Phytochemical screening

Medicinal plants are best owed with large number of pharmaceutically useful compounds which can be studied for investigation of new drugs for many serious diseases like cancer, tumours, AIDS and many human degenerative diseases. Medicinal plants are the local heritage with global importance. Plants and plant-based medicaments are the basis of many of the modern pharmaceuticals we use today for our various ailments.

Medicinal plants are known to produce certain bioactive molecules which inhibit bacterial or fungal growth (antimicrobial activity) (Gerretsen and Netty haagsma, 1951; Mothana and Lindequist, 2005; Sharma and Kamar, 2009). Phytochemical studies on *Sopubia delphinifolia* were carried out by Deokule and Patale (2001).

Faraz *et al.* (2003) carried out quantitative phytochemical analysis in fifty five Iranian plants belonging to 21 families. Falodun *et al.* (2006) reported the occurrence of flavonoids, saponins, diterpenes and phorbol estersin in the aqueous and methanol extracts of *Euphorbia heterophylla*. Raghavendra *et al.* (2006) examined the powdered leaf material of *Oxalis corniculata* with different solvents and reported the presence of phenols, glycosides, carbohydrates, phytosterols and tannins. Awoyinka *et al.* (2007) extracted eight bioactive compounds from dry leaf of *Cindoscolus aconitifolius* using water and ethanol. Different extracts of *Semacarpus anacardium* were analysed by Mohanta *et al.* (2007) for its phytochemical properties. Onwukaeme *et al.* (2007) detected reducing sugars, phenols, tannins and flavonoids in *Pycanthus*
angolensis. Sixty two compounds were identified in the fresh matured leaves of Lantana camara by GC-MS technique (Chowdhury et al., 2007).

Uma Devi et al. (2007) carried out phytochemical analysis in Achyranthes bidentata. The methanol and acetone extracts of 14 plants belonging to different families were evaluated for phytochemicals and this study revealed the presence of tannins, cardiac glycosides, steroids and saponins (Vaghasiya and Chanda, 2007). Methanol leaf extract of Pterocarpus santalinus was evaluated by the HPTLC finger print analysis (Arokiyaraj et al., 2008). Ivana et al. (2008) used GC-MS techniques to analyze the chemical composition present in the leaf extracts of Stevia rebaudiana. The extracts of Aloe greatheadii were examined for the phytochemical contents that were identified, quantified and compared using GC-MS techniques (Lisa et al., 2008). Ayoola et al. (2008) investigated the phytochemical components of four medicinal plants used for the treatment of malaria in Southwestern Nigeria. Suhad and Viorica (2008) did quantitative analysis of bioactive compounds (flavonoids) in Hibiscus sabdariffa. Ichnocarpus frutescens leaf, stem and root were investigated (Mishra et al., 2009) for their phytochemical and physicochemical properties. Vikas Kumar et al. (2009) examined leaves of Paederia foetida for the pharmacognostic and phytochemical studies. Aiyelaagbe and Osamundiemen (2009) screened Mangifera indica for the chemically active compounds. Qualitative analysis was made for the active compounds present in the four important medicinal plants, Acalypha indica, Cassia auriculata, Eclipta alba and Phyllanthus niruri (Chitravadivu et al., 2009).

The phytochemical constituents of six Malaysian medicinal plants belonging to different families were examined and conducted comparative study between them by Krishnaiah et al. (2009). Ravirajisingh et al. (2009) took methanol extract from Clerodendron glandulosum to study its qualitative and quantitative phytochemical
constituents. Krishna et al. (2009) conducted preliminary phytochemicals, total phenolics and flavonoids content analysis in the methanol extract of Justicia gendarussa. The aerial parts of Hypericum perforatum were experimented to acquire knowledge about their composition of bioactive compounds (Gioti et al., 2009). Quantitative estimation of phytochemical constituents from wood of Caesalpinia pulcherrima was carried out using Camag HPTLC system (Pawar et al., 2009).

Abdul-kabir khan et al. (2009) selected eight plant species belonging to 7 families for the screening of alkaloids, saponins, tannins and total phenolics contents from their matured and immaturity plant leaves and stems. Aurapa and Wandee (2009) estimated total anthraquinone glycosides from the boiled filtrates of Senna siamea young leaves. Bhise and Salunkhe (2009) used TLC and HPTLC techniques to screen phytochemical components from Ashwagandha, Tulsi, Mulethi, Shatavari, Gokharu, Arjun, Giloy, Safed musli, Kalimirchi, Haldi and Jaiphal. Preeti et al. (2009) made qualitative and quantitative analyses of phytochemical components in Leidium sativum using HPTLC. Methanol extracts of Ocimum basilicum were analysed by TLC and HPTLC techniques to get fingerprint information by Maria et al. (2009). Sirohi et al. (2009) evaluated total sugar, protein, tannin and saponin contents of aqueous, methanol and acetone extracts of twenty one different herbal plants and their parts.

Tannins, saponins, phlobatannins, flavonoids, anthraquinones, terpenoids, steroids, alkaloids, carbohydrates and glycosides distribution in four medicinal plants belonging to different families were investigated and compared (Victor Njoku and Chidi, 2009). Sazada et al. (2009) analysed preliminary phytochemicals in some of the important medicinal and aromatic plants. The leaves and fruits of Pedalium murex were experimented to evaluate the phytochemical components (Sermakkani and
Thangapandian, 2010). Preliminary phytochemical screening of petroleum ether and alcohol extracts of *Symplocos racemosa* was carried out by Davmurari (2010).

The phytochemicals, minerals and vitamins A and C compositions of *Spondias mombin* leaves were determined by Igwe *et al.* (2010). Phytochemicals were identified in the leaf extract of *Andrographis stenophylla* using TLC and its hypoglycemic activity was also recorded by Parasuraman *et al.* (2010). Ayo (2010) evaluated the phytochemical constituents and bioactivities of the extracts of *Cassia nigricans*. The preliminary phytochemical screening was made in *Pergularia daemia*. Separation and identification of compounds were done from the crude extract of leaves using TLC, HPLC and HPTLC by Karthishwaran *et al.* (2010). HPTLC fingerprint was drawn for the phytochemicals derived from the methanol leaf extract of *Acacia nilotica* by Venkataswamy *et al.* (2010).

Sivaraj *et al.* (2011) analyzed phytochemical constituents in *Hibiscus sabdariffa* and various analyses were carried out in *Aegle marmelos, Ruta graveolens, Opuntia dilleni, Euphorbia royleana* and *Euphorbia antiquorum* that were extracted using five different solvents. Momoh *et al.* (2011) screened methanol leaf extract of *Costus* for its phytochemical composition. Phytochemical and pharmacognistic analyses were carried out in *Dolichandrone arcuata* by Bojaca and Henry Joseph (2011). Standardization of phytochemical analysis was done in *Zizyphus nummularia* leaves by Raghavendra *et al.* (2011). Hassain *et al.* (2011) screened phytochemical constituents from methanol leaf extract of *Bombax malabaricum*. Various organic solvent extracts of *Pedalium murex* were subjected to preliminary phytochemical screenings (Thamizh mozhi *et al.*, 2011). Vaghasiya *et al.* (2011) selected 53 traditionally used medicinal plants from western region of India for their qualitative phytochemical screenings, total phenols and flavonoids contents. Pascaline *et al.*
(2011) screened phytochemical constituents of some medicinal plants used by the Nandis of South Nandi District, Kenya.

