1. INTRODUCTION

Plants, since time immemorial, have been used globally across the varied cultures throughout the known civilizations as a valuable and safe natural source of medicine and agents of therapeutic, industrial and environmental utilities. World is endowed with a rich wealth of medicinal plants.

1.1. Use of plants in Traditional medicine

Medicinal plants are used at the household level by women taking care of their families, at the village level by medicine men or tribal shamans and by the practitioners of classical traditional systems of medicine such as Ayurveda, Chinese medicine or the Japanese Kampo system. According to the World Health Organization, over 80% of the world’s population or 4.3 billion people rely upon such traditional plant based systems of medicine to provide them with primary health care. Plant material such as leaves, flowers, fruits, seeds, stem, wood, bark, root, rhizomes or other plant parts which may be complete, fragmented or powdered, constitutes herbs (WHO, 2002). Herbs have always been the principal form of medicine in India and presently they are becoming popular throughout the developed world.

In India, medicinal plants have made a good contribution to the development of ancient Indian Materia Medica. One of the earliest treatises on Indian medicine, the Charak Samhita (1000 B.C.) records the use of over 340 drugs of vegetable origin. Medicinal plants have curative properties due to the presence of various complex chemical substances of different composition, which are found as
secondary plant metabolites in one or more parts of these plants (Purohit et al., 2004).

The widespread use of herbal remedies and health care preparations, as described in ancient texts including the Vedas, holy Koran and the Bible are obtained from commonly used traditional herbs and medicinal plants. In India, approximately 1700 plant species are used in Ayurveda, 500 for Siddha, 400 for Unani, 300 for Amchi systems of medicine with substantial overlaps of common plants among these systems. The trend of using natural products is increasing steadily.

The use of traditional medicines and medicinal plants in most developing countries as a normative basis for maintenance of good health has been widely observed. Further an increasing reliance on the use of medicinal plants in the industrialized societies has been related to the development of several drugs and chemotherapeutics from plant species as well as from traditionally used rural herbal preparations. Herbal remedies have attained much more popularity in the treatment of minor ailments, due to increasing awareness of personal health maintenance through natural products.

The oldest written evidence of medicinal plants’ usage for preparation of drugs has been found on a Sumerian clay slab from Nagpur, approximately 5000 years old. It comprised 12 recipes for drug preparation referring to over 250 various plants such as poppy, henbane and mandrake.

The Indian holy books Vedas mention treatment with plants, which are abundant in the country. According to data from the Bible and the holy Jewish book
the Talmud, during various rituals accompanying a treatment, aromatic plants were utilized such as myrtle and incense (Biljana Bauer Petrovska, 2012).

Theophrast (371-287 BC) “the father of botany,” founded botanical science with his books “De Causis Plantarium”- Plant Etiology and “De Historia Plantarium”-Plant History. In the books, he generated a classification of more than 500 medicinal plants known at the time.

In ancient history, the most prominent writer on plant drugs was Dioscorides, “the father of pharmacognosy”, who, as a military physician and pharmacognosist of Nero's Army, studied medicinal plants wherever he travelled with the Roman Army. Circa 77 AD he wrote the work “De Materia Medica”. This classical work of ancient history, translated many times, offers plenty of data on the medicinal plants constituting the basic Materia Medica until the late middle ages and the renaissance.

The Arabs introduced numerous new plants in pharmacotherapy, mostly from India, a country they used to have trade relations with, whereas the majority of the plants were with real medicinal value, and they have persisted in all pharmacopoeias in the world till today.

Marco Polo's journeys (1254-1324) in tropical Asia, China and Persia, the discovery of America (1492), and Vasco De Gama's journeys to India (1498), resulted in many medicinal plants being brought into Europe. With the discovery of America, Materia Medica was enriched with a large number of new medicinal plants.
Paracelsus (1493-1541) was one of the proponents of chemically prepared drugs out of raw plants and mineral substances. He was a firm believer that the collection of those substances ought to be astrologically determined. He continuously emphasized his belief in observation, and simultaneously supported the “Signatura doctrinae” - the signature doctrine. According to this belief, God designated his own sign on the healing substances, which indicated their application for certain diseases.

