unanimity among the traditional healers in the treatment of tumours, rabies and insect bite using these plant species.

Lulekal et al. (2008) conducted an ethnobotanical study of medicinal plants in Mana Angetu district of South Eastern Ethiopia and documented indigenous medicinal plant utilization, management and the treatment affecting them. A total of 230 plant species of medicinal plants were documented of which a majority (78.7%) were used to treat human diseases. In terms of the plant parts used, roots were more frequent (33.9%) followed by leaves (25.6%). A check-list of medicinal flora of Tehsil Isakheol, District Minwali in Pakistan was prepared by Ahmad et al. (2006). The ethnomedicinal data on 55 plant species belonging to 52 genera of 30 families was also recorded.

Volpato et al. (2009) reported 123 plant species of 112 genera and 63 families used by Haitian immigrants and their descendents in the Camaguey province of Cuba. The investigators brought to light some 22 herbal mixtures used as medicinal baths and decoctions. A similar study was conducted by Signorini et al. (2009), focusing on ethnobotanical investigation of plants and traditional knowledge using semi-structured interviews. The data were collected on the local names, part used, local frequencies and habitats of plants in Nuoro, Sardinia region of Italy. The authors came up with a list of 72 plant species used traditionally in the area. These plants were found to be used for curing about 191 ailments and the findings were supported by 301 citations.

Long et al. (2009) conducted field surveys using ethno botanical, anthropology and participatory rural appraisal in their study on medicinal plants used by the Yi ethnic group of Central Yunnan. The authors reported 116 medicinal plant species belonging to 58 families being used by the local people in the treatment of various diseases like trauma, gastrointestinal disorders and common cold.

Liu et al. (2009) made an elaborate study of the medicinal plants used by Tibetans in Shangri-La, Yunnan in China. The investigators interviewed local healers as the key informants and used the methods of ethnobotany, anthropology and participatory rural appraisal in field surveys. They recorded and collected 68 medicinal plant species belonging to 64 genera and 40 families.
Moshi et al. (2009) studied the ethnomedicines of the Hoya people of Bugabo ward, Kagera region of North-Western Tanzania. The study revealed 94 plant species representing 84 genera and 43 families, which were commonly used in the treatment of a variety of human ailments. Family Asteraceae contributed the highest number of species towards the traditional medicines. Among different ailments, Malaria was treated using highest number of medicinal species (30) followed by skin diseases (19), maternal illness and sexually transmitted diseases (14) and respiratory diseases (11). Leaves comprised the maximum (40%) of the plant parts used in curing different diseases or ailments.

2.3 Phytochemical studies

India is known for a rich diversity of medicinal plants which are in great demand all over the world. Plants produce a variety of metabolites, those play an important role in the life processes of the plant. Many of the substances used in the pharmaceuticals, food flavour and perfume industry originate from plants and the trend over last fifty years has been towards chemical synthesis but still the plants remain an important source of a lot of these compounds. However, many compounds are still difficult or costly to synthesize. Moreover, the increased consumer preference for natural food colours and flavours over their synthetic counterparts has further increased our dependence on plants. Some plants are rich in secondary metabolites which are botanical source of some drugs and essential oils. The secondary metabolites have high economical and pharmaceutical importance and the industries are highly interested in the large variety of chemical constituents being produced by plants.

Medicinal importance of any plant depends on some specific substances found in them such as flavonoids, steroids, alkaloids, phenols, terpenoids, glycosides, essential oils, insecticides, gums, resins, and tannins. These active substances are present in storage organs of plants like roots, leaves, bark, seeds etc. The important secondary metabolites of pharmaceutical importance of the plants surveyed during the present investigations are reviewed below.
2.3.1 Flavonoids

2.3.2 Steroids

Steroids are the most important group of secondary metabolites. Steroid represents the nonsaponifiable fraction of the lipids extracted in the fat solvents which bear cyclopentano-perhydro-phenanthrene nucleus in their molecular structure. The steroid nucleus consists of four rings A, B, C, D. The first three rings i.e. A, B, C are six-membered whereas D is five-membered. Steroids occur more abundantly in the plant world than in the animal and thus the plant steroids have been employed as starting material for hormone synthesis. The phytosterols are ubiquitous in higher plants and probably also in plant tissue cultures.