Vladimir-Knezevic et al. (2011) selected three *Micromeria* species to estimate flavonoids, phenolic acids and tannins from their extracts by thin layer chromatography (TLC). Joshi et al. (2011) examined entire plant extract of *Cyathocline lyrata* for phytochemical constituents by TLC and High Performance Liquid Chromatography. Alam et al. (2011) standardized high performance thin layer chromatographic densitometric method for the analysis of swertiamarin in 60% methanol extract of *Enicostemma littorale*.

Mamtha (2011) estimated quantitative HPTLC analysis of andrographolice in *Andrographis paniculata* obtained from different geographical sources (India). Optimization and development of a sensitive HPTLC method for estimation of wedelolactone in different extracts of *Eclipta alba* was established by Savitha and Prakashchandra (2011). Yamunadevi et al. (2011) investigated alkaloid profile of *Aerva lanata* using HPTLC. Abirami and Murugan (2011) standardized HPTLC quantification of flavonoids in *Cassia occidentalis* and its larvicidal and smoke repellent activities were tested against malarial vector, *Anopheles stephensi*. Thenmozhi et al. (2011) reported that some phytochemicals were present in methanol extract of *Eclipta alba* and *Emilia sonchifolia* and these phytochemicals were identified using HPTLC and FTIR.

Wang et al. (2003) took active principles from selected Chinese herbs and used Gas Chromatography - Mass Spectrometric analysis for structure elucidation. Theeshan et al. (2005) studied the phytochemical constituents of *Cassia fistula*. Two new homoisoflavonoids were isolated from the whole plant of *Caesalpinia*.
pulcherrima (Maheswara et al., 2006). Rahaman et al. (2006) reported the flavones 3,5,7,4- tetrahydroxy flavones isolated from Cassia alata leaves. Teffo et al. (2009) delivered dichloromethane and acetone fractions from leaves of Dodonaea viscosa var. angustifolia to isolate four keampferol.

The isolation and identification of two products from Chrysanthemum myconis were determined by Nadiet et al. (2009). GC-MS analysis of Mentha arvensis was compared by Sharma et al. (2009). The water distilled essential oils extracted from leaves, stems and roots of Chrysanthemum parthenium were analyzed by GC and GC-MS methods (Shafaghat et al., 2009). Senthil kumar and Venkatesalu (2009) reported phytochemical contents from the essential oil extract from the leaf of Clausena anisata by GC-MS. Ayo et al. (2009) examined methanol extract of Cassia nigricans leaves and further purification and identification were done by GC-MS spectrometric analysis. Parasuraman et al. (2009) identified number of constituents present in Cleistanthus collinus leaves and they were quantified by GC-MS method.

The essential oils from the leaves of Cupressus lusitanica were obtained by hydrodistillation method and their contents were analyzed by GC-MS (Hassanzadeh et al., 2010). Khaled et al. (2010) isolated and identified twelve fatty acids in which linolinic acid and palmitic acid were the main acids and that chemical constituents were derived from the aerial parts of Beaumontia grandiflora. Sarumathy et al. (2011) reported antiinflammatory activity and nature of compounds present in Caesalpinia sappan by GC-MS. Rani et al. (2011) identified possible chemical components present in Lantana camara leaves by GC-MS method. Similar work and same method were carried out by Sriram et al. (2011) in the methanol extract of Mimosa pudica.
Nezhadali and Baghan (2011) followed solid-phase micro-extraction (HS-SPME) method and gas chromatography - mass spectrometry for the analysis of volatile compounds present in the leaves of *Malabila isfahanica*. Sharafzadeh *et al.* (2011) isolated essential oils by GC and GC-MS methods from the leaf and stem of lemon balm (*Melissa officinalis*). Hema *et al.* (2011) evaluated the bioactive components of *Murraya koenigii* leaves using GC-MS. Laisonjam *et al.* (2011) isolated and compared the chemical constituents taken from *Cissus adnata* leaves and *Smilax lanceaefolia* roots and their free radical scavenging activities were also tested. Sasidharan *et al.* (2011) reported extraction, isolation and characterization of bioactive compounds. Isolation and identification of bioactive compounds from *Andrographis paniculata* was revealed by Chao and Lin (2011). Surendra and Talele (2011) reported isolation and characterization of phytoconstituents from *Tridax procumbens*.

**Antioxidant activity**

Total antioxidant activity in 23 Iranian basil accessions was estimated as Trolox equivalent antioxidant capacity and total phenolics contents (Jevanmardi *et al.*, 2003). Total antioxidant activities of several popular vegetables and traditional Chinese herbals were evaluated (Chen *et al.*, 2004) in an ABTS, $H_2O_2$ and HRP system. Three local Mediterranean plant originated foods (i.e., *Cichorium intybus*, *Sonchus oleraceus* and *Papaver rhoeas*) were collected and made an in vitro survey for their antioxidant potentials (Schaffer *et al.*, 2005). Pourmorad *et al.* (2006) carried out the relative antioxidant activity in selected Iranian medicinal plant species extracts. The antioxidant properties of 25 edible tropical plants were studied using Trolox equivalent antioxidant capacity, DPPH scavenging, reducing power and total polyphenol contents by Wong *et al.* (2006). Thirteen medicinal plants from Western
Ghats of India were analyzed for their *in vitro* antioxidant activity using different models (Badami and Channabasavaraj, 2007). Suresh kumar *et al.* (2008) surveyed antioxidant activities of selected medicinal plants namely *Albizia amara, Achyranthes aspera, Cassia fistula, C. auriculata* and *Datura stramonium*.


The antioxidant activity, total phenol and flavonoid contents of water, ethanol and methanol extracts of *Hieracium pilosella* were reported by Ljiljana *et al.* (2009). Antioxidant activity and total phenolics contents of some species (*Mentha piperita, Origanum vulgare* and *Capsicum annum*) were determined by Univer *et al.* (2009). 123 extracts were prepared (by direct methanol and sequential petroleum ether, dichloromethane, ethyl acetate and methanol) from 59 plant samples and from 32 plant species to measure their ability of scavenging of radicals (Rajendra and Shakti, 2009). Bushra *et al.* (2009) derived extracts from the leaves of *Terminalia arjuna* and *Aloe barbadensis* using four solvents by adopting two extraction techniques (shaking and reflu) to observe their antioxidant activity. *In vitro* antioxidant activity (DPPH

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and reducing power assay) of methanol leaf and flower extracts of *Lippia alba* was determined by Naznin and Hasan (2009). *Aegle marmelos, Abroma augusta, Lagersroemia speciosa, Cassia fistula, Anthocephalus chinensis* and *Syzygium cumini* leaves were collected to prepare methanol extracts to evaluate their antioxidant potentiality (Laizuman et al., 2009).

Methanol and aqueous extracts of *Martynia annua* leaves were evaluated by Nagda et al. (2009) for its antioxidant ability using *in vitro* systems namely reducing power assay, DPPH radical scavenging activity, nitric oxide scavenging activity, H$_2$O$_2$ radical scavenging activity, superoxide radical scavenging assay, hydroxyl radical scavenging activity, total antioxidant capacity and analyzed total phenolics content. Antioxidant activity potential was evaluated by Jaleel (2009) in leaves and roots of *Withania somnifera*. The antioxidant potential of four varieties of eggplant, *Solanum melongena* was evaluated in terms of total phenolics content, DPPH, total reducing power, superoxide radical scavenging activity, metal chelating activity and total anthocyanin content by Nisha et al. (2009).