While the old peoples used medicinal plants primarily as simple pharmaceutical forms - infusions, decoctions and macerations - in the middle ages, and in particular between 16th and 18th centuries, the demand for compound drugs was increasing.

With the upgrading of the chemical methods, other active substances from medicinal plants were also discovered such as tannins, saponosides, etheric oils, vitamins, hormones etc.

In present days, almost all pharmacopoeias in the world prescribe plant drugs of real medicinal value. For the sake of adequate and successfully applied therapy, knowledge of the precise diagnosis of the illness as well as of medicinal plants, i.e. the pharmacological effect of their components is essential. Plant drugs and phytopreparations most commonly with defined active components, verified action and sometimes, therapeutic efficiency are applied as therapeutic means (Biljana Bauer Petrovska, 2012).
1.2. Use of plants in today’s world

Current trends all over the world have shown that for one reason or the other, people are not only willing to try natural medicine especially those of plant origin, but also activity seeking nonconventional remedies.

Plants can be used as therapeutic resources in several ways. They can be used as herbal teas or other homemade remedies, when they are considered as medicinal plants. They can be used as crude extracts or “standard enriched fractions” in pharmaceutical preparations, such as tinctures, fluid extracts, powder, pills and capsules, when they are considered as phytopharmaceutical preparations or herbal medicines (Rates et al., 2001).

According to the OPS (Arias, 1999) a medicinal plant is (1) any plant used in order to relieve, prevent or cure a disease or to alter physiological and pathological process, or (2) any plant employed as a source of drugs or their precursors.

A phytopharmaceutical preparation or herbal medicine is any manufactured medicine obtained exclusively from plants (aerial and non-aerial parts, juices, resins and oil), either in the crude state or as a pharmaceutical formulation.

A medicine is a product prepared according to legal and technical procedures that is used for the diagnosis, prevention and treatment of disease and has been scientifically characterised in terms of its efficacy, safety and quality (WHO, 1992).
A drug is a pharmacologically active compound, which is a component of a medicine, irrespective of its natural, biotechnological or synthetic origin. (Rates et al., 2001).

Of the estimated 2,50,000–5,00,000 plant species, only a small percentage has been investigated phytochemically and even a smaller percentage has been properly studied in terms of their pharmacological properties. Concerning drugs of plant origin, it is important to bear in mind certain conceptual distinctions.

Finally, plants can be subjected to successive extraction and purification procedures to isolate the compounds of interest, which can themselves be active and used directly as a drug, or they can be used as precursors in hemisynthetic processes or as models for total synthesis, with well-defined pharmacological activity or structure-activity relationship studies determining a prototype drug (Rates et al., 2001).

The Industrial Revolution and the development of organic chemistry resulted in a preference for synthetic products for pharmacological treatment. The reasons for this were that pure compounds were easily obtained, structural modifications to produce potentially more active and safer drugs could be easily performed and the economic power of the pharmaceutical companies was increasing. Furthermore, throughout the development of human culture, the use of natural products has had magical-religious significance and different points of view regarding the concepts of health and disease existed within each culture.

In recent years, there has been growing interest in alternative therapies and the therapeutic use of natural products, especially those derived from plants.
(Goldfrank et al., 1982, Vulto et al., 1988, Mentz et al., 1989). This interest in drugs of plant origin is due to several reasons, namely, conventional medicine can be inefficient (e.g. side effects and ineffective therapy), abusive and/or incorrect use of synthetic drugs results in side effects and other problems, a large percentage of the world’s population does not have access to conventional pharmacological treatment, and folk medicine and ecological awareness suggest that “natural” products are harmless (Purohit et al., 2004).

1.3. Status of Medicinal plants in India

Medicinal plants as a group comprise approximately 8,000 species and account for about 50% of all the higher flowering plant species of India. Millions of rural mass use medicinal plants. In recent years, the growing demand for herbal products has led to a quantum jump in volume of plant material traded within and outside the country.

The medicinal plants species belong to a wide range of habits/life form viz. trees, herbs, shrubs, lianas, and woody climbers. Habit wise analysis carried out so far indicates that nearly one third of these botanical entities are trees and around the same proportion consists of shrubs and woody climbers. The remaining one third are herbs and twiners. Very small proportions of the medicinal plants are lichens, ferns, algae etc., The majority of the medicinal plants are higher plants.