Till now, more than four thousand plant species have been investigated which have resulted in the identification of some thirty naturally occurring steroidal sapogenins, many of which provide valuable source materials for steroid compounds. The steroids attached with sugar are very common in plants. One class of these substances is known as saponins. The steroidal part of these saponins is called sapogenins. Sapogenin are widely used in medicine as they are main precursors of many medicinally useful steroidal hormones. The sapogenins and diosgenins, which are abundantly available in plants are of particular importance for the production of sex hormones.


2.3.3 Alkaloids

Alkaloids are naturally occurring chemical compounds containing basic nitrogen atom. They are produced by a large variety of organisms, including bacteria, fungi, plants
and animals and are part of the group of natural products (also called secondary metabolites). Many alkaloids are toxic to other organisms. They often have pharmacological effects and are used as medications. More than 10,000 different alkaloids have been discovered in species from over 300 plant families. The amazing effect of these alkaloids has led to the development of powerful pain killer medications, spiritual drugs and serious addictions by people who are ignorant of the properties of these powerful chemicals. A large number of plants have been found to possess alkaloids. Some species from the present study which possess alkaloids include: Abrus precatorius (Dipanjan and Tapas 2007), Justicia adhatoda (Kumar et al. 2010a), Aegle marmelos (Venkatesan et al. 2009), Ageratum conyzoides (Galati et al. 2001), Alstonia scholaris (Abe et al. 1989), Argemone mexicana (Changa et al. 2003), Arundo donax (Zhalolov et al. 2002), Azadirachta indica (Siddiqui et al. 2009a), Boerhaavia diffusa (Manu and Kuttan 2009), Catharanthus roseus (Luca and Cutler 1987), Coccinia indica (Shaheen et al. 2009), Convolvulus arvensis (Molyneux et al. 1993), Convolvulus microphyllus (Dandekar et al. 1992), Croton bonplandianum (Rizk 1987), Datura stramonium (Parr et al. 1990), Evolvulus alsinoides (Cervenka et al. 2004), Momordica charantia (Tongia et al. 2004), Nelumbo nucifera (Mukherjee et al. 2009), Nyctanthes arbor-tristis (Maleki et al. 2004), Papaver somniferum (Singh et al. 2000), Plumeria rubra (Guan et al. 2009), Prunus persica (Rho et al. 2007), Putranjiva roxburghii (Siddiqui et al. 2009b), Raphanus sativus (Gutierrez et al. 2004), Rumex dentatus (Fatima et al. 2009), Solanum nigrum (Mohy-Ud-Din et al. 2010), Solanum nigrum (Potawel et al. 2008), Tabernaemontana divaricata (Pratchayasakul et al. 2008), Tinospora cordifolia (Sarma et al. 2009), Tribulus terrestris (Sahelain 2003), Vitex negundo (Sahare et al. 2008), Withania somnifera (Padmavati et al. 2005).