Laetitia and Christian (2009) studied antioxidant activity and phenol contents of *Crithum maritinum*. Two parts of three medicinal plants (leaves of *Tilia argentea* and *Crataegi folium* and roots of *Polygonum bistorta*) were screened by Demiray et al. (2009) for their phenolics profiles and antioxidant properties. Amal Kumar et al. (2009) estimated the antioxidant activity, total phenols and total flavonoids contents of leaf and bark of *Azadirachta indica*. The methanol extract of *Portulaca oleracea* was evaluated for its antioxidant activity by DPPH free radical scavenging activity, reducing power by FeCl$_3$, nitricoxide free radical scavenging activity and superoxide scavenging activity (Sanja et al., 2009). Devi et al. (2009) conducted two antioxidant activity experiments in *Nephellium lappaceum* under *in vitro* condition. Aliyu et al.
(2009) evaluated antioxidant potential by DPPH and reducing power assays on the methanolic extract of Bauhinia rufescens leaves.

The hexane and ethyl acetate extracts of Stephania dinklagei showed the most pronounced DPPH scavenging activity (Udegbunam et al., 2012). Similar studies showed that extracts of Stephania rotunda and Stephania hernandifolia strongly scavenged DPPH radicals (Gulchin et al., 2010; Sharma et al., 2010a). Patel et al. (2010) studied the total phenols, flavonoids and free radical scavenging activity of certain medicinal plants in Gujarat region. Different dried herbal parts of Cassia sophera were estimated by Dheeraj et al. (2010) to assess their effects on antioxidant, antiinflammatory and analgesic activities. The antioxidant activity of aqueous and methanol extracts was tested in Erythrina indica leaves by DPPH, nitricoxide radical scavenging activity and inhibition of lipid peroxidation by thiobarbituric acid reactive substance under in vitro condition and quantitative analysis of total phenolics, flavonoids were also estimated by Saket and Juvekar (2010). Shajiselvin and Kottai Muthu (2010) examined in vitro free radical scavenging potential (DPPH radical scavenging activity, Superoxide anion scavenging activity and Iron chelating activity) of various extracts of whole plant of Borreria hispida. In vitro antioxidant activity in leaves and stem of Aristolochia indica was evaluated by Gayathri Devi et al. (2010).

Ayesha et al. (2010) assessed antioxidant ability of the methanol extract of Muntingia calabura leaves. Paula et al. (2010) assayed antioxidant properties of Jacaranda puberula leaf extract. Aqueous and methanol extracts (Anethum sowia) of soap mix were prepared and their phenolics content, reducing power ability and free radical scavenging activity were determined by Rekha et al. (2010). Asaolu et al. (2010) evaluated antioxidant levels in aqueous and methanol extracts of dry leaves of Vernonia amygdalina, Carica papaya, Persea americana and Cnidoscolous
aconitifolius. Pavithra et al. (2010) estimated antioxidant activity of Evolvulus nummularius methanol extract. Praveenkumar et al. (2010) screened leaf extract of Vitex negundo to identify their phytochemicals, total phenols, total flavonoids and antioxidant activity. Arash et al. (2010) investigated antioxidant capacity and total phenolic compounds in ethanol extracts of leaves, stem and fruits of Andrographis paniculata. The crude methanol extracts of four Philippine medicinal plants, Brucea amarissima, Intsia bijuga, Laportea meyeniana and Pipturus arborescens were examined by Peteros and Uy (2010) for their antioxidant and cytotoxicity activities. The antioxidant capacity and total phenolic contents present in the acetone and methanol extracts of leaves, stem, fruits and roots of Melothria madraspatana were evaluated by Sowndharajan et al. (2010).

Antioxidant potentials of different parts of Coleus forskohlii including root, stem, leaves and tubers were analysed by Selima et al. (2011). Mishra et al. (2011) screened ten Indian medicinal plant species extracts for their antioxidant activities. Antioxidant potentials of methanol leaf extracts of Caesalpinia coriaria, Flacourtia cataphracta, Hiptage benghalensis, Sesbania sesban, Persea macrophylla and tubers of Gloriosa superba were described by Amudha and Shanthi (2011). Sathisha et al. (2011) determined antioxidant potentials of some herbal plants (Curcuma longa, Coffea arabica, Tribulus terrestris, Bacopa monnieri and Trigonella foenum-graceum) using various in vitro assays. Naveen Prasad et al. (2011) screened antioxidant potential of some common plants. Stankovic et al. (2011) derived twenty extracts from Teucrium montanum and its parts (leaves, flowers and stem) to determine total phenolic and flavonoid contents and in vitro antioxidant activity.

Nithya and Balakrishnan (2009) screened 13 important medicinal plants for their antioxidant properties. Methanol extracts of Carica papaya, Fagara
*Zanthoxyloides, Cajanus cajan* and *Parquetina nigrescens* were evaluated for their antioxidant activities (Imaga et al., 2010). Sengul et al. (2011) analyzed three native Turkish medicinal and aromatic plants (*Artemisia absinthum, Artemisia santonicum* and *Saponaria officinalis*) for their antioxidant activities, total phenolic content and antimicrobial activities. Antioxidant potential of extracts of *Gynura procumbens, Achyranthes aspera* and *Polygonum tomentosum* were reported by Mon et al. (2011). The chloroform and methanol leaf extracts of 124 Egyptian plant species belonging to 56 families were investigated and compared for their antioxidant activity by DPPH scavenging assay (Moussa et al., 2011). Gokhan et al. (2011) examined in vitro antioxidant activities and fatty acid composition of *Centaurea urvillei*.

**Anticancer activity**

Cancer is the second major cause of deaths after cardiovascular diseases. It is a disease characterized by unregulated proliferation of cells. The search for natural products as potential anticancer agents dates back, at least, to the Ebers papyrus in 1550 BC, but the scientific period of this search is much more recent, beginning with the investigations by Hartwell and co-workers in late 1960s on the application of Podophyllotoxin and its derivatives as anticancer agents. A large number of plants, marine and microbial sources have been tested as leads, and many compounds have survived the potential leads.

Plants have been a long history of use in the treatment of cancer. Hartwell, in his review plants against cancer, listed more than 3000 plant species that have been repeatedly used in the treatment of cancer. The search for anticancer agents from the plant source started in earnest in the 1950s with the discovery and development of *Vinca* alkaloids, Vincristine and Vinblastine and isolation of the cytotoxic
podophyllotoxins. These discoveries promoted the United States National Cancer Institute (NCI) to initiate an extensive plant collection program in 1960. This lead to the discovery of many novel chemotypes showing a range of cytotoxic activities, including the taxanes and camptothecins. The first clinically used anticancer drug was isolated from *Catharanthus roseus* of Apocynaceae i.e., Vincristine and Vinblastine.