Though India has rich biodiversity and one among the twelve megadiversity centres, the growing demand is putting a heavy strain on the existing resources causing a number of species to be either threatened or endangered category. About 90% of medicinal plants used by industries are collected from the
wild. While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation.

Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants, if biodiversity is not sustainably used. Recently some rapid assessment of the threat status of medicinal plants using IUCN designed CAMP methodology revealed that about 112 species in southern India, 74 species in Northern and Central India and 42 species in the high altitude of Himalayas are threatened in the wild.

The need of the hour, then, is to replan India’s participation in the expanding global market, in light of the interest of all the stakeholders who are affected and who play a role in this sector. There is a need to collect all the available information regarding medicinal plants development in the country in order to obtain a comprehensive overview which will provide the necessary insight for coordinated and effective action. Such an overview could form the basis of a renewed development of India’s medicinal plants sector, and a strategic exploitation on a sustainable and equitable basis.

Over the past ten years there has been a considerable interest in the use of herbal medicines in the world. Utilizing our biodiversity and proper planning, Indian products can very well enter the overseas markets. This can be achieved only through proper development of medicinal plants, standardization of the extracts and keeping the quality (Purohit et al., 2004).
1.4. Pharmacognostic study of the plants

Pharmacognosy included information on the macroscopic characterizations of the plant parts used in medicine (e.g., roots, barks, leaves, seeds, fruits, etc.), country of origin of medicinal plants, specific guidance regarding botanical quality, and potential adulterations. All of these bodies of information are of substantial relevance to the quality sourcing of crude medicinal materials, which at one time was the primary domain of the pharmacognosist.

After the application of the microscope to plant morphology, microscopic descriptions were also included, becoming integral to the identity tests provide by pharmacopoeias. Both macroscopic and microscopic descriptions persist in pharmacopoeias today and are accompanied by qualitative and/or quantitative chemical analyses. The botanical and descriptive aspects of pharmacognosy were supplanted by medicinal and pharmaceutical chemistry as drug quality assurance tools. Continued specialization in analytical chemistry (e.g., paper chromatography) and structural elucidation, versus the broad organism-based general approach employed by pharmacognosists was more appropriate for the development of modern drugs.

According to WHO (1996a and b, 1992), standardization and quality control of herbals is the process involved in the physicochemical evaluation of crude drug covering aspects, such as selection and handling of crude material, safety, efficacy and stability assessment of finished product, documentation of safety and risk based on experience, provision of product information to consumer and product promotion. Attention is normally paid to such quality indices such as:
1. Macro and microscopic examination: For Identification of right variety and search of adulterants.

2. Foreign organic matter: This involves removal of matter other than source plant to get the drug in pure form.

3. Ash values: These are criteria to judge the identity and purity of crude drug – Total ash, sulphated ash, water soluble ash and acid insoluble ash etc.

4. Moisture content: Checking moisture content helps reduce errors in the estimation of the actual weight of drug material. Low moisture suggests better stability against degradation of product.

5. Extractive values: These are indicative weights of the extractable chemical constituents of crude drug under different solvents environment.

6. Crude fibre: This helps to determine the woody material component, and it is a criterion for judging purity.

7. Qualitative chemical evaluation: This covers identification and characterization of crude drug with respect to phytochemical constituent. It employs different analytical technique to detect and isolate the active constituents. Phytochemical screening techniques involve botanical identification, extraction with suitable solvents, purification, and characterization of the active constituents of pharmaceutical importance.

8. Chromatographic examination: Include identification of crude drug based on the use of major chemical constituents as markers.
9. Quantitative chemical evaluation: To estimate the amount of the major classes of constituents.

10. Toxicological studies: This helps to determine the pesticide residues, potentially toxic elements, safety studies in animals like LD$_{50}$ and Microbial assay to establish the absence or presence of potentially harmful microorganisms.

The processes mentioned above involves wide array of scientific investigations, which include physical, chemical and biological evaluation employing various analytical methods and tools (Kunle et al., 2012).