2.3.4 Phenols

Sometimes called as phenolics, these are a class of chemical compounds consisting of a hydroxyl group (-OH) bonded directly to an aromatic hydrocarbon group. Some phenols are germicidal and are used in formulating disinfectants. A large number of plants have been found to have phenolic compounds. Some plants reported to possess phenols and included in the present study are: Allium sativum (Ichikawa et al. 2003),
Aloe vera (Hamman 2008), Althea rosea (Dudek et al. 2006), Anethum graveolens (Yili et al. 2006), Anthocephalus cadamba (Kapil et al. 1995), Brassica oleracea (Heimler et al. 2006), Cannabis sativa (Sakaibara et al. 1995), Carica papaya (Antonella et al. 2007), Catharanthes roseus (Mustafa and Verpoorte 2007), Chenopodium album (Pande and pathak 2010), Chukrassia tabularis (Kaur and Arora. 2009), Citrus limon (González-Molina et al. 2010), Coccinia indica (Shaheen et al. 2009), Cyperus rotundus (Sayed et al. 2007), Emblica officinalis (Khan 2009), Euphorbia hirta (Patil et al. 2009), Euphorbia prostrata (Rene et al. 2007), Hordeum vulgare (Arnowskia et al. 2002), Mangifera indica (Severi et al. 2009), Momordica charantia (Tongia et al. 2004), Musa paradisiaca (Vijayakumar et al. 2008), Ocimum sanctum (Lukmanul et al. 2007), Phyllanthus fraternus (Malau et al. 2009), Populus alba (Kwon and Bae 2009), Prunus persica (Liakopoulos et al. 2001), Putranjiva roxburghii (Siddiqui et al. 2009b), Raphanus sativus (Gutierrez et al. 2004), Tabernaemontana divaricata (Pratchayasakul et al. 2008), Terminalia bellerica (Yadava and Rathore 2001), Yucca gloriosa (Montoro et al. 2008), Ziziphus mauritiana (Muchuweti et al. 2005).

2.3.5 Terpenoids

Sometimes called isoprenoids, are a large and diverse class of naturally occurring organic chemicals similar to terpenes. Plant terpenoids are used extensively for their aromatic qualities. They play a role in traditional herbal remedies and are under investigation for antibacterial, antineoplastic and other pharmaceutical functions. Terpenoids contribute to the scent of eucalyptus, the flavour of cinnamon, clove, ginger and colours of yellow flowers. The steroids and sterols in animals are biologically produced from terpenoid precursor. A large number of plants contain terpenoids viz. Abrus precatorius (Dipanjan and Tapas 2007), Aegle marmelos (Venkatesan et al. 2009), Ageratum conyzoids (Sandufu and Shoushan 2003), Azadirachta indica (Siddiqui et al. 2009a), Bauhinia variegata (Mohamed et al. 2009a), Capsicum annuum (Kawaguchi et al. 2004), Catharanthus roseus (Luca and Cutler 1987), Clerodendrum inerme (Pandey et al. 2005), Coccinia indica (Shaheen et al. 2009), Eclipta prostrata (Lee et al. 2008a), Euphorbia prostrata (Rene et al. 2007), Ficus carica (Oliveria et al. 2010), Foeniculum vulgare (Chowdhury et al. 2009), Melilotus indica (Palombo 2006), Mentha longifolia (Akroum et al. 2009), Nelumbo nucifera (Chaudhuri and Singh 2009), Nelumbo nucifera
Glycosides are molecules in which a sugar is bound to a non-carbohydrate moiety, usually a small organic molecule. The sugar group is known as the glycone and non sugar group as the aglycone part of glycoside. Glycosides play numerous important roles in living organisms. Many plants store chemicals in the form of inactive glycosides. These can be activated by enzyme hydrolysis, which causes the sugar part to be broken off, making the chemical available for use. Many such plant glycosides are used as medications.


2.3.7 Essential oils

Essential oil is a concentrated, hydrophobic liquid containing volatile, aromatic compounds. These are obtained from plants and are used in making perfumes, cosmetics, soaps, and other products and also for flavouring food and drinks. Essential oils are also used in medicine for skin treatments. Interest in essential oils has revived in recent decades, with the popularity of aromatherapy, a branch of alternative medicine which claims that the specific aromas carried by essential oils have curative effects. Essential oils have been extracted from a large number of plants and some of these which are also reported in the present study include: Ageratum conyzoids (Sandufa and Shoushan 2003), Anethum graveolens (Yili et al. 2006), Artemisia cappillaris (Liu et al. 2010; Cha et al. 2005), Brassica compestris (Appelquist et al. 1981), Brassica juncea (Yu et al. 2003), Cannabis sativa (Slatkin et al. 1971), Chenopodium ambrosioides (Singh et al. 2008), Coriandrum sativum (Matasyoh et al. 2009), Curcuma longa (Ajaiyeoba et al. 2008), Eucalyptus citriodora (Dagne et al. 2000), Euphorbia hirta (Ogunlesi et al. 2009), Foeniculum vulgare (Chowdhury et al. 2009), Lantana camara (Chowdhury et al. 2007), Mentha arvensis (Pandey et al. 2003), Mentha longifolia (Ghoulami et al. 2001), Ocimum sanctum (Agnieszka et al. 2005), Papaver somniferum (Sengupta and Mazumder 2006), Trigonella foenum-graecum (Ahmadiani et al. 2001), Vitex negundo (Banerji et al. 1969; Dutta et al. 1983), Zingiber officinale (Ekundayo et al. 2006).