Some medicinal plants have been found effective in various types of malignant (cancer) and benign tumours of humans and experimental animals. These include: *Agrimonia pilosa* in sarcoma-180; *Adilanthus altissima* in intestinal cancer, sarcoma-180, sarcoma-37 and leukaemia-16; *Akebia quinata* in sarcoma-180 and sarcoma-37; *Chelidonium jajus* var. *asiaticum* in stomach cancer; *Chimaphila umbellata* in breast tumour; *Coix lachrymahjobi* in ascites cancer and Yoshida’s sarcoma; *Fritillaria thunbergii* in tumours of the throat, chest, neck and breast; *Larrea tridentata* in various cancers, especially leukaemia; *Lonicera japonica* in ascites carcinoma and sarcoma-180; *Nidus vespae* in gastric and liver cancer; *Oldenlandia diffusa* in leukaemia, Yoshida’s sarcoma, sarcoma-180 and Ehrlich’s ascites sarcoma; *Patrinia heterophylla* and *P. scabiosaefolia* in ascites cancer; *Phaleria macrocarpa* in oesophageal cancer; *Polygonum cuspidatum* in sarcoma-180; *Pteris multifida* in sarcoma-180, sarcoma-37 and Yoshida’s sarcoma; *Pygeum africanum* in prostate cancer; *Pyrus malus* in lung, colon, breast and intestinal cancer; *Scutellaria barbata* in sarcoma-180 and Ehrlich’s ascites carcinoma; *Smilax chinensis* and *S. glabra* in sarcoma-180 and ascites sarcoma; *Solanum lyrati* in sarcoma-180, sarcoma-37, Ehrlich’s ascites carcinoma and stomach cancer; *Sophora flavescens* and *S. subprostrata* in sarcoma-180, leukaemia and cervical cancer-14 cells; *Taraxacum mongolicum* in ascites cancer, sarcoma-180 and lung cancer cells and *Vitex rotundifolia* in lung tumour (Hsu, 1990; Hecht et al., 1990; Pan, 1992; Chang, 1992;
Boik, 1995; Han and Xu, 1998; Eberhsrdt et al., 2000; Prajapati et al., 2003; Faried et al., 2007).

Taxol is a diterpenoid compound isolated from *Taxus brevifolia* and these molecules called taxanes by the US Department of Agriculture (USDA) for the National Cancer Institute (NCI). Various parts of *T. brevifolia* and other *Taxus* species, *T. canadiensis, T. baccata* are used for the treatment of some non-cancerous conditions. The leaves of *T. baccata* are used in traditional Asiatic Indian Ayurvedic medicine system, with one reported in the treatment of cancer. Palitaxel, occurs in the leaves of various *Taxus* species has provided a major renewable natural sources of natural drugs. It is used in the treatment of breast, ovarian and non-small-cell lung cancer and has shown efficacy against *Kaposi sarcoma* (Cragg and Newman, 2006).

Another important addition to the anticancer drug armamentarium is the class of clinically-active agents derived from camptothecin, which is isolated from the Chinese ornamental tree *Camptotheca acuminata* Deche (Nyssaceae), known in China as the tree of joy. The derivatives of Camptothecine, Topotecin and Irinotecin, originally developed by Japanese company, YAKUH Honsha, are now in clinical use. These are used for the treatment of ovarian, lung and colorectal cancers. Several genera of the Apocynaceae family including *Bleekeria vitensis* have reputed anticancer properties (Cragg and Newman, 2006).

The two clinically active agents, etoposide and teniposide, which are semi synthetic derivatives of the natural product, epipodophyllotaxin (an isomer of podophyllotaxin), may be considered as being more closely linked to a plant, *Podophyllum* species used for the treatment of cancer. *Podophyllum peltatum* L. (American *Podophyllum*) and *P. emodii* from India (Indian *Podophyllum*) have a long
history of medicinal use, including the treatment of skin cancer and warts. The major active constituent of this plant is podophyllotoxin. With the identification of an increasing number of molecule targets associated with particular cancer, anticancer drug discovery is now based on high throughput screening of compounds against a range of such target (Cragg and Newman, 2006).

The ethanol, petroleum ether and dichloromethane extracts of *Thelesperma megapotamicum*, *Oxalis erythrorhiza* and *Larrea divaricata* showed high inhibitory activity on MCF-7 (cell line from human breast cancer) cell line proliferation (Bongiovanni et al., 2006). Pradhan et al. (2008) studied the methanolic extracts of *Foeniculum vulgare* and *Helicteres isora* against normal human blood lymphocytes by micronucleus assay and antitumour activity against B16F10 melanoma cell line by trypan blue exclusion assay for cell viability. 70% methanolic extract of *Foeniculum vulgare* displayed good antitumour activity and 50% methanolic extract of *Helicteres isora* displayed good antitumour activity. They stated that *Foeniculum vulgare* and *Helicteres isora* could be considered as a normal resource of antitumour agents. The anticancer activity of hydro distilled essential oils obtained from flowers of *Matricaria chamomilla* and the dried leaves of *Marjorana hortensis* against leukaemia HL-60 and NB 4 cells were tested *in vitro*. The essential oils of above said plants could be used as a potential natural antioxidant and anticancer agents (Romeilah, 2009).

Forty four extracts from sixteen plants used traditionally as anticancer agents were evaluated *in vitro* for their antiproliferative activity against Hep-2, MCF-7 and Vero cell lines. Twenty of these extracts demonstrated significant antiproliferative activity against one or more of the cell lines. Among the tested extracts, methanol
fractions of *Ononis hirta* (aerial parts) and *Irula viscosa* (flowers) were the most active fractions against MCF-7 cells (Talib and Mahasneh, 2010).

**Antidiabetic activity**

Diabetic mellitus is a clinical syndrome characterized by inappropriate hyperglycemia caused by a relative or absolute deficiency of insulin or by a resistance to the action of insulin at the cellular level. It is the most common endocrine disorder, affecting 16 million individuals in the United States and as many as 200 million worldwide.

Diabetic mellitus (DM) is the condition arising due to abnormal metabolism of carbohydrate, proteins and fats. It is caused by insulin deficiency, often combined with insulin resistance. This disorder occurs worldwide and its occurrence is increasing quickly in most of the countries. Various complications develop as a consequence of the metabolic derangement in diabetes 2. The treatment of DM is based on parental insulin and oral antidiabetic drugs. Oral hypoglycemic agents currently used have serious side effects, hence, there is a need to search newer antidiabetic agents that having high therapeutic efficacy with minimum side effects. This may be fulfilled by treating DM with traditional medicine using antidiabetic agents from medicinal plants (Rajkumar *et al*., 2011).

Diabetes is a disorder of metabolism, the way our bodies use digested food for growth and energy. Most of the food we eat is broken down into glucose, the form of sugar in the blood. Glucose is the main source of fuel for the body. After digestion, glucose passes into the bloodstream, where it is used by the cells for growth and energy. For glucose to get into cells, insulin must be present. Insulin is a hormone produced by the pancreas, a large gland behind the stomach. When we eat, the
pancreas automatically produces the right amount of insulin to move glucose from blood into our cells. In people with diabetes, however, the pancreas either produces little or no insulin, or the cells do not respond appropriately to the insulin that is produced. Glucose builds up in the blood, overflows into the urine and passes out of the body in the urine. Thus, the body loses its main source of fuel even though the blood contains large amount of glucose.

Numerous animal studies have shown that ethanolic extracts of leaves and flowers of *Catharanthus* lower blood glucose levels (Ghosh and Gupta, 1980). Several plant species have been described as hypoglycemic. These include *Opuntia streptacantha*, *Trigonella foenum-graceum*, *Momordica charantia*, *Ficus benghalensis*, *Polygala senega*, *Gymnema sylvestre*, *Allium sativum*, *Citrullus colocynthis*, myrrh, black seeds, helteet, fenugreek, *Aloe* and *Artemisia* (Atta-Ur-Rahman and Zaman, 1989; Ziiyyat *et al*., 1997; Bnouham *et al*., 2002).