1.5. Secondary metabolites

Phytochemistry or plant chemistry is concerned with the enormous variety of organic substances that are elaborated and accumulated by plants and deals with the chemical structures of these substances, their biosynthesis, turnover and metabolism, their natural distribution and their biological function (Harborne, 1998).

In plants, as a result of metabolic processes, many different kinds and types of organic compounds or metabolites are produced. These metabolites are grouped into primary and secondary metabolites. The primary metabolites like chlorophyll, amino acids, nucleotides, simple carbohydrates or membrane lipids play recognised roles in photosynthesis, respiration, nutrient assimilation and differentiation. Other chemical compounds in plants apart from these listed above are secondary metabolites. Such compounds usually exert peculiar, unique and
specific active physiological effects responsible for their therapeutic and pharmacological functions. Activities of such naturally occurring compounds are generally responsible for changes, which are utilized to satisfy man’s desires. The secondary metabolites also differ from primary metabolites in having a restricted distribution in the plant kingdom. That is, particular secondary metabolites are often found in only one plant species or a taxonomically related group of species, whereas the basic primary metabolites are found throughout the plant kingdom (Taiz et al., 2006). These complex substances of diverse nature occur in very small amounts in grams or mg or μg/Kg of samples. They do not add to body calorie and are numerous in types. These phytochemical are applied mostly for preventive and healing purposes (Hamburger et al., 1991). During the past few decades, experimental and circumstantial evidence has made it clear that many secondary metabolites do indeed have functions that are vital for the fitness of a plant producing them. The main roles are:

- Defence against herbivores and microbes
- Defence against other plants competing for light, water and nutrients
- Signal compounds to attract pollinating and seed dispersing animals
- Signals for communication between plants and symbiotic microorganisms
- Protection against UV-light or other physical stress (Wink, 1999).

They have also provided an invaluable resource that has been used to find new drug molecules (Gurib-Fakim, 2006). Plant secondary metabolites can be grouped into
three chemically distinct classes: terpenes, phenolics and nitrogen containing compounds (Mendonca-Filho et al., 2006).

1.6. Antimicrobial activities of plant substances

Infectious diseases represent an important cause of morbidity and mortality among the general population, particularly in developing countries. Therefore, pharmaceutical companies have been motivated to develop new antimicrobial drugs in recent years, especially due to the constant emergence of microorganisms resistant to conventional antimicrobials (Silva et al., 2010).

Basically, there are two ways to control or inhibit the growth of microorganisms, i.e. through physical or chemical agents, where choice is made on the basis of situation. Heat, pasteurization, freezing, radiation and filtration are regarded as physical agents whereas a wide variety of antimicrobial substances and drugs are categorized as chemical agents. Antibiotic and antimicrobial agents are two different terms. An antibiotic is a product produced by microorganisms to inhibit the growth of other microorganisms whereas antimicrobial agent encompassed any compound either derived from natural or synthetically produced that can be applied clinically in the treatment of bacterial infection. In more specific, antimicrobial agents are categorized based on the spectrum of action, namely narrow and broad spectrum. Narrow spectrum antimicrobial agent can only inhibit the growth of either Gram positive or Gram negative bacteria whereas broad spectrum antimicrobial agent can inhibit both Gram positive and negative bacteria. Nevertheless, most of the antibiotics have no longer effective to control bacterial diseases due to the occurrence of antibiotic resistance. Therefore, scientists around
the world were struggling to find for alternative, preferably from the natural resources (Lee Seong Wei et al., 2008).

Plants are great source of thousands new useful phytochemicals of great diversity, which have inhibitory effects on all types of microorganisms in vitro. Till date more than 600 plants have been reported for their antifungal properties, however a few of them were explored for the active components. They need to be active against those fungi causing infections which we cannot eradicate. They need to be formulated for both oral and parental administration. They need to be extremely safe and as cheap as possible (Silva et al., 2010).

1.7. Antioxidant activities of plant products

Oxygen is absolutely essential for the life of aerobic organism but it may become toxic if supplied at higher concentrations. Dioxygen in its ground state is relatively unreactive; its partial reduction gives rise to active oxygen species (AOS) such as singlet oxygen, super oxide radical anion, hydroxyl radicals, hydrogen peroxide etc. This is partly due to the oxidative stress that is basically the adverse effect of oxidant on physiological function (Sulekha Mandal et al., 2009).

