CHAPTER – I
REVIEW AND BACKGROUND

INTRODUCTION

Plants are the source of energy for the animal kingdom including the human beings. All human beings require a number of complex organic and inorganic compounds in diet to meet the need for their activities and plants are the rich source of all the elements essential for them. Hence vegetarianism became popular in recent years even in Western countries. Plant foods such as vegetables and fruits play a vital role in the health of human beings providing carbohydrates, vitamins and minerals.

Throughout history, civilized societies have developed interest and concern about the integrity of food for the above compounds. Long before the development of the distinct scientific discipline of nutrition, philosophers and later physicians paid close attention to the role of daily diet in individual and public health.

The important constitution of diet are carbohydrates, fats, proteins, vitamins, minerals and water (Indrayan et al., 2005). These constituents play an important role in the physiology of animals including human beings and deficiency or excess of one or more component lead to manifestation of abnormalities which are known as diseases. The Greek physician compiled the first European treaty on the properties and uses of medicinal plants, De Materia Medica. In the first century AD, Dioscorides wrote a compendium of more than 500 plants that remained an authoritative reference into the 17th century. Similarly important for herbalists and botanists of later centuries was the Greek book that founded the science of botany, Theophrastus’ Historia Plantarum, written in the fourth century B.C. (Bhandari, 2004).

During the last 2000 years, from the time of Hippokrates (B.C. 460-377) to the dawn of modern medicine, there was only a little distinction made between food and
drugs. The practice of medicine itself consisted largely of the wise choice of natural food products. Hippokrates recognized the essential relationship between food and health (Jones, 1923a, 1923b). Galen (131-201AD), a physician reflected confidence in the knowledge and ability of physicians to establish sound diet that would advance public health (Green, 1951).

Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies, including opium, aspirin, digital and quinine. The World Health Organization (WHO) estimates that 80 percent of the world's population presently uses herbal medicine for some aspect of primary health care. Pharmaceuticals are prohibitively expensive for most of the world's population and on the contrary, herbal medicines can be grown from seed or gathered from nature for little or no cost. In addition to the use in the developing world, herbal medicine is used in industrialized nations by alternative medicine practitioners such as naturopaths. A 1998 survey of herbalists in the UK found that many of the herbs recommended by them were used traditionally but had not been evaluated in clinical trials. In Australia, a 2007 survey found that these Western herbalists tend to prescribe liquid herbal combinations of herbs rather than tablets of single herb.

Nutritional and medicinal properties of plants are known since a long time. However, their disease preventing and health promoting aspects are realized only recently. The scientific basis behind the use of plants as medicines came to light only recently due to scientific advancements happened in research and instrumental analysis.

Medicinal plants have been used in traditional treatments for numerous human diseases for thousands of years and they continue to be a therapeutic aid even in modern era also. Interestingly today, there is a renewed interest happened in traditional medicine and an increasing demand for more drugs from plant sources. This revival of interest in
plant derived drugs is mainly due to the current widespread belief that the green medicine is safe and more dependable and without side effects compared to the synthetic drugs.

Nature has bestowed the earth with rich botanical wealth and diverse group of plants grow wild in different part of the world. The knowledge on medicinal plants predates the human history and evidences are available globally.

A 60,000 year old Neanderthal burial site, "Shanidar IV", in northern Iraq has yielded large amounts of pollen from 8 plant species, 7 of which are used now as herbal remedies. In the written record, the study of herbs dates back over 5,000 years to the Sumerians, who described well-established medicinal uses for such plants as laurel, caraway and thyme. Ancient Egyptian medicine of 1000 B.C. is known to have used garlic, opium, castor oil, coriander, mint, indigo, and other herbs for medicine and the Old Testament also mentions herbal use and cultivation, including mandrake, vetch, caraway, wheat, barley and rye. The Indian Ayurvedic medicine has used many herbs such as turmeric possibly as early as 1900 B.C. Many other herbs and minerals used in Ayurveda were later described by ancient Indian herbalists such as Charaka and Sushruta during the 1st millennium BC. Since their time, the collection and identification of medically important plants led to the development of pharmacognosy to day in which pharmaceutically important products are studied.

The first Chinese herbal book, the Shennong Bencao Jing, compiled during the Han Dynasty dating back to a much earlier date, possibly 2700 B.C., have listed 365 medicinal plants and their uses including Ma-Huang, the shrub that introduced the drug ephedrine to modern medicine (Bhattacharjee, 2000).

The ancient Greeks and Romans made medicinal use of plants. Greek and Roman medicinal practices, as preserved in the writings of Hippocrates and especially Galen,
provided the pattern for later western medicine. Hippocrates advocated the use of a few simple herbal drugs along with fresh air, rest and proper diet. Galen, on the other hand, recommended large doses of drug mixtures including plant, animal, and mineral ingredients.

In their natural environments, plants have to cope with an array of stress conditions to improve their survival chances and stress factors include drought, salinity, nutritional deficiency, adverse climate condition, pollutants, pathogens, insects, phytophagy etc., and Hence plants exhibit a variety of defense responses to make their survival possible in a particular environment. Moreover, being sessile, they synthesize numerous phytochemicals as a major strategy to counteract unfavorable conditions. Most of the phytochemicals are secondary metabolites, not directly involved in development, growth and reproduction, but mostly defense molecules, produced considering the factors prevailing in the immediate environments and the related ecological networks in that region. A great array of molecules derived from plant secondary metabolism, are of extreme interest in human nutrition and pharmacology, in addition to perfumery and cosmetics.

Plants have evolved the ability to synthesize chemical compounds that help them to defend against the attack from a wide variety of predators such as insects, fungi and herbivorous mammals. By chance, some of these compounds whilst being toxic to plant predators turned out to have beneficial effects in treating human diseases. Such secondary metabolites are highly varied in structure; many are aromatic substances, most of which are phenols or their oxygen-substituted derivatives. At least 12,000 have been isolated so far; a number estimated to be less than 10% of the total. Chemical compounds in plants mediate their effects on the human body by binding to receptor molecules present in the body; such processes are identical to those already well understood for
conventional drugs and as such herbal medicines do not differ greatly from conventional drugs in terms of working principles. This enables herbal medicines to be in principle just as effective as conventional medicines but without harmful side effects. Many of the spices used in seasoning of foods have compounds with the medicinal properties (Singh et al., 2004).

Plant derived food stuffs and beverages include mainly fruits, vegetables, herbs, spices, chocolate, tea, beer, wine etc. are known as functional foods. These are not considered as pharmaceutical products, but known as nutraceuticals as they are components able to ameliorate human fitness of health. However based on their biological properties such as antioxidant, anti hypersensitive, cardio protective, anti-inflammatory, anti mutagenic, antitumoral, anticancer, most of them are called as pharmaconutrients. The term “nutraceutical” was coined in 1989 by the Foundation for Innovation in medicine (Newyork, US) to provide a name for this rapidly growing area of biomedical research. A nutraceutical can be defined as any substance that may be considered as a food or part of a food and provides medical or health benefits (De Felice, 1992). Nutraceuticals may include specific nutrients, dietary supplements, diets, genetically engineered designer foods, herbal products, processed products like soups, beverages etc.,

Due to the explosion happened in research publications and providing scientific evidence to support the health effects, the term “phytochemicals” became popular referring the functional components as a functional food (or) nutraceutical or phytinutrient.