Oral administration of the extract of *Astracantha longifolia* can significantly improve glucose tolerance in healthy human subjects and diabetic patients (Fernando *et al*., 1991). *Achyranthes aspera* L. extract produced a significant dose-related hypoglycemic effect in normoglycemic and alloxan induced diabetic rabbits. In these animals, water and methanol extracts also decreased blood sugar levels. The plant may act by providing certain necessary elements like calcium, zinc, magnesium, manganese and copper to the beta-cells (Akhtar and Iqbal, 1991). S-allyl cysteine sulphoxide (SACS), a sulphur-containing amino acid of *Allium sativum* L. (garlic) that is the precursor of allicin and garlic oil, has been found to show significant antidiabetic effects in alloxan diabetic rats. Administration of a dose of 200 mg/kg significantly decreased the concentration of serum lipids, blood glucose and activities of serum enzymes like alkaline phosphatase, acid phosphatase and lactate
dehydrogenase and liver glucose 6 phosphatase. It significantly increased liver and intestinal HMG CoA reductase activity and liver hexokinase activity (Sheela and Augusti, 1992).

*Azadirachta indica* leaf extract was found to have the most potent blood sugar lowering property followed by *Catharanthus roseus, Gymnema sylvestre* and *Ocimum sanctum* (Chattapadhyay, 1993). Several medicinal plants have been used as dietary adjunct and in the treatment of numerous diseases without proper knowledge of their function. Although phytotherapy continues to be used in several countries, few plants have received scientific or medical scrutiny. Moreover, a large number of medicinal plants possess some degree of toxicity. For example, it was reported that about one third of medicinal plants used in the treatment of diabetes are considered to be toxic (Marles and Fransworth, 1994). Saponin isolated from the leaves of *Acanthopanax senticosus* injected to mice decreased experimental hyperglycemia induced by injection of adrenalin, glucose and alloxan, without affecting the levels of blood sugar in untreated mice (Sui et al., 1994). The leaf extract of *Aegle marmelos* was found to be as effective as insulin in the restoration of blood glucose and body weight to normal levels. *A. marmelos* can be used as potential hypoglycemic agent (Benjamin et al., 1994).

The antihyperglycemic effect of *Cuminum cyminum* L. was studied in healthy rabbits subjected to weekly subcutaneous glucose tolerance tests after gastric administration of water, tolbutamide or a traditional preparation of the plant. The results showed that the *C. cyminum* significantly decreased the area under glucose tolerance curve and the hyperglycemic peak (Roman-Ramos et al., 1995). A methanol extract of *Nelumbo nucifera* Gaertn. (East Indian Lotus) extract caused a decrease in
glycemia in streptozotocin-induced diabetic rats by 53% and 55% respectively at the end of 12 hrs. (Mukherjee et al., 1995).

Once daily administration of the juice of *Lantana camara* L. leaves given at different dose levels for 14 days in rats resulted in alterations in various haematological and biochemical parameters. A strong hypoglycemic effect was seen with 1500 mg only (Garg et al., 1997). Administration of extracts obtained from *Beta vulgaris* var. *cicla* L. leaf (sugar beet) inhibited the increase in the nonenzymatic glycosylation of skin proteins and blood glucose. These results demonstrated the ability of this plant in preventing or at least retarding the development of some diabetic complications (Tunali et al., 1998).

Stimulation of insulin release via modulation of intracellular Ca$^{2+}$ concentration in pancreatic beta-cells was observed in *Tinospora crispa* (Noor and Asherof, 1998). *Sida cordifolia* extracts of the aerial and root parts showed hypoglycemic activity. Moreover, the methanol extract of root was found to possess significant hypoglycemic activity. *Azadirachta indica* leaf extract significantly blocked the inhibitory effect of serotonin on insulin secretion mediated by glucose (Chattapadhyay, 1999). Oral administration of an aqueous extract of *Tinospora cordifolia* roots produced a significant decrease in glycemia and brain lipids in alloxan-induced diabetic rats (Stanley et al., 1999).

Oral administration of ethanolic extract of *Cinnamomum zeylanicum* leaves in the doses of 100, 150 and 200 mg/kg body weight to white Wistar albino rats significantly reduced their blood sugar level in allxan induced diabetic rats under acute and sub acute studies (Tailang et al., 2008). *Gymnema sylvestre* has significant antidiabetic activity and a hypolipidemric activity in alloxan induced and normal
fasting rats (Mall et al., 2009). Ethanolic extract of *Euphorbia hirta* possess significant antihyperglycemic activity in streptozotocin induced diabetic mice (Kumar et al., 2010). *Hibiscus cannabinus* leaf extract has significant antidiabetic activity, which lowered the fasting blood glucose level in Streptozotocin induced diabetic rats (Rajkumar et al., 2011).

**Hepatoprotective activity**

Liver diseases are one of the most severe ailments. They are mainly caused by toxic chemicals, excess consumption of alcohol, infections and autoimmune disorders. Most of the hepatotoxic chemicals damage liver cells mainly by inducing lipid peroxidation and other oxidative damage in the liver. They may be classified as acute or chronic hepatitis (inflammatory liver diseases), hepatosis (non-inflammatory diseases) and cirrhosis (degenerative disorder resulting in fibrosis of the liver).

In order to develop satisfactory herbal combination to treat liver diseases, plants have antioxidant, stimulation of liver regeneration and cholorectic properties (Subramaniam and Pushpangadan, 1999). Ayurvedic and other traditional medical practitioners of the world have claimed for centuries that, extracts from plants can be effectively used for the alleviation of different types of liver diseases (Subramaniam and Pushpangadan, 1999).

Plant drugs are known to play a vital role in the management of liver diseases. About 80% of the world’s population relies on the use of traditional medicines which are predominantly based on plant materials (Satagopan, 2000). Numerous plants and polyherbal formulations are reported to possess hepatoprotective activities (Malhotra et al., 2001).
Most of the claims, however, are anecdotal and very few have received adequate medical or scientific evaluation. Except for the use of appropriate vaccine for the treatment of hepatitis caused by viral infection, very few effective treatments are available today to cure liver diseases. It is not surprising, therefore, that considerable interest has been taken by researchers to examine numerous traditional plant remedies, used for treating liver disorders. In recent years, investigations have been carried out to provide experimental evidence confirming that many of these plants do have hepatoprotective properties (Sharma et al., 2003).

Inspite of tremendous advances made in allopathic medicine, management of liver diseases is still a challenge to modern medicine. The modern medicine offers little for the alleviation of hepatic ailments, whereas the most important representatives are the phytoconstituents (Chandrasekhar et al., 2004). Mondal et al. (2005) reported that methanol extract of Diospyros malabarica bark has potent hepatoprotective activity against carbon tetrachloride induced liver damage in rats. Dash et al. (2007) reported that chloroform and methanol extracts of entire plant of Ichnocarpus frutescens are effective hepatoprotective agents by paracetamol induced liver damage in rats.