Accumulation of the free radicals in body organs or tissues can cause oxidative damage to bimolecules and membranes of cell, eventually leading to many chronic diseases, such as inflammatory, cancer, diabetes, aging, cardiac disfunction and other degenerative diseases (Wang et al., 2004).

In the last 50 years, antioxidant and anti-inflammatory activities of extracts from medicinal or food plants have been extensively investigated. Many
pharmacological studies have shown that extracts of some antioxidant plant possess anti-inflammatory, anti-allergic, anti-tumour, anti-bacterial, anti-mutagenic and anti-viral activities to a greater or lesser extent. Researchers reported that intake of fruits, vegetables and other foods having high antioxidant activity has been associated with reduced risks of cancer, cardiovascular disease, diabetes and other diseases (Kris-Etherton et al., 2004).

1.8. Anti-proliferative activity of the plants

Cancer is a multi-step disease incorporating environmental, chemical, physical, metabolic, and genetic factors which play a direct and/or indirect role in the induction and deterioration of cancers. Strong and consistent epidemiology evidence indicates a diet with high consumption of antioxidant rich fruits and vegetables significantly reduces the risk of many cancers, suggesting that certain dietary antioxidants could be effective agents for the prevention of cancer incidence and mortality. These agents present in the diet are a very promising group of compounds because of their safety, low toxicity, and general acceptance. Consequently, in the last few years, the identification and development of such agents has become a major area of experimental cancer research.

Agents that suppress the proliferation of malignant cells by enhancing apoptosis may constitute a useful mechanistic approach to both cancer chemoprevention and chemotherapy. However, unfavourable side effects and resistance to many developed anticancer agents have been serious problems. Thus, there is a growing interest in the use of plant based compounds to develop safe, more effective therapeutic agents in cancer treatment (Ali A Alshatwi et al., 2012).
1.9. Phylogenetic Analysis

Living organisms evolving over time from ancestral forms to more derived forms keep many of their ancestral features. Some of these features gradually change to help organisms adjust to their environment. Studying the phylogeny of organisms can help explain the similarities and differences among species.

Phylogenetics is the study of evolutionary relationships. Phylogenetic analysis is the means of inferring these relationships. The evolutionary history estimated from phylogenetic analysis is elicited as branching, treelike diagrams that represent the inherited relationships among molecules (‘‘gene trees’’), organisms or both.

The principle behind Phylogenetic analysis is that members of a group or clade share a common evolutionary history. These clade members are more related to each other than to members of another group. A given group is recognised by sharing unique features that were not present in distant ancestors. These derived or shared features may be anything that can be observed from two organisms having developed a spine to two sequences having developed a mutation at a certain base pair of a gene (Andreas D Baxevanis *et al*., 2004)

The phylogenetic trees available at all levels of the taxonomic hierarchy for animals and plants, play a pivotal role in comparative studies of diverse fields from ecology to molecular evolution and comparative genetics (Soltis *et al*., 2000, Ajmal Ali *et al*., 2014).
Analysis of green plant phylogeny largely employed chloroplast genes and rbcL gene and have been used to infer plant phylogeny at different taxonomic levels. The rbcL gene, which encodes the large subunit of ribulose- 1,5-bisphosphate carboxylase / oxygenase (RUBISCO), has been widely sequenced from numerous plant taxa, and the resulting data base has greatly aided studies of plant phylogeny (Palmer et al., 1988, Clegg et al., 1991, Chase et al., 1993). To evaluate relationships at the generic level, the commonly used rbcL gene is well suited for higher-level intrafamilial questions (Bremer et al., 1995, Plunkett et al., 1996, Cameron et al., 2001). The large existing database of rbcL sequences make this gene the locus of choice for evaluating taxa of uncertain affinity and the monophyly of families (Chase et al., 2002, Kenneth et al., 2004).