Harborne (1999) identified the three major classes of plant chemicals as terpenoids, phenolic metabolites, alkaloids and other nitrogen-containing plant constituents. As delineated by Harborne, the terpenoids include monoterpenoids,
iridoids, sesquiterpenoids, sesquiterpene lactones, diterpenoids, triterpenoid saponins, steroid saponins, cardenolides and bufadienolides, phytoesters, cucurbitacins, nortriterpenoids, other triterpenoids and carotenoids. The phenolic metabolites include anthocyanins, anthochlors, benzofurans, chromones, coumarins, minor flavonoids, flavonones and flavonols, isoflavonoids, lignans, phenols and phenolic acids, phenolic ketones, phenylpropanoids, quinonoids, stilbenoids, tannins and xanthones. The alkaloids include amaryllidaceae, betalain, diterpenoid, indole, isoquinoline, lycopodium, monoterpane, sesquiterpene, peptide, pyrrolidine and piperidine, pyrrolizidine, quinoline, quinolizidine, steroidal and tropane compounds. Other nitrogen-containing constituents include nonprotein amino acids, amines, cyanogenic glycosides, glucosinolates, purines and pyrimidines.

Specific phytochemicals can be used as therapeutic drug if their efficacy is confirmed by proper scientific research. The traditional procedures to prepare plant preparations may enhance the chemotherapeutic value of the plant derivatives. However, the individual components to be scientifically validated to support the specific health claims. The biological test systems like animal models, in vitro cultured cell system and various stages of clinical trials in human beings to be followed to convert a phytochemical into a potent drug. For most of the medicinal plants, the information available is of the observational or descriptive type and information on functions and mechanism of action especially on individual components are lacking.

Researchers from Ohio Wesleyan University found that some birds select nesting materials, which are rich in antimicrobial agents that protect their young ones from harmful bacteria. Sick animals tend to forage plants rich in secondary metabolites, such as tannins and alkaloids. Since these phytochemicals often have antiviral, antibacterial,
antifungal and antihelminthic properties, a plausible case can be made for self-medication by animals in the wild (Saxena, 2004).

The use of and search for, drugs and dietary supplements derived from plants have accelerated in recent years. Pharmacologists, microbiologists, botanists, and natural-products chemists are combing the Earth for phytochemicals that could be used for treatment of various diseases. In fact, according to the World Health Organisation, approximately 25% of modern drugs used in the United States have been derived from plants (Dayal, 2004).

Among the 120 active compounds currently isolated from the higher plants and widely used in modern medicine today, 80 percent show a positive correlation between their modern therapeutic use and the traditional use of the plants from which they are derived.

More than two thirds of the world's plant species - at least 35,000 of which are estimated to have medicinal value mostly come from the developing countries. All plants produce chemical compounds as part of their normal metabolic activities. These are divided into primary metabolites, such as sugars and fats, found in all plants, and secondary metabolites, compounds not essential for basic function found in a smaller range of plants, some useful ones found only in a particular genus or species. Pigments harvest light, protect the organism from radiation and display colors to attract pollinators. Many common weeds, such as nettle, dandelion and chickweed, have medicinal properties.

The functions of secondary metabolites are varied. For example, some secondary metabolites are toxins used to deter predation, and others are pheromones used to attract insects for pollination. Phytoalexins protect against bacterial and fungal attacks. Allelochemicals inhibit rival plants that are competing for soil and light. Plants either
up-regulate or down-regulate their biochemical paths in response to the local mix of herbivores, pollinators and microorganisms. The chemical profile of a single plant may vary over time as it reacts to changing conditions. It is the secondary metabolites that can have therapeutic actions in humans and which can be refined to produce drugs. Plants synthesize a bewildering variety of phytochemicals but most are derivatives of a few biochemical motifs.

Alkaloids contain a ring with nitrogen. Many alkaloids have dramatic effects on the central nervous system. Caffeine is an alkaloid that provides a mild lift but the alkaloids in datura cause severe intoxication and even death. Polyphenol, also known as phenolics, contain phenol rings. The anthocyanins that give grapes their purple color, the isoflavones, the phytoestrogens from soy and the tannins that give tea its astringency are phenolics. Terpenoids are built up from terpene building blocks. Each terpene consists of two paired isoprenes. The names monoterpenes, sesquiterpenes, diterpenes and triterpenes are based on the number of isoprene units. The fragrance of rose and lavender is due to monoterpenes. The carotenoids impart the red, yellow, orange colors to pumpkin, corn and tomatoes.

Glycosides consist of a glucose moiety attached to an aglycone. The aglycone is a molecule that is bioactive in its free form but inert until the glycoside bond is broken by water or enzymes. This mechanism allows the plant to defer the availability of the molecule to an appropriate time, similar to a safety lock on a gun. An example is the cyanoglycosides present in cherry plants which is released as a toxin only when the plant is bitten by herbivores.

Research in herbal medicine and isolated drug discovery need to be continued, considering the threat of new emerging disease such as SARS, bird flu and the killer disease AIDS. Plants are a good source of herbal medicine and natural products/
phytochemicals. Many synthetic drugs owe their discovery and potency as a result of a mimic of structures from natural products isolated from plants rather than to the creativity and imagination of contemporary organic chemists. For example, the drug taxol (a diterpenoid), first isolated from the bark of the yew tree *Taxus brevifolia* had yielded two approved drugs for breast and ovarian cancer. In Guyana, there are many medicinal folklore practices but most of them are without scientific validation. For example, the aqueous extract of *Momordica charantia* seemed to be a good remedy for diabetes. Thus, there exists an urgent need to correlate folklore herbal practices with scientific evidences. The condition is same worldwide, however there is a growing concern over this (Rahuman *et al.*, 2008).

India is one of the world’s 12 mega biodiversity country, having rich vegetation with 47,000 plant species and a wide variety of medicinal plants along with tradition of plant based knowledge distributed among the vast numbers of ethnic groups. There are many medicinally important species which are used to produce various types of drug and medicines to treat many ailments in India since the time of the Rig Veda (approximately 2000 BC). India represents one of the great emporia of ethno-medicinal wealth has enormously diversified living ethnic groups and rich biological resources (Roopashree *et al.*, 1965).

Herbal medicines are plant derived material or preparations, which contain raw or processed ingredient from one or more plants or its parts, with therapeutic value and used as dietary supplements to fight or prevent common disease in various systems of medicine such as Ayurveda, Unani and Siddha. Plant derived natural products have received considerable attention in recent years due to their diverse pharmacological activities. The traditional herbal combinations and extracts are known to improve health
by combating or preventing microbial infections and curing various ailments and diseases (Serti et al., 2001 and Roy et al., 2005).