Iniaghe et al. (2008) reported that the aqueous extract of leaves of Acalypha racemosa has effective hepatoprotective activity against CCl4 induced liver damage. Aqueous extract from seeds of Areca catechu and nutgalls of Quercus infectoria were investigated for their hepatoprotective potential against liver injury induced by carbon tetrachloride (CCl4) in rats (Pithayanukul et al., 2009). The hepatoprotective activity of ethanolic and aqueous extracts of Amorphophallus campanulatus tubers were evaluated against carbon tetrachloride induced hepatic damage in rats. The ethanolic extract was found hepatoprotective more than the aqueous extract (Jain et al., 2009).
The volatile oil, ethyl acetate, n-butanol and total alcoholic extracts of *Juncus subulatus* were evaluated for their hepatoprotective and antioxidant activity in female rats against ethanol-induced hepatic injury. The results showed that all extracts of *Juncus subulatus* exhibited hepatoprotective activity (Abdul-Razik *et al*., 2009). Tiwari and Khosa (2009) evaluated the hepatoprotective and antioxidant effects of aqueous and methanolic extracts of flower heads of *Sphaeranthus indicus* on acetaminophen induced hepatotoxicity in rats *in vivo*. Shyamal *et al*. (2010) reported that ethanol extracts of roots of *Ixora coccinea*, *Rhinacanthus nasutus* and whole plant of *Spilanthes ciliata* have potent hepatoprotective activity against aflatoxin B1 intoxicated livers of albino male Wistar rats. The flower heads of *Sphaeranthus indicus*, a traditional Indian medicinal plant is commonly used to nourish and improve the liver conditions. Hepatoprotective activity of hydro alcoholic extract of *Luffa acutangula* against carbon tetrachloride and rifampicin-induced hepatotoxicity in rats was evaluated and probable mechanism of action has been suggested (Jadhav *et al*., 2010).

**Fertility studies**

**Antifertility activity**

The options available to men for fertility control are much more limited compared to those for women. The male reproductive system, particularly the process of spermatogenesis, sperm maturation and transport and also the sperm-egg interaction are so complex that it has not so far been possible to find an effective intervention that can be converted into a product. Continued efforts over the past three decades to develop additional methods of male contraception have made some significant contribution in the field. However, there is still no method available in the field of male contraception that satisfies the essential criteria of safety, efficacy,
economy and complete reversibility. Inspite of considerable development in contraceptive technology, search for male antifertility agents in plants continues to be a potential area of investigation.

Recently, efforts are being made to explore the hidden wealth of medicinal plants for contraceptive use. With the exciting prospects of gene therapy, herbal medicine remains one of the common forms of therapy available to much of world’s population, to maintain health and to treat diseases.

There has been a steady accumulation of information regarding the screening of plants having antifertility efficacy (Hanshaw, 1953; Chopra et al., 1956, 1958; Casey, 1960; Bhakuni et al., 1969; Farnsworth et al., 1975a, b). The folklore information and the ancient literature about the plants and herbs can help the antifertility program. In the recent past, a number of plants have been identified and evaluation of extracts and active principles from different parts of plants like seeds, roots, leaves, flowers, stem or stem barks have been done by various researchers. These reports have been exhaustively reviewed (Orzechowski, 1972; Brondegaard, 1973; Kholkute et al., 1976; Kamboj and Dhawan, 1982; Zhu, 1982; Satyavati, 1983). A literature survey for the period of 25 years (1980-2005) revealed that there are about 105 plants which possess antifertility activity in males (Gupta and Sharma, 2006).

Antifertility effect of ethanolic leaf extracts of *Alstonia scholaris*, *Cleistanthus collinus* and *Terminalia bellerica* and root extract of *Murraya paniculata* were observed in male albino rats (Choudhary et al., 1991). Gossypol, a yellow phenolic compound isolated from cotton seed oil was proposed as a male contraceptive drug. Hadley et al. (1981) found that gossypol treatment reduced the level of serum
testosterone and luteinizing hormone levels in a dose and duration dependent manner. Gossypol acts directly on testes and induces azoospermia or oligospermia (Xue, 1980, 1985; Taitzoglou et al., 1999). A multiglycoside extracted from the root xylem of *Tripterygium wilfordii* was shown to have a reversible antifertility action in male rats in a Task-Force supported study (Qian, 1987). Its antifertility activity is well documented in rats, mice and humans (Qian, 1986; Qian et al., 1995).

Administration of chloroform extract of *Carica papaya* seeds showed suppression of cauda epididymal sperm motility and counts in rats and suggested that contraceptive effects are mainly post testicular in nature without influencing toxicological profile and lipids of animals (Lohiya and Goyal, 1992). Verma and Chinoy (2001) reported that *Carica papaya* seed extract alters cauda epididymal micro environment. Manivannan et al. (2004) observed ultrastructural changes in the testis and epididymis of rats following treatment with the benzene chromatographic fraction of the chloroform extracts of *Carica papaya* seeds. Dehghan et al. (2006) reported that *Azadirachta indica* seed extract alters vas deferens and epididymal milieu and affects the spermatozoa. It is evident that extract has potential as an antifertility agent.

**Fertility enhancement**

It has been reported that several unani formulations containing Nutmeg and Clove were used as aphrodisiacs (Hubul Ibn, 1962). Ratnasooriya and Dharmasiri (2000) evaluated the aphrodisiac potential of *Terminalia catappa* seeds using a suspension of its kernel in 1% methyl cellulose in rats. 50% ethanolic extracts of Nutmeg and Clove were evaluated experimentally by Tajuddin et al. (2003) and compared with the standard drug Penegra (Sildenafil citrate). Yakubu et al. (2005)
analysed the phytochemical constituents and the aphrodisiac potential of the aqueous extract of *Fadogia agrestis* (Rubiaceae) stem in male albino rats.

The elephant creeper, *Argyreia nervosa* has promising potential to be developed into an effective medicine for stimulating male sexual activity with an influence on sex ratio favoring males (Subramoniam *et al*., 2007). Thakur and Dixit (2007) studied the aphrodisiac activity of *Dactylorhiza hatagirea* in male albino rats. Orally administered ethanol (300 mg/kg) and aqueous (300 mg/kg) extracts of *Hybanthus enneaspermus* were evaluated by Narayanswamy *et al*. (2007) for its aphrodisiac activity in sexually inactive male rats both in a single dose regimen and in a chronic regimen as a daily dose for 28 days. Petroleum ether extract of *Pedalium murex* was evaluated by Balamurugan *et al*. (2010) for its ability to increase aphrodisiac activity and to cure ethanol induced germ cell damage and infertility in male rat models.

The effect of *Crocus sativus* (saffron) was studied on male erectile dysfunction (ED) by Shamsa *et al*. (2009). Saffron showed a positive effect on sexual function with increased number and duration of erectile events seen in patients with ED even only after taking it for ten days. Gundidza *et al*. (2009) determined the effects of some Zimbabwean medicinal plants formulations composed of *Mondia whitei*, *Ekebergia capensis*, aloe tincture (*Aloe exelsa*) and pumpkin seed (*Cucurbita pepo*) on sexual behaviour of inexperienced male rats. The alkaloidal fraction isolated from aerial parts of *Turnera aphrodisiaca* was tested for aphrodisiac activity (Kumar *et al*., 2009). Sharma and Jacob (2001) showed that the aqueous extract of *Anacyclus pyrethrum* had a dose dependent influence on sperm count and seminal fructose concentration which increased significantly.
Antiinflammatory activity

The term “rheumatism” embraces a variety of disorders that have in common pain and stiffness referable to the musculoskeletal system. When such symptoms are due to abnormality of the joint itself, the condition can be classified as arthritis. Non articular rheumatism includes those conditions in which the symptoms are produced not by pathologic changes in the joints proper, but in the structures contiguous to, or related to the joints. Although arthritis occurs in a number of different forms, there are essentially two fundamental pathological processes that affect the joints viz., inflammation, which may be exudative or proliferative or a combination of each and degenerative changes, which are primarily dependent on the limited capacity of articular cartilage to repair itself (Loeb, 1971). The target should be to discover new drugs from plant kingdom which may provide therapeutic cure and would be free from undesirable effect as well as economical, which would be accepted by the developing nations like India (Huang, 1999).