2.4 The present study

A careful perusal of the literature revealed that there is no published account of the medicinal plant diversity of Punjab or any of its regions/districts, except for a very general and casual account entitled “100 Medicinal Plants of Punjab” by Jerath and Saxena (2004). There also exist a few floras of Punjab but this deal with the whole of the erstwhile state of Punjab. These include those by Aitchison (1864 a, b; 1868; 1869); Coventry (1901); Bamber (1916); and Parker (1918). Besides these, Sabnis (1940) has also given comprehensive lists of plants, covering mainly the plains and the associated hill regions of Punjab. It may be added that the political boundaries of Punjab have
changed thrice since 1947. The present state of Punjab is a region quite distinct floristically from the former Punjab. The only account of the plants of the present state of Punjab is by Nair (1978). However, fairly large amount of this work is based on herbarium materials only, housed at the Herbarium of the Forest Research Institute Dehra Dun (DD) and Herbarium of The Northern Circle of The Botanical Survey of India, Dehra Dun (BSD), and includes several plants from localities now not a part of Punjab. Sharma (1990) published a checklist of the plants of Punjab which is more authentic, but the lack of species descriptions, illustrations, and keys to the identification of genera and species, limits its utility. Ireland (1985) compiled an account the ‘Trees and Shrubs of the Punjab’ while Sharma and Khosla (1989) published an illustrated account of the ‘Grasses of Punjab and Chandigarh’. Other works dealing with plants of few districts of Panjab include ‘Flora of Patiala’ by Sharma and Bir (1978); ‘Flora of Ropar District (Punjab)’ by Meenakshi and Sharma (1985); and Sharma and Sharma (1974) who contributed to the flora of Ludhiana district. Apart from these publications, there is no other recent account of either the flora of Punjab or of any other district, including Amritsar.

The need for flora of Amritsar has been actually felt ever since the shifting of Department of Botany of Punjab University from Lahore to Khalsa College, Amritsar after partition of the country in 1947 (from where it was shifted to Chandigarh in 1960). No specific information is available on the plants of Amritsar though most of the species found here have already been recorded and described in various floras and botanical reports of the present and erstwhile state of Punjab and of the adjoining areas. All the accounts of the plants of Punjab mentioned above have served as a general means of reference, but none of these have, however, proved sufficient to fulfil the needs of students and teachers of Botany and medicine based in Amritsar. The Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar has been occasionally receiving enquiries about the identity of some local plants of medicinal importance from teachers of other science departments of the University, degree colleges, Ayurvedic and Medical Colleges located in Amritsar, and local herbal traders. Amritsar is an important export hub of North-West India dealing in export of a large number of products, raw materials, and crude drugs/medicinal plants. It was with this aim of fulfilling the requirements of local researchers, teachers, the students, and the traders that
the present work on the “Studies on the Medicinal Flora of Amritsar District” was initiated. This study shall form a base for the compilation of a much desired flora of Amritsar, and shall also introduce readers to the floristic wealth of India and its traditional uses in health care. Further, in the present study, the literature relevant to ethanobotanical and phytochemical aspects of plants already in use for medicinal purposes, has been extensively reviewed which would serve as a reference for the future generation of ethnobotanists, interested in this aspect of study.

Amritsar is an important pilgrimage centre of the Sikh community and is the “Religious Capital of Sikhs”. Planting of trees in different areas of the city has been done to overcome the increasing threat of pollution. Some gardens and parks have been set up to help in greening the city. A wide variety of trees have also been planted along the roadsides. The present study includes all these cultivated plants, along with those that grow in the wild.