Silver et al., 1993, Senatare 2004, and Si et al., 2006, reported that the plant derived medicines are relatively safer than synthetic drugs and offering profound therapeutic benefits by providing alternative and effective treatment for chronic disorders and various diseases. More than 1500 herbal preparations are sold in India as dietary supplements or ethnic traditional medicine to treat the diseases but only a few of them have been scientifically explored for its antibacterial potentials. The most frequently used herbal preparations is churna; a preparation comprising of fine powders of medicinal plants either in single or in combination. Combinations of medicinal plants may increase the antimicrobial spectrum and potency of activity. Enteric or diarrhoeal infections account for high proportion of health problems in the developing countries and contribute to the death of 3.3 to 6.0 million children annually. Enteric bacteria such as Salmonella sp., Shigella sp., Proteus sp., Klebsiella sp., Escherichia coli, Pseudomonas sp., Vibrio cholerae, and Staphylococcus aureus are major etiologic agents of sporadic and epidemic diarrhea in both children and adults. Recently, it has been demonstrated that many human pathogenic bacteria have developed resistance against several synthetic drugs, discourage their use and insist the search for alternative medicines. There are several reports on antimicrobial activity of crude extracts prepared from plants that inhibit various bacterial pathogens, but a limited numbers of in vitro studies on herbal preparations have been published. Therefore, it is need of the hour to identify antibacterial potential of herbs especially diseases which no medicine or only palliative therapy is available (Tamboli, 2000). At this juncture, it is of interest to determine the scientific basis for the traditional use of these herbal medicines and to evaluate their bioactive potential.
Recently, phytocompounds were standardized from many *Echinacea* sp. According to their echinacoside content because this caffeic acid derivative is a marker chemical, unique to *Echinacea* sp. However, such standardization does not consider the complex chemical interactions and possible synergistic effects necessary for the beneficial effects of this phytocompound on humans beings (Tambekar 2009).

The work done by plant physiologist, Zahra (2000) on medicinal plants opened up a wide range of research possibilities, and plant physiological studies would indeed have a major role to play in this burgeoning field. With only a few exceptions, many widely used medicinal plants have not received the extensive plant physiological characterization received by food crops or model plant systems. Although active phytochemicals may have been identified, in general, many pathways for the biosynthesis of specific medicinal compounds and the factors (biotic and abiotic) regulating their production remain unclear. At present, a major concern with the use of phytocompounds is regarding the maintenance of consistent medicinal quality in botanical medicines. Whereas the focus has tended to be on quality control in herbal manufacturing practices. Variation in phytochemical content due to environmental effects upon secondary plant metabolism in the plant material could represent a significant factor. Recently many works have been done to understand the environmental factors influencing phytochemical production so as to maximize the recovery of phytochemical of medical importance. At this juncture it is to be noted that effective utilization of herbal resources for the development of herbal medicines or health formulations face unique problems as given below.

Traditional knowledge and skills on these traditional medication systems are transmitted intergenerationally and in most cases orally. But an unfortunate development over the past half century has been that these traditional medicine based systems have
largely been neglected by the government. Consequently, the professions based on these systems, e.g., are no longer financially lucrative to the potential practitioners. Thus, the traditional knowledge reserve, which is not well documented, is eroding gradually.

The over extraction and ignorant activities of these people cause biodiversity loss and resource depletion as many communities are unfamiliar with ecological issues and few currently participate in decisions regarding local natural resources (USAID, 2004). In addition, systematic data on ecosystems are scanty in many countries including India. Inadequate data and limited local participation lead to poor environmental policies. There are also few people trained in advanced natural resource management. Thus, without sufficient environmental protection, biodiversity in many countries continues to decrease.

While this process of gradual loss of medicinal plants is continuing unabated, the demand for medicinal plants and plant-derived drugs is increasing rapidly with the current resurgence of traditional medicines all over the world (Ghani, 2003). There is unprecedented demand for natural medicines, green health products, pharmaceuticals, food supplements, cosmetics and herbal pesticides, which is bringing about this alarming loss of plant biodiversity. It is estimated that 70-80% of people worldwide rely chiefly on traditional, largely herbal medicine to meet their primary healthcare needs (Farnsworth and Soejarto, 1991 and Shengji, 2001). The global market for herbal medicine is not only large but expanding by 15-20% annually (Subrat, 2002).

The subsequent steps after the conservation and diversification of production are the challenges of creating a competitive economic value chain for any product to be sustained commercially and accepted globally. In this respect, it is very important to develop appropriate market and product strategies for the medicinal plant-based products in order to meet both the local and global trends for standardized quality. SEDF (2003)
found that the lack of expertise and knowledge in setting standards and quality parameters in traditional systems of medicine, as well as inadequate processing and storage facilities, are contributing to the poor marketability of medicinal plant-based products.

Medicinal plants are used at the household level, especially by the 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 the Ayurveda, Chinese medicine, or Japanese Kampo system (Bannerman et al., 1983).

Medicinal plants are socially acceptable employment avenues for women. Traditionally, women have been the mainstays of medicinal plant-based activities and microenterprises because the products and activities thereof easily fit within the average daily needs and work schedules of women. These typically include medicinal plant raw materials that are collected, dried and transported to the market. Medicinal plants have also been used to develop family-based health and livelihood oriented enterprises in rural areas. Many traditional healers have been running medicinal plant-based health care systems to earn their livelihoods. Arya Vaidya Sala (AVS) and Kabirajghar in South Asia are excellent examples of combining business and traditional medicine services. Such industries not only strengthen the social fabric, but also help: a) preserve the traditional medical knowledge, and provide easily adaptable enterprising opportunities for unemployed youth and rural poor who can learn the trade from their parents and peers and earn not only their livelihood but also contribute to the society (Karki., 2000).
Biology of *Sesbania Grandiflora*

**Taxonomy**

- **Kingdom:** Plantae
- **Order:** Fabales
- **Family:** Fabaceae
- **Genus:** Sesbania
- **Species:** grandiflora

**Binomial name:** *Sesbania grandiflora* (L.) Poiret

The exact origin of *Sesbania grandiflora* (in Tamil Agati) is not known but it is considered as native to many South East Asian countries.

*Sesbania grandiflora* is a loosely branched tree grows up to 15m height. Its leaves are pinnately compound up to 30 cm long with 20 – 50 leaflets in pairs, dimensions 12.44 x 5.15 mm and oblong to elliptical in shape. Flowers are large, white, yellowish, rose pink or red with a calyx of 15-22 mm long, the standard dimensions up to 10.5 x 6 cm. Pods are long (20 – 60 cm) and thin (6 – 9 mm) with broad sutures containing 15-50 seeds.

It is well adapted to hot, humid environments and does not grow well in the subtropics particularly in areas with a cool season minimum temperature of below 10°C. It has the ability to tolerate water logging and is ideally suited to seasonally water logged or flooded environments. When flooded, they initiate floating adventitious roots and protect their stems, roots and nodules with spongy, aerenchyma tissue. *Sesbania grandiflora* is adapted to rain fall conditions of 2000 – 4000 mm but grow well in areas receiving only 800 mm. Another interesting feature is its extraordinary tolerance to saline, alkaline as well as to highly acidic soils. Cutting management has a very important influence on the productivity of perennial *Sesbania* species. *Sesbania*
*Sesbania grandiflora* cannot survive by repeated cutting. Farmers used to cut only the side branches of trees for fodder leaving the main growing stem untouched. The trees are grown on rice paddy walls at 1.5 – 2 m intervals and forage is harvested in this manner for 3 – 4 years, yielding up to 2 kg dry matter per harvest per tree. When the foliage is no longer within easy reach the trees are cut and the long straight poles are used as firewood or for construction purposes.