In the sixties, formaldehyde induced arthritis and croton oil induced granuloma pouch in rats were mainly used as the experimental models of inflammation. Later, with the introduction of better and more specific models of experimental inflammation like carrageenan induced paw oedema in rats, cotton pellet induced granuloma in rats, Freud’s complete adjuvant induced arthritis etc., workers in different laboratories tested their drugs with the help of the later models. Scientists in Central drugs Research Institute, Lucknow have studied nearly two thousand Indian medicinal plants for their various pharmacological properties (Chatterjee and Pal, 1984; Shah et al., 2006). The greatest disadvantage in the presently available potent synthetic antiinflammatory drugs lies in their toxicity and reappearance of symptoms
after discontinuation. Therefore, the search for their antiinflammatory activity (AIA) is an unending problem (Shen, 1981; Chawla et al., 1987).

The oleoresin fraction of *Commiphora mukul* possesses significant antiarthritic and antiinflammatory activities. A steroidal compound isolated from *C. mukul* displayed a significant activity which is dose dependent and more potent than the resin fraction present in *C. mukul*. A comparison of the antiinflammatory activity of petroleum ether extractive of *C. mukul* with standard drugs showed the former to be effective as well. The ethyl acetate-soluble portion of the resin (guggalipid) on fractionation revealed that the acids display a significant antiinflammatory activity while the neutral portion carries partially all hypocholesterolemic activity. It was soon found that neutral fraction contained several ketones, which exhibited a high lipid lowering activity. Further work led to the isolation of these compounds and it was found that two steroids named Z- and E- guggalsterone are responsible for the activity of the resin. The former has shown in rats to have a thyroid-stimulating action, suggesting that this property may be contributing to antihyperlipidaemic activity of the oleoresin (Satyavati et al., 1969).

The triterpenoids of the oleanene and ursene series were found to be active against carrageenan induced oedema, formaldehyde induced oedema and formaldehyde-induced arthritis in rats. It has been suggested that the antiinflammatory activity of the triterpenoids of the oleanene series with the polarity of compounds is enhanced by the number of hydroxyl groups in the molecule (Bhargava et al., 1970). β-sitosterol isolated from *Cyperus rotundus* possessed potent antiinflammatory activity against carrageenan and cotton pellet-induced oedema in rats and was
comparable to hydrocortisone and oxyphenbutazone (Singh et al., 1970). The compound also possesses significant antipyretic activity (Gupta et al., 1971).

The petroleum ether extract of the rhizomes of *Curcuma longa* (turmeric) showed significant antiinflammatory activity (AIA) and was effective in delayed hypersensitivity. Curcumin, a constituent of turmeric, chemically known as diferuloyl methane has been shown to be effective (Srimal and Dhawan, 1973). The flavanoid glycoside, chrysoeriol 7-0-β-D glucopyranosyl-D-apiofuranoside isolated from *Dalbergia volubilis* exhibited AIA (Hye and Gafur, 1975). A glucosidic substance from leaves of *Dalbergia volubilis* (Papilionaceae) showed antiinflammatory and antiarthritic activities (Hye and Gafur, 1975).

*Cedrus deodora*, stem bark showed significant AIA in rat (Gopala et al., 1976). It is as potent as phenylbutazone in the carrageenan induced oedema test but half as potent in chronic tests. Mangiferin, a xanthone C-glucoside from *Canscora decussatta*, mangostin and related compounds from *Garcinia mangostana* (Shankaranarayan et al., 1979) was shown to have anti-inflammatory activity. Salai guggal, the oleogum of *Boswellia serrata*, has been shown to possess antiinflammatory and antiarthritic activities. It was shown to be effective in controlled clinical trials in arthritic patients. Its activity may be due to the boswellic acids present in the oleogum (Atal et al., 1980). Bergenin, isolated from the pods of *Peltophorum pterocarpum* was found to be an equipotent to phenylbutazone in rats against carrageenan induced oedema (Menon et al., 1982). Oleanolic acid 3-β-glucoside isolated from the seeds of *Randia dumetron* showed a significant AIA in the exudative and proliferative phases of inflammation in rats (Ghosh et al., 1983). Gangetin, one of the pterocarpens, isolated from hexane extract of root of *Desmodium*
*gangeticum* also produced a significant AIA in the exudative and proliferative phases of inflammation in rats (Ghosh and Kumar, 1983).

A flavonoid from *Hedychium spicatum* showed a significant activity with less ulcerogenic index than phenylbutazone (Srimal *et al*., 1984). In subacute inflammation models in rats, it is found to be a stabilizer of lysosomal membrane (more potent than Ibuprofen) and as an uncoupler of oxidative phosphorylation (Srivastava and Srimal, 1985). Radiological findings evidently supported the long term antiarthritic property of *Withania somnifera* (Solanaceae) (Hazeena Begum and Sadique, 1988). Handa *et al*. (1992) cited that species of 96 genera belonging to 56 families are ascribed for antiinflammatory activity. The dichloromethane extract of the aerial parts of *Tanacetum microphyllum* (Compositae) yielded two antiinflammatory flavonoids: 5,7,3’-trihydroxy-3,6,4’-trimethoxy flavones (centaureidin) and 5,3’-dihydroxy-4’-methoxy-7-carbomethoxyflavonol (Abad *et al*., 1993).

The triterpenes, alpha-amyrin acetate, beta-amyrin acetate and lupeol acetate of *Alstonia boonei* were evaluated for antiarthritic activities in rats (Kweifio-Okai and Carroll, 1992, 1993). Ammar *et al*. (1997) have revealed the antiinflammatory activity of bioactive fractions isolated from the seeds of *Trigonella foenum-graceum* L. roots of *Glycyrrhiza glabra* L. and fruits of *Coriandrum sativum*. The antiinflammatory activity of the aqueous extract of the stem bark of *Bridelia ferruginea* was evaluated using carrageenan induced paw oedema in rats and mice (Olajide *et al*., 1999). Three flavonoids isolated from *Inula viscosa* (Asteraceae) dichloromethane extract were 7-0-methylaromadendrin, rhamnocitrin and 3-0-acetylpadmatin along with a sesquiterpene lactone inuvisolide; a sesquiterpene acid, ilicic acid and a diagalactosidiacetylglycerol, inugalcolipid A and shown to have 12-0-tetradecanoylphorbol-13-acetate induced ear oedema inhibitory activity in mice (Manez *et al*., 1999).
The antiinflammatory activity of the aqueous extract of roots of *Rumex patientia* was evaluated using carrageenan, histamine, dextrane, serotonin and formaldehyde-induced oedema tests (Suleyman *et al*., 1999). The alcoholic extract of *Clerodendron serratum* roots was evaluated for its antiinflammatory activity in animal models (Narayanan *et al*., 1999).

The lyophilized aqueous extract of the fruits of *Opuntia dillenii* was demonstrated for analgesic and antiinflammatory properties in rats and mice (Loro *et al*., 1999). Aqueous and alcoholic extracts of pods and flowers of *Tecoma sambucifolia* were analysed to determine their antiinflammatory activity using carrageenan-induced oedema test (Alguacil *et al*., 2000). Fangchinoline and tetrandrine, major alkaloids from *Stephania tetrandrae* have been used traditionally to treat inflammatory diseases in Korea. Both fangchinoline and tetrandrine showed antiinflammatory effects on the mouse (Choi *et al*., 2000). The compounds Dicadalenol, Caryolane-1,9β-diol and quercetin were the most active substances tested and displayed dose dependent activities, isolated from aerial parts of *Heterotheca inuloide* (Asteraceae) (Delgado *et al*., 2001).