Ribosomal DNA (rDNA) has long been used as a potential marker for phylogenetic studies (Avise, 2004). rRNA genes are organized in clusters of tandemly repeated units, each of which consists of coding regions (18S, 5.8S and 28S) and two internal transcribed spacers (ITS) and one non-transcribed spacer (NTS) region. While the coding regions are evolutionarily conserved and have been utilized for phylogenetic inferences for major phyla (Hills and Dixon 1991), the two ITS regions are appropriate for detecting differences between conspecific individuals and are hence potentially useful markers to study the relationships of populations and closely related species in fungal, plant, and animal taxa due to their relatively rapid evolutionary rates (Baldwin, 1992, Mai et al., 1997, Chen et al., 2002, Nu-Wei Vivian Wei et al., 2006).
The 18S and 28S rRNA genes evolve relatively slowly and are useful in addressing broad phylogenetic hypotheses involving a broad range of organisms (Bruns et al., 1991, Maidak et al., 1997). The internal transcribed spacer (ITS) evolves relatively quickly and can be useful in determining interspecies (Cullings et al., 1996, Vogler et al., 1998) and sometimes intraspecies relationships (Baura et al., 1992). Within the ITS is a largely ignored coding region, the 5.8S rRNA gene. Similar to the other coding regions, the 5.8S region evolves relatively slowly but, because of its location within the ITS, it is generally used only as an alignment tool. Recently, however, this region was shown to contain considerable phylogenetic information, particularly with respect to deep basal branches (Hershkovitz et al., 1996, Kenneth W Cullings et al., 1998).

1.10. *Sesbania sesban*

The genus *Sesbania* Scop. contains about 50 species, are widely distributed in the tropics and subtropics. The majority of *Sesbania* species are annuals, and some are relatively short-lived woody perennials. The greatest species diversity occurs in Africa (distributed widely in northern, eastern, southern and central Africa) with 33 species described (Degefu et al., 2011, Yang et al., 2003, Gupta et al., 2011). Five varieties of *S. sesban* are recognised botanically (Mani et al., 2011, Gutteridge, 1993) viz., *S. sesban* var. *sesban*, *S. sesban* var. *bicolor*, *S. sesban* var. *nubica*, *S. sesban* var. *zambesiaca* and *S. sesban* subsp. *punctata*. The first three varieties are all similar and have been noted for their vigorous growth and high yields, while the rest are less known varieties (Gutteridge, 1993).
1.10.1. Geographical distribution

*Sesbania sesban* is very common throughout Africa and in Asian countries such as India, Malaysia, Indonesia and the Philippines where it is commonly seen growing on the dikes between rice paddies, along roadsides and in backyard vegetable gardens.

The exact origin of *Sesbania sesban* is unclear, but it is widely distributed and cultivated throughout tropical Africa and Asia. It has also been introduced in tropical America. It is an exotic plant to Ethiopia and is originally from east Africa.

1.10.2. Classification

Angiosperms
Dicotyledons
Polypetalae
Calyciflorae
Rosales
Leguminosae
Fabaceae
*Sesbania sesban* (L.) Merr.

1.10.3. Synonyms

*Aeschynomene sesban* L.
*Coronilla sesban* Willd.
*Emerus sesban* (L.)Kuntze
*Sesban aegyptiaca* Poir.
*Sesban aegyptiacus* Poir.
*Sesbania aegyptiaca* Poir.
*Sesbania aegyptiaca* sensu auct.
Sesbania aegyptiaca var. concolor Wight & Arn.
Sesbania aegyptiaca var. picta Prain
Sesbania confaloniana (Chiov.) Chiov.
Sesbania pubescens sensu auct. Sesbania sesban var. concolor
(Wight & Arn.) Baquar

2n = 12 chromosome (Gillett, 1963, Heering, 1995) and n = 6, 7, 8, 12 and 14 haploid chromosome (Heering, 1995).

1.10.4. Vernacular name

Sesbania sesban is known by different vernacular names such as Egyptian Pea, Egyptian Sesban, Egyptian rattle pod, Frother, River Bean, Common Sesban, Sesban or Sesbania (English); Karunchembai, Champai, Sithagathi in Tamil; Bichu, Jait, Jainty, Rawasan in Hindi; Jayantika, Jayanti in Sanskrit; Janti or Jayant (Bengali); Rivie rboontjie (Afrikaans); Girangire (Amharic); Sesban (Arabic); Dien-dien (Vietnamese); Umsokosoko (Zulu); Janti, Jayanti or Puri (Indonesian); Anil frances, Tamarindillo (Spanish) and Mubimba or Muzimbandeya (Luganda) (Zerihun Nigussie et al., 2013).