The tree is grown as an ornamental shade tree, and as a fast growing plant used for reforestation also. The tree is extensively used as a pulp source. A gum, resembling Kino (called katurai in which language), fresh when red, nearly black after exposure, exudes from wounds of the tree. This astringent gum is partially soluble in water and in alcohol, and is applied to fishing cord, to make it more durable. *Pepper* vines (*Piper nigrum*) are sometimes grown on and in the shade of the Agati. It is a suitable plant for agro forestry, capable of growing in paddy fields, where trees are not normally grown. However, botanist’s quote three undesirable features i.e. (i) short lived (ii) shallow rooted and subject to wind throw, and (iii) being prolific seeder, the pods are often considered as a litter.

In India, *Sesbania* has a long history of agricultural use primarily as green manure and as a source of forage. Bark, leaves, gums, and flowers are used for medicinal purpose.

Leaves are poulticed onto bruises. In Yunani the tonic of leaves are used in biliousness, fever and nyctalopia. The juice of leaves is used for headache and nasal catarrh, mixed with stramonium. Malayans apply crushed leaves to sprains. They gargle the leaf juice to cleanse the mouth and throat. In Java leaves are chewed to disinfect the mouth and throat. The tender leaves, green fruit, and flowers are eaten alone as vegetable or mixed into curries or salads. The dried leaves of both *Sesbania grandiflora*
and *Sesbania sesban* are used in some countries as tea and are considered to have antibiotic, anti-helminthic, anti tumor and contraceptive properties.

In small doses, the bark is used for dysentery, in large doses as laxative and in still larger doses used as emetic. Powdered bark is applied to scabies. Philippines use the powdered bark for hemoptysis. The powdered bark is also recommended for ulcers of the mouth and alimentary canal. In Java, the bark is used for thrush and infantile stomach disorders. The astringent bark is used in treating small pox and other eruptive fevers. Cambodians use the bark for diarrhoea, dysentery and paludism. The inner bark can serve as fiber and the white, soft wood not too durable, can be used for making corks. In Asian countries, like bamboo, the wood is used for construction of houses. Dried and powdered bark is used as a cosmetic in Java. An aqueous extract of bark is said to be toxic to cockroaches.

Rheumatic swellings are poulticed or rubbed with aqueous decoctions of the powdered roots of the red flowered variant. Paste of the root is poulticed onto painful swellings. Indians apply the roots for rheumatism.

The juice of flowers is used for headache and nasal catarrh, mixed with stramonium. The juice from the flowers is used to treat headache, head congestion, or stuffy nose. As a snuff, the juice is supposed to clear the nasal sinuses. In Amboina, flower juice is squeezed into the eye to correct dim vision. Cambodians use the flowers as emollient and laxative. Flowers may be dipped in butter and fried in ghee.
1.2 REVIEW OF LITERATURE

The literature available on herbal medicines dated back to the early age of the Rig veda (4500-1600 BC). The Rig veda mentions 67 herbal drugs, the Yajur veda 81 and Atharua veda about 290.

Charaka Samhita (700BC), first recorded treatise Ayurveda was followed by Sushruta Samhita (600 BC) and both compiled a centuary apart believed to be not later than 900 BC. Charaka Samhita gives the properties of drugs prepared from indigenous plants, their uses and the methods of their administration.

Hindu thoughts influenced the Greek medical literature in the fifth and 6th centuries BC. About 400BC, a Greek named Hippocrates asserted that medicine was a science and art rather than religious ritual full of imagination and mystery.

Pliny was the most important writer on plants in ancient Rome, and seven out of his 37 volumes of Historia Naturale were composed in 77AD, which was devoted to medicinal plants.

Malayans apply crushed leaves of Sesbania to sprains. They gargle with the leaf juice to cleanse the mouth and throat. In small doses, the bark is used for dysentery, in large doses as laxative, in still larger doses, as emetic. Powdered bark is applied to scabies. Philippines use the powdered bark for hemoptysis. The powdered bark is also recommended for ulcers of the mouth and alimentary canal. In Java, the bark is used for thrush and infantile disorders of the stomach. Leaves are chewed to disinfect the mouth and throat (Kirtikar and Basu, 1999).
According to World Health Organization, medicinal plants would be the best source to obtain a variety of drugs. About 80% of individuals from developed countries use traditional medicine, which has compounds derived from medicinal plants. Therefore, such plants should be investigated to understand their properties, safety and efficiency better. The use of plant extracts and phytochemicals, both with known antimicrobial properties, can be of great significance in therapeutic treatments. In the last few years, a number of studies have been conducted in different countries to prove such an efficiency (Uma et al., 2009).

Many plants have been used because of their antimicrobial traits, which are due to compounds synthesized in the secondary metabolism of the plant. These products are known by their active substances. For example, the phenolic compounds are part of the essential oils, as well as tannin (Venkateswaran and Pari, 2003).

Herbal medicines play an important role in clinical cancer therapy and have been widely accepted as potential high quality pools in drug screening around the world, owing to their unmatched chemical diversity and less side-effects. Recently there have been a significant increase in the exploitation of herbal medicine and herbal remedies are perceived as being natural and safe (Bastert, 2001).

**Distribution of medicinal plants**


**Phytochemicals**

Singh et al., 1988 estimated the flavoniod content of some arid zone plants of Rajasthan.

Harborne, 1998 studied the phytochemical consitutents of three different species of *Sesbania*.

*Sesbania grandiflora* extracts showed the presence of alkaloids, carbohydrates, tannins, proteins and it also exhibited the presence of glycosides, saponins, triterpenes, diterpenes and flavanoids in its extract (Harborne, 1998).

Kirithikar and Basu (1999) found that preliminary phytochemical screening of methanolic extract of *Sesbania grandiflora* revealed the presence of saponins, tannins and triterpenes. Oral administration of extract in two different doses showed a significant reduction in ulcer index, gastric volume, free acidity, total acidity as compared to the control group.
Ahmed-El-Sawi et al., 1999 estimated flavonoids and antimicrobial volatiles from *Adhatoda vasica* Nees. Ahmed and Beg-Arina (2001) isolated phytochemicals from 45 Indian medicinal plants and tested their antimicrobial potential. Kapoor and Ranga (2003) made an account on flavonoids from Asteraceous medicinal plants found in Rajasthan desert. Habbu et al., 2009 isolated flavanoid sulphates from roots of the *Argyreia speciosa*, a plant commonly known as Vrudhadaruka in Indian system of medicine. They identified the flavanoids and tested their antimicrobial activity.

Soliman et al., 2002 isolated an acylated kaempferol glycoside, namely kaempferol-3-O-α-L-(2,3-di-E-pcoumaroyl)-rhamnoside (1) from the flowers of *Foeniculum vulgare* Mill. and *F. dulce* DC for the first time from family Apiaceae. In addition, the different organs of both plants afforded six flavonoid glycosides - namely afzelin (kaempferol-3-O-α-L-rhamnoside) (2), quercitrin (3), isorhamnetin-3-O-β-D-glucoside (4), isoquercitrin (5), rutin (6), and miquelianin (quercetin-3-O-β-D-glucuronide) (7). Structure elucidation of the above mentioned flavonoids was achieved by UV, $^1$H- and $^{13}$C-NMR, $^1$H-$^1$H COSY, HMQC and EI-MS.

Hadizadeh et al., 2003 isolated kaempferol from the fresh flower petals of *C. sativus* L. (Iridaceae) as the sole component. The structure of the compound was determined by chemical and spectroscopic methods.

Furusawa et al., 2005 isolated fourteen flavonol glycosides including two new compounds from the leaves of two *Diospyros* plants (*D. cathayensis* and *D. rhombifolia*). The structure of isolated compounds was determined by spectroscopic analysis. The scavenging activity of 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical of the isolated compounds was also investigated.
Jamal et al., 2008 conducted a phytochemical study on the leaves of *Phyllanthus reticulatus* obtained from a riverside in Taman Negara Kuala Koh, Kelantan. The separations of the chemical components was carried out using different chromatographic techniques and structure of compounds was elucidated by spectroscopic methods including nuclear magnetic resonance as well as mass spectrometry. Three compounds were isolated and identified as lupeol acetate, stigmasterol and lupeol.

Nayeem and Karvekar (2010) isolated gallic acid, ellagic acid, rutin and quarcetin from methanol extract of the leaves of *Tectona grandis*. The structure of the isolated compounds were established based on chemical tests, and melting point determination.

Erosa-Rejon et al., 2010 isolated Kaempferol-3-rutinoside (1), together with α-amyrin, β-amyrin, acetato de taraxasterol and stigmasterol, from the organic crude extract of the leaves of *Sideroxylon foetidissimum* subsp. *gaumeri*. Identification of the various metabolites was carried out by analyzing their spectroscopic data and/or by compared it with those reported in the literature.

Singh et al., 2011 isolated and quantified kaempferol-7-0-glucoside from *Cassia nodosa*, a weed of rainy season usually found in shade of trees, crevices of rocks, prevalently available in Rajasthan, India. kaempferol-7-0-glucoside was identified by them as a new flavonoid, which was found in higher concentration in flowers of this plant (0.21mg/gdw). Among isolated flavonoids, quarcetin was found to be more effective against *E.coli, A.flavus, A.niger, F.moniliforme* and *R.bataticola*.

Momin and Kadam, 2011 investigated the seasonal variation of chlorophyll a, chlorophyll b and carotenoid from leaves of *Sesbania grandiflora, Sesbania cannabina* and *Sesbania bispinosa* which are important medicinal plants. Comparative account of
chlorophyll a, chlorophyll b and carotenoid content of leaves of the three medicinal plants revealed that, the highest amount of chlorophyll a, chlorophyll b and carotenoid content in the leaves of *Sesbania cannabina* were 3.2 mg/g fresh wt, (2.76 mg/g fresh wt.) and (1.44 mg/g fresh wt.) in summer season which showed the highest concentration.

Bhatt (2011) did phytochemical investigation of the ethyl acetate extract of the roots of *Solanum xanthocarpum* growing in Ramnagar region and it led to the isolation of caffeic acid and oleanolic acid using different chromatographic methods (i.e. paper, thin layer, and column chromatography). The structure of these compounds was determined by extensive IR, UV, and NMR spectroscopy.

Rizvi et al., 2011 studied the phytochemicals present in methanol extract of leaf and flowers of *Vernonia cinerea* which indicated the presence of alkaloids, phenols, tannins, saponins and flavonoids.

Bahera et al., 2012 did a preliminary analysis of leaf and bark extracts of *S.grandiflora* and identified various phytochemical constituents using qualitative assays and also through spectroscopic analysis viz., IR, NMR and mass spectroscopy.

Momin and Kadam, 2012 investigated the seasonal variation of protein and amino acid contents in leaves, wood and bark of *Sesbania grandiflora, Sesbania bispinosa* and *Sesbania cannabina* which are the medicinally important plants. Protein content of leaves, wood and bark of *Sesbania cannabina* was found to be in the highest range of 3.957 to 5.939 mg/g dry wt. followed by *Sesbania grandiflora* (range 3.347 to 4.288 mg/g dry wt.) and *Sesbania bispinosa* (range 2.706 to 3.575 mg/g dry wt). Regarding the leaves *Sesbania cannabina* showed the highest level (1.034 to 1.223 mg/g
dry wt) and the wood of *Sesbania bispinosa* showed the lowest a.a content (range 0.399 to 0.458 mg/g dry wt).

Hasan et al., 2012 isolated three new isoflavanoids, isovestitol, medicarpin and sativan, along with another known compound, betulinic acid from the root of *Sesbania grandiflora*. The structure of the isolated compounds was characterised by means of spectroscopic techniques (UV, IR, MS, $^1$H- and $^{13}$C-NMR, DEPT, COSY, HMQC and HMBC) and MS analysis.

Hasan et al., 2012 in another study isolated, characterized and purified compounds from the root of *Sesbania grandiflora*. A new natural compound: 1,1'-binaphthalene-2,2'-diol (1) together with two known isoflavanoids were separated. Complete $^1$H- and $^{13}$C-NMR data of compounds isolated were reported. The structures were determined through various spectroscopic methods notably 1D- and 2D-NMR, UV, IR and HRESIMS.

Mythili and Ravindhran (2012) did the phytochemical analysis of the methanol and ethanol extracts of both stem and root of *Sesbania sesban* which revealed the presence of alkaloids, carbohydrates, proteins, phytosterol, phenol, flavonoids, mixed oil and gum.

Rao and Ahmed (2013) estimated biologically active flavonoidal compounds, quercetin and rutin in ethanolic leaves extract of *Melia azedarach* Linn by using high-performance thin-layer chromatography (HPTLC). This HPTLC method was found to be a simple and convenient method for rapid screening of active compounds and quantification of the investigated flavonoids in *Melia azedarach* Linn.
Sumayya and Srinivasan (2013) based on the preliminary qualitative screening of phytochemicals, performed the quantitative analysis of phytochemicals in the dried powder of araikeerai (*Amaranthus tritis*) and agati (*Sesbania grandiflora*). Biochemical constituents such as total chlorophyll, carotenoids, total carbohydrate, and cellulose of agati were found to be higher than araikeerai. On the contrary, the phytonutrients such as total phenol and protein of agati were experimentally found to be lesser compared to araikeerai.

Leela and Saraswathy (2013) quantified gallic acid, quercetin and lupeol of *Acacia beucophloea* wild flowers using HPTLC method. The results obtained in their study showed that quantification of these compounds showed good resolution and separation from other constituents of extract, and this method due to its simplicity might be useful in standardization of herbal formulations made.

Demirezeri et al., 2013 isolated lupeol, from the chloroform soluble fraction of a methanol extract of the stem-bark of *Lonchocarpus sericeus*, a plant variously used in ethnomedicine to stimulate appetite, treat constipation, backache and convulsion. Its isolation was carried out by a combination of column chromatography and preparative thin layer chromatography (TLC). The structure was determined by analysis of its IR, $^1$H NMR, $^{13}$C NMR, and 2D NMR spectral data, as well as comparison with reported data. This is the first report of isolation of lupeol from the stem-bark of this species.

Mohan kumar et al., 2013 carried out estimation and validation of gallic acid content in polyherbal formulation by HPTLC analysis which is a very cheap and cost effective method. The samples were separated on pre-coated TLC plates with silica gel 60F254. The mobile phase used was Toluene: Methanol: Ethylacetate: Formic acid
The plates were scanned at 280nm using CAMAG densitometer with WINCAT software. The LOD and LOQ for gallic acid were found to be 18ng and 55ng respectively. The developed method was validated as per ICH guidelines.

Dua et al., 2013 analyzed the methanolic extract of Fennel (Foeniculum vulgare) for the presence of polyphenolic compounds, flavonoids and their antibacterial potential. The extract, rich in flavonoids was subjected to HPLC analysis for identification and quantification of phenolics. Gallic acid (277.131μg), caffeic acid (166.062μg), ellagic acid (99.476μg), quercetin (781.986μg) and kaempferol (92.856μg)/g dry seeds were identified.

Lee et al., 2013 identified and quantify a total of 20 polyphenolic compounds in A. absinthium leaves, which include hydroxybenzoic acids, hydroxycinnamic acids, flavonols and other groups of phenolic compounds. The ultra-high performance liquid chromatography (UHPLC) analysis of the phenolic compounds profile revealed that salicylic acid was the dominant phenolic compound present in the leaf extract followed by myricetin, caffeic acid, gallic acid and ferulic acid. Using 3 different solvents (ethyl acetate, methanol and water) they screened for total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activity. Compared with those of major commercial leafy vegetables, leaves of Artemisia contain high contented of phenolic acids and flavonoids, which may provide significant health benefits.

**Antimicrobial**

In a study done by Kubo et al., 1992 aqueous extracts of seed of Sesbania and flowers of Calendula officinalis exhibited better antibacterial activity compared to their
petroleum ether, methanol and ethanol extracts. Among the organisms tested, *S. aureus* was the most susceptible to the aqueous extracts of *Sesbania*.

The antimicrobial compound obtained from *Parthenium argentatum* showed activity against *C. albicans, Torulopsis, Hansemula, K. pneumoniae* and *P. aeruginosa* (Ahmed *et al.*, 1998).

Harborne (1998) studied the effects of phytochemicals and observed the antimicrobial activity of anacardic acid on *S. aureus, Brevibacterium ammoniagenes, Streptococcus mutans* and *Propionibacterium acnes*. Later, the bactericidal activity of anacardic acid and totarol was tested against methicillin resistant strains of *S. aureus* (MRSA) and the synergistic effect of these compounds with methicillin was noted.

Minimum inhibitory concentrations of *Sesbania* leaf extract against the growth of *B. subtilis* and *E. coli* was reported by Arora and Kaur (1999).

Kennet *et al.*, 1999 made an attempt to study the antimicrobial activity of *Caesalpina digyna* extracts against 8 human pathogens. Aqueous extracts of dry fruits and seeds at various concentrations were assessed by disc diffusion method. The fruit extracts showed broad spectrum of antibacterial property and was most effective against *S. aureus* and least effective against *P. aeruginosa*. Regarding seed extracts, *S. typhi* was inhibited the most and *Y. enterocolitica* the least. The minimal inhibitory concentration of fruit extract, ranged from 200-800 µg mL⁻¹ where as for seed extract it was 500-3000 µg mL⁻¹.

Extracts from *Lippia gracilis* and *Xylopia sericea* showed antifungal activity. The investigation of antimicrobial activity as well as cell toxicity of extracts from 30 plant
species against five bacterial species and two fungal species was studied by Nascimento et al., 1990.

Kasture et al., 2002 observed that the aqueous extract of *Sesbania grandiflora* leaves inhibited *S.aureus, P.aeruginosa* and *E.coli* at a concentration of 100µg/mL, 200 µg/mL and 250 µg/mL respectively but it did not inhibit the growth of *B.subtilis* at any of the concentration tested.

Elizabeth (2002) reviewed on studies done by different research groups, and reported that many naturally occurring compounds found in plants have been shown to possess biological activities such as antibacterial, antifungal, antiviral, anti-allergic, anticholinesterase, antioxidant, anti-inflammatory, antitumor, antityrosinase, anti-plasmodial and cytotoxic effects.

Wasantwisut and Thara (2003) isolated a potent compound from the extracts of *Tabebuia impetiginosa*.

Halim (2003) reported that in a study conducted in Brazil, the inhibitory activity of activity of *Vatairea macrocarpa* on *Klebsiella spp.* and *S. aureus* and *Eucaliptus* extract against soil fungi were observed. A more detailed study on antimicrobial compounds was done evaluating extracts from 120 plant species belonged to 28 different families. It was documented that 81 extracts obtained from 58 plants were active against *S. aureus*, and five extracts from four other plants inhibited the growth of *P. aeruginosa*.

Misra and Dixit (2004) observed the MIC values of the fractionated extracts of *S.grandiflora* stem bark against ten strains of pathogenic bacteria. The results indicated that ethyl acetate extract showed the strongest antibacterial activity followed by the
butanol extract. The MIC of ethyl acetate extract against all tested pathogens was lower than that of other solvents.

Ilic et al., 2004 collected Linum capitatum, a plant widespread in carbonate and silicate rocks of south east Europe. They found antimicrobial activity in floral extracts and etheric oil against S. aureus, E.coli, B.subtilis, Ps. aeruginosa and Aspergillus niger, C.albicans and Herpes simplex virus.

Krasaekoopt and Kongkarnchanatip (2005) studied three types of Thai traditional flower vegetables, such as Sesbania grandiflora, Senna siamea and Telosma minor, which were used to check the claim that they cures stomach disorder. Ratio of flower to water of 1:2 was used for water extraction with shaking condition for seven days. The crude extracts were then examined for antimicrobial properties using disc diffusion test on three types of bacteria, B.cereus, E.coli and S. aureus. The results indicated that the seven-day extraction provided the highest anti-microbial property of these three flower vegetables against all bacterium, especially for S. aureus that had the highest inhibition zone. In addition, the antimicrobial activity of Senna and Sesbania were higher than that of Telosma extract. Using column chromatography, the crude flavonoid was separated. The percentage of flavonoid found in Sesbania flower, Senna flower and Telosma were 8.4, 8.6 and 3.4%, respectively. The anti-microbial property of these crude flavonoids were also investigated and the obtained results were corresponding to those of crude extracts.

Kapoor and Kumar (2007) evaluated the antimicrobial principles from herbal plants of Rajasthan desert. In another study Kapoor et al., 2007 evaluated the
antimicrobial activity of some tree species of Hanumangarh district of Rajasthan where as Kapoor et al., (2011) worked out the tilaceous plants for their potential.

Doddola, et al., 2008 observed that the substances extracted from nine known plants in Uruguai did not show any activity against *C. albicans* and *S. cerevisiae*, but inhibited the growth of *B. subtilis, E. coli* and *P. aeruginosa*.

Aiyeguro et al., 2008 observed the antibacterial activity of aqueous decoction of *Sesbania sesban*.

According to Kiruthika et al., 2009 plants are known to contain innumerable biologically active compounds and essential oils occur in sixty families including laminaceae and many of them have been reported to possess biological activites such as antifungal, antibacterial and activity against insects. They opined that these compounds can be easily extracted from plant tissues without any change either in activity or composition.

Lakshmi et al., 2011 evaluated the antibacterial activity of ethanolic and aqueous leaf extract of *Sesbania grandiflora* Linn on selected bacterial species. They showed significant antibacterial activity on *Staphylococcus aureus* and *E.coli* compared to standards.

Sukirtha and Growther (2012) worked on the antibacterial, antifungal and phytochemical analyses of four medicinal plants. *Punica granatum* was more effective followed by *Prosopis juliflora, Psidium guajava* and *Aegle marmelos*.

Kalpana et al., 2012 stated that *Sesbania grandiflora* used in traditional knowledge of ayurveda for various diseases and infections. They quantified the total
flavonoids and phenolic content in acetone extract (70% acetone) of flower part. The total polyphenolic content in the flower extract was found to be 49.1+0.96 mcg/mg and flavonoid content was 12.86+0.72 mcg/mg. Extracts also found to have a good antibacterial activity. The flower extract FE 200 showed the highest inhibition against *P. aeruginosa* (25.00 ± 0.60 mm), followed by *S. aureus* (21.00 ± 0.50 mm) and *E. coli* (19.00±0.60), which are especially responsible for ophthalmic infection, known as conjunctivitis.

Kapoor *et al.*, (2012) screened medicinal plants like *Corchorus depressus, C. tridens, Grewia tenax* and *Capparis decidua* for their antimicrobial potential using ethyl ether and alcoholic extracts of leaves. All of them were found to have inhibitory effect on *S. aureus, E.coli* and *C. albicans*.

Mythili and Ravindran (2012) did *In vitro* biological screening of the methanol stem extract against ten bacterial species and five fungal species. Highly significant activity was observed against the bacteria *Erwinia amylovora* followed by *Escherichia coli*. In the case of fungi, *Curvularia lunata* and *Fusarium oxysporum* were inhibited completely.

Manigandan and Muzammil (2013) investigated the antibacterial activity of ethanolic root extract of *Sesbania grandiflora*.

Vandita *et al.*, (2013) analysed three medicinal plants, *Ricinus communis, Pterocarpus santalinus, Terminalia belerica* for their phytochemical constituents which showed antibacterial activity, antifungal activity and cytotoxicity. In phytochemical analysis, results showed the presence of tannins, alkaloids, cardiac glycosides, terpenoids, flavonoids and steroids in all the three plants. Antibacterial activity was
tested against human pathogenic micro-organisms like *B. subtilis, S. aureus, S. abony, E.coli, P. aeruginosa* by agar well diffusion method. Antifungal activity was tested against certain pathogenic fungi *A. niger, C. albicans, Rhizopus, Lasiodiploidia theobromae* and *A. solani* by pour plate method. The cytotoxic effect of selected plants were tested against HEK293T (Human embryonic kidney cell line) and c2c12 (Mouse, Muscle cell line) by MTT assay.

Ahmed *et al.*, (2013) undertaken a study on antimicrobial activity of the ethanol, ether (diethyl ether) and chloroform extracts of *S. sesban* bark against five Gram-positive bacteria, nine Gram-negative bacteria and seven fungi by disc diffusion and broth macro-dilution assay. The zone of inhibition was observed with almost all bacteria and fungi with some exceptions. Findings of the study justified the use of the plant in traditional medicine and suggested for further investigation.

**Antioxidant activity**

Several plant extracts are found to have antioxidant properties which was revealed by many researchers. Garlic (Gupta, 1988), ginseng (Pande *et al.*, 1998a), *aloe vera* (Pande *et al.*, 1998b), Podophyllum (Goel *et al.*, 1999), Ocimum (Umadevi *et al.*, 2000), *Rubia cordifolia* (Pandey *et al.*, 1994); *Withania* (Bhattacharya *et al.*, 1996; Pande and Kan 1997); caffeine from Coffee (Hebbar *et al.*, 2000) have been investigated for their antioxidant property.

Demmig (1990) and Schubert *et al.*, (1994) observed the role of zeaxanthin, a carotenoid that protect the photosynthetic apparatus when photon density was high.
Stocker and Frei (1991) observed Vit. C, as the most important antioxidant in extracellular fluids and showed that it had many cellular activities (Moser and Benedich, 1991).

Graf (1992) showed that the ferulic acid present in plant, accounted for its antioxidant property.

Cotelle et al., (1993) opined that polyphenolic flavonoids inhibit lipid peroxidation by forming less reactive arlyloxyxl radicals with free radicals.

Bhattacharya et al., (1996); Lee et al., 1996 and Yen et al., (1996) showed that a large number of compounds from various plant sources possess antioxidant properties.

Rajammal et al., (1996) studied the consumption pattern of β-carotene rich foods from 500 households of Coimbatore district. Results indicated that amaranth tender (Amaranthus gangeticus) and Ponnanganni (Albernanthera sessilis) were carotene – rich foods available round the year for the households.

According to Gopalan et al., (1996) Amaranthus had 14, 190 mg/ 100g of carotein and Spinacia has 5, 580 mg/ 100 g of carotene content. Chanda (1997) stated that Vit E, Vit C, selenium, phenolic compounds, carotenoids, flavonoids etc., are having potent antioxidant property. Ferrers et al., (1997) isolated new naturally occuring flavonoids from Spinacia leaves.

Fruta et al., (1997) found out that beans, cloves, turmeric and mustard were found to have antioxidant property.
According to Casten-miller and West, 1998 carotenoids are important micronutrient and so far, almost 600 carotenoids had been identified and described. Evidences are available that β-carotene can indeed function as an effective radical trapping antioxidant (Sisodia et al., 1999). According to Conn et al., (1991), the quenching efficiency of carotenoids increases with increasing number of conjugated bonds.

Al–Sereiti et al., (1999) worked on and found out anti-oxidant and anti-peroxidant properties of carotenoids.

Aqil et al., (2001) evaluated antioxidant property of peppermint oil.

Bergman et al., (2001) studied the chemical identity of several antioxidants isolated from spinach leaves.

Bergam et al., (2001) reported that Spinacia oleracea, belonging to family Chenopodiaceae had many active fractions with antioxidant properties.

Verma et al., (2002) observed that Amaranthus gangeticus widely considered as a weed had brain protective activity due to the presence of radio protective compounds.

Fuenjiep et al., (2002) isolated chalconoid and stilbenoid glycosides from Guibourtia tessmanii with antioxidant, anticancer and antiviral properties.

Itharat et al., (2004) worked on the in vitro cytotoxic activity of Thai medicinal plants used traditionally to treat cancer.
Dhalwal et al., (2007) used densio-metric method for the analysis of umbelliferone, psoralen and engenol in herbal material using HPTLC and they showed that was a rapid method.

Kueta et al., (2008) identified antitumour and antioxidant properties of *Bersama engleriana*, a plant belonged to the family *Melianthaceae*.

Fawzy et al., (2008) observed the antidiabetic and antioxidant activities of major flavonoids isolated from *Cynanchum acutum L. (Asclepiadaceae)*, a plant available in Egypt.

Prasad et al., (2008) worked on the protective effect of mango extract against androgen induced oxidative stress in swiss albino mice model.

Nanasombat and Teckchuen (2009) screened Thai local vegetables (20 species) for their antimicrobial and antioxidant activities. Methanolic extracts of *Cassia siamea, Garcinia cowa, Limnophila aromatica* and *Polygonum odoratum* exhibited strong antioxidant and antibacterial activities. Among all plant extracts, the extract of *P. odoratum* had the highest phenolic content and antioxidant activity. These plant extracts were also tested for cytotoxicity against human oral epidermal carcinoma (KB), breast adenocarcinoma (MCF-7) and small cell lung carcinoma (NCI-H187). *P. odoratum* extract was moderately active against MCF-7. Major types of active compounds in *P. odoratum* extract were identified by HPLC method. Flavonoids found in this plant were rutin, catechin, quercetin, kaempferol and isorhamnetin. Among these compounds, rutin was found in the highest amount (3.77% w/w dry extract).
Kuete (2010) in another study identified the pharmacological potential of cameroonian plants.

Shyamala – Gowri and Vasantha (2010) observed the free radical scavenging capacity and antioxidant activity of ethanol and acetone extracts of *S.grandiflora* leaves and floweres. The result indicated that extracts of leaves and contained higher concentration of total phenolics than the respective solvent extracts of flower.

Mbaveng *et al.*, (2011) worked on the methanolic extract of leaves, bark and roots of four Cameroonian medicinal plants *Bersama engleriana, Cupressus lusitanica, Vitellaria paradoxa* and *Guibourtia tessmannii* for antioxidant and anticancer properties. Result showed that the extract contained compounds belonging to the classes of phenols and terpenoids.

Longhi *et al.*, (2011) showed that *M. pruriens* had high antioxidant capacity, although not superior to isolated levodopa antioxidant capacity.

Padmaja *et al.*, (2011) worked on the aqueous leaf extract of *Adhatoda vasica* Nees and *Sesbania grandiflora* (L.) Pers, two important medicinal plants native to India. The content of total phenolics (expressed as mg of gallic acid equivalents/gm) and total flavonoids (expressed as mg of quercetin equivalent/gm) and ascorbic acid were determined along with antioxidant enzymes. The results indicated that *A. vasica* and *S. grandiflora* showed significant antioxidant activity *in vitro*. The enzymatic and non enzymatic antioxidants in *A. vasica* were found to be more than that of *S. grandiflora*. Similarly the antioxidant and radical scavenging activities of *A. vasica* were found to be more significant than *S. grandiflora*. 
Shankarlal et al., (2011), investigated antimicrobial (antibacterial and antifungal) and antioxidant properties of *Salmacis virgulata* methanolic extract. The antioxidant property of the extract was assessed by 2, 2- diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging method. DPPH free radical scavenging effect of the extract was compared with standard antioxidant ascorbic acid and it showed significant result. *Salmacis virgulata* (77.51%) showed potent activity at the concentration of 100μg/mL compared to standard ascorbic acid. This study showed that methanolic extract of *Salmacis virgulata* had potential antimicrobial and antioxidant activity.

Jain and Jain (2011) designed a study to explore the antioxidant activity of some medicinal plants traditionally used in treatment of cancer in Chhattisgarh (Herbal state) of India. The ethanolic extracts of five medicinal plants including *Artocarpus heterophyllus, Alangium salvifolium, Buchanania lanzan, Sesbania grandiflora* and *Wrightia tinctoria* were evaluated for their total phenolic content and in-vitro antioxidant activity by 1, 1’-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging method, reducing power assay and total antioxidant capacity (Phosphomolybdenum reduction Assay). All five plants showed antioxidant activity but *Buchanania lanzan* was found to be the most effective antioxidant.

Kale et al., (2012) investigated the hepatoprotective activity of ethanolic and aqueous extract of *S.grandiflora* flower in CCl₄ induced hepatotoxicity models in rats. Their finding suggested that the floral extract at the rate of 500mg/Kg brought out functional improvements of hepatocytes.

Sarkar et al., (2012) designed a study to check the antioxidant activity of *Sesbania grandiflora*. The extraction of fruit of *Sesbania grandiflora* was carried out by
using the solvent aqueous methanol. The antioxidant activity of plant *Sesbania grandiflora* was determined by using different *in vitro* antioxidant assays. The TP (Total Phenolic) and TF (Total Flavonoid) contents in extracts of the plant *Sesbania grandiflora* were found to be in the range of 48.2±0.74 mcg/mg and 11.75±0.51 mcg/mg, respectively.

Bhadoriya *et al.*, (2012), investigated on the antioxidant capacities and phenolic content of gallic acid isolated from plant *Caesalpinia decapetala*, a plant used to treat burns, biliousness and stomach disorders. The total phenolic content was found to be 4.31% (w/w). Isolation of gallic acid with optimum yield was performed using a mixture of solvents (Ethanol: Water 65:35) which showed significant *in vitro* free radical scavenging activity in both models but in ABTS assay significant % inhibition of free radical was observed compared to DPPH assay.

Narayanasamy (2012) worked on *Zanthoxylum tetraspermum* W.A. (*Rutaceae*) a medicinal plant traditionally used by the tribals. Their investigation dealt with antioxidant activity of stem bark extract and they evaluated using a series of *In-vitro* assays involving free radicals and reactive oxygen species (ROS). The hydroethanolic plant extract exhibited its scavenging effect in concentration dependent manner on superoxide anion radicals, hydroxyl radicals, hydrogen peroxide and DPPH radical scavenging activity.

Otles and Yalcin (2012) collected different types of nettles (*Urtica dioica*) from different regions to analyze phenolic compounds. Nettle samples were collected from coastal part of (Mediterranean, Aegean, Black sea, and Marmara) Turkey. Phenolic profile, total phenol compounds, and antioxidant activities of the samples were analyzed.
According to Okonkwo and Po (2013) *Landolphia owariensis* *P. beauv* is a tropical climber, and is economically important for latex/rubber and folklore medicine. The acetone extract was fractionated serially into chloroform, ethylacetate and acetone to obtain the respective solvent fractions. Ultraviolet/visible light, infrared, $^1$H-NMR, $^{13}$C-NMR spectroscopy and gas chromatography-mass spectrometry of LOSSP/CF-1 indicated it to be ascorbic acid. They isolated and characterized important active pharmaceutical ingredients from *Landolphia owariensis* stringy seed pulp with strong anti-oxidant effect.

**Anticancer**

Manoharan *et al.*, (2010), worked on 7, 12-dimethylbenz [a] anthracene (DMBA)-induced hamster buccal pouch carcinogenesis which closely mimics with human oral tumour on biochemical, morphological and histological aspects as well as at molecular level.

Balakrishnan *et al.*, (2010), designed a study to check the over production of reactive oxygen species (ROS), chronic inflammation, oxidative modification of DNA bases, impairment in antioxidant defense system, defect in the activities of detoxification cascade and deregulated expression pattern of molecular markers of DMBA-induced oral carcinogenesis.

Garcia-Montesinos-Perea *et al.*, (2005), studied that the pathogenesis of oral cancer would help to improve its diagnosis, prognosis and elaboration of new treatment approaches. Analysis of expression pattern of molecular markers underlying oral squamous cell carcinoma can thus help to predict the behaviour of cancer.
Cichocki et al., (2010), observed that NFκB has crucial role in cell survival, cell adhesion, inflammation, differentiation and cell growth. Deregulation of NFκB has therefore been implicated in the pathogenesis of several cancers including oral cancer

Wang et al., (2011), observed that genes which are negatively regulate apoptosis in tumor cells are controlled by NFκB activation.

Higdon and Frei, (2003), identified that consumption of tea has been associated with reduced incidences of cancers of the breast, cervix, colon and rectum, gall bladder, liver, lung, nasopharynx, pancreas, prostate, stomach, ovary and uterus

Nooroozi et al., (1998) used the comet assay