Hexane, chloroform and methanol extracts of seven herbal drugs (*Aristolochia trilobata* - leaves and bark, *Bursera simaruba* - bark, *Hamelia patens* - leaves, *Piper amalago* - leaves and *Syngonium podophyllum* - leaves and bark) were evaluated for their typical antiinflammatory activity (Sosa *et al*., 2002). The ethanol extract of the rhizomes of *Cistanche deserticola* has been evaluated for its antiinflammatory activity (Lin *et al*., 2002). *Satureja hortensis* is a medicinal plant used in Iranian folk medicine as muscle and bone pain reliever. In the hydro alcoholic extract, polyphenolic fraction and essential oil of the aerial parts of the herb were prepared.
and evaluated for their antiinflammatory activity using carrageenan induced paw oedema in rats (Hajhashemi et al., 2002).

Methanol extract of dried leaves of *Alstonia macrophylla* and its fractions were investigated for its antiinflammatory activity in carrageenan-induced rat paw oedema (Arunachalam et al., 2002). Antiinflammatory activity of ethanolic extract from *Bouchea fluminensis* leaves had been demonstrated (Delaporte et al., 2002). The crude ethanol extract and the chloroformic and aqueous fractions of *Sideritis canariensis* var. *pannosa* had been examined for their antiinflammatory and analgesic effects in several animal models (Hernandez-Perez and Rabanal, 2002).

Aqueous, hexane and methanol extracts of 12 plant species, traditionally used in Kenya were evaluated for their antiinflammatory activity (Matu and Van Staden, 2003). The antiinflammatory activity of the alcoholic extract of stems of *Tabernaemontana pandacaqui* was evolved using carrageenan induced rat paw oedema (Taesotikul et al., 2003). *Mitragyna ciliata* is widely used in traditional medicine to treat inflammation, hypertension, headache, rheumatism, gonorrhoea and broncho-pulmonary diseases. The antiinflammatory and analgesic properties of the hexane and methanolic extracts of the stem bark of *M. ciliata* have been investigated (Dongno et al., 2003).

Antiinflammatory activity of ethanol extracts from 9 vine plants used in traditional Chinese medicine to treat inflammatory conditions were evaluated (Li et al., 2003). The methanol-water extract of *Barleria prionitis* was evaluated for antiinflammatory and antiarthritic activities against different acute and chronic animal test models (Singh et al., 2003). The leaves of *Acanthus ebracteatus*, stem bark of *Oroxylum indicum* and the stems of *Cryptolepis buchanani* and *Derris scandens* are
used as traditional remedies in Thailand for arthritis. Aqueous and alcoholic extracts were tested using three different *in vitro* systems for effects relevant to antiinflammatory activity (Laupattarakasem *et al.*, 2003).

Pharmacological studies were conducted on the hexane extract of the dry stem of *Diospyros variegata* on experimental animals for evaluating its analgesic, antipypretic and antiinflammatory activities (Trongsakul *et al.*, 2003). The methanolic extract from *Clerodendrum petasites* was assessed for antiinflammatory and antipypretic activities on experimental animals. It was found that the extract possessed moderate inhibitory activity on acute phase of inflammation (Panthong *et al.*, 2003). Bagul *et al.* (2005) have reported the antiinflammatory activity of two ayurvedic formulations containing 'guggul'. Bhattacharya *et al.* (2005) have reported antiinflammatory potential of methanol extract of *Stephania glabra* of Menispermaceae family.

The petroleum ether, chloroform, methanol and aqueous extracts of *Sesbania sesban* leaves were investigated for antiinflammatory activity in albino rats (Tatiya *et al.*, 2007). The petroleum ether, ethyl acetate, ethanol and aqueous extracts of *Calotropis gigantea* leaves were screened for antiarthritic activities in albino rats (Patil *et al.*, 2007). The aqueous extract of *Eucalyptus globulus* leaves was investigated for its antiinflammatory activity in carrageenan-induced paw oedema and cotton pellet granuloma technique in albino rats (Deb *et al.*, 2007). Total alcoholic extract and successive petroleum ether fractions of *Mirabilis jalapa* possess good antiinflammatory property which may be attributed to the individual or combined action of phytoconstituents like alkaloids and steroids present in it (Nath *et al.*, 2010).
Central Nervous System (CNS) activity

The various compounds belonging to the 1-4, disubstituted piperazine series exhibited the adrenolytic, hypotensive and CNS depressant activities. This was reported by Dadkar et al. (1976). A number of scientific reports indicated that triterpenoids produced CNS depressant action (Chattopadhyay et al., 2003). Bramhi Ghrita (BG), a polyherbal formulation containing Bacopa monneri, Evolvulus alsinoids, Acorus calamus, Saussurea lappa and cow’s ghee protected mice from maximum electroshock and pentylene tetrazole-induced convulsions. The Bramhi Ghrita was found to be a CNS depressant with anticonvulsant activity (Achliya et al., 2005).

Uckun et al. (2005) carried out CNS activity of Pokeweed Antiviral Protein (PAP) in mice infected with Lymphocytic Choriomeningitis Virus (LCMV). This study revealed that PAP exhibits antiviral activity in the CNS of LCMV-infected mice. Syzygium cumini seed extracts possess significant CNS activity due to the presence of saponins (Kumar et al., 2007). Using rotarod, CNS activity was assessed in Nelumbo nucifera (red and white type) by Deepa et al. (2008). The presence of triterpenoids in methanol extract of Careya arborea may be responsible for the CNS activity (Kumar et al., 2008). CNS activities of ethanol extract of Cyperus rotundus (EECR) roots and rhizomes were evaluated by Pal et al. (2009) in mice. Pre-treatment with EECR caused significant protection against strychnine and leptazol-induced convulsions.

CNS activity of methanol and acetone extracts of Acorus calamus leaves in mice was designed by Pandy et al. (2009). Katade et al. (2009) studied the CNS depressant activity of the ethanol extract of Sterculia guttata seeds in mice. Jayashree
et al. (2010) evaluated central nervous system activity of different extracts of *Lagenaria siceraria* leaves. Among the extracts studied, petroleum ether and methanolic extracts showed analgesic and CNS-depressant activities which may be due to the presence of different chemical compounds present in that extracts. The ethanol extract of *Wedelia chinensis* at 200 and 300 mg/kg exhibited CNS depressant activity in experimental animals (Suresh et al., 2010).

Maharudra and Sanjay (2010) examined CNS depressant activity of methanolic and aqueous extracts of *Momordica dioica* fruit pulp which possess significant analgesic and antipsychotic activities, that may be attributed to various mechanisms such as decreased serotonergic and dopaminergic transmission and increased cholinergic transmission. These findings scientifically validated the traditional claim and suggested its valuable role in the treatment of various CNS disorders. Synergistic depressant activity of petroleum ether extract of *Amorphophallus paeonifolius* in Swiss albino mice was examined by Dey et al. (2011).

In *Parthenium hysterophorus*, CNS activity was carried out by Jha et al. (2011) to evaluate the effect of methanol extract on psychological behaviour of animals. Some central nervous system activities of *Nerium oleander* flower extract were studied by Singhal and Gupta (2011). Muchimapura et al. (2012) evaluated the neuropharmacological activities of *Stephania venosa* herb in healthy rats.