1.10.5. Botanical description of Sesbania sesban

Sesbania sesban is a narrow-crowned, deep-rooting (Plate.2F), nitrogen fixing, shrub or small soft-wooded tree, often prickly which may grow up to 8 m and up to 20 cm stem in diameter (Plate.2B). The plant is fast growing and it grows 4.5 to 6.0 m high in one year and normally flowers and produces ripe pods within the first year after planting. If the trees planted are widely spaced they usually develop many side branches. The many branches give the tree a shrubby appearance (Plate.1).
Leaves are paripinnate compound 12 to 18 cm long and narrow. Leaflets are 6 to 27 pairs, linear-oblong, entire, usually asymmetric at the base, mucronate, deciduous, often glaucous and stipules are minute or absent (Plate.2A).

Flowers are yellow with purple or brown streaks on the corolla, red, purplish, variegated or streaked on slender pedicels, solitary or paired in short axillary racemes, usually unpleasantly scented (Plate.2C&D). Calyx campanulate with five short equal teeth. Corolla much exerted, glabrous, all petals are long clawed, standard orbicular or ovate, spreading or reflexed wings falcate-oblong, keel petals obtuse of subrostrate.

Stamen 10, diadelphous (9+1), vexillary stamen free, anthers uniform. Ovary linear, usually stipitate with numerous ovules, style in-curved, glabrous, stigma capitate. Pods long, pale yellow when dried and subcylindrical, straight or slightly curved with 10 to 20 cm long and 5 mm wide containing up to 50 seeds, septate within or between the seeds (Plate.2E). Seeds are oblong or sub-quadrate, brown or dark green mottled with black (Plate.2G) (Gamble, 1915).

*Sesbania sesban* has proved to be extremely popular due to in part to its fast growth and also because of its wide use as fuel wood and for fodder. It has also proved to be extremely tolerant of a wide range of sites including those which can be regarded as difficult such as saline, waterlogged. Being a legume, the tree fixes nitrogen and has proved to be popular as a fallow species and as an agroforestry species.
1.10.6. Phytochemical properties

Phytochemical investigations of the plant led to the isolation of oleanolic acid, stigmasta-5, 24(28)-dieno-3-ol-3-0-β-D-galactopyranoside, fatty acids and amino acids. Various types of lignins composed of the building unit guaiacyl, syringyl and P-hydroxyphenylpropane (Gupta et al., 1989), and also antitumor principal kaempferol disaccharide (Upadhyaya et al., 1991) were reported.

1.10.7. Ethnobotany

Traditionally the plant is used in the treatment of inflammatory rheumatic conditions, diarrhoea, in excessive menstrual flow, to reduce enlargement of spleen and in skin diseases. The plant is used as carminative, anthelmintic, astringent, anti-inflammatory, antimicrobial, antifertility, demulcent and purgative. It is also given as a medicine against fever and ulcers (Sheikh Sajid et al., 2012).

1.11. Aim and Objectives of the study

For the valuable application of the plant parts in modern medicine, physico-chemical and phytochemical standardization is very important. Thus, the medical benefits of the plant may be used properly and scientifically and reach the larger part of people in the world. The plant Sesbania sesban possesses significant medicinal properties and many details about the leaf, flower and seed are available but systematic studies have not been reported for its pharmacognostical study of the stem. Hence the following objectives were framed:
i. Study of the pharmacognostic details of the *Sesbania sesban*.

ii. Extraction of the leaf, stem and root of *Sesbania sesban* by using different solvents.

iii. Qualitative analysis of the phytochemicals present in the different extracts to get preliminary idea about the compounds present in the extracts.

iv. Characterization of the phytochemicals isolated from the methanol extract of the stem through various chromatographic techniques.

v. Evaluation of the biological activity of the methanol extract of the stem and the fractions separated from the crude extract.

vi. Phylogenetic analysis of the plant to assess the evolutionary relationship with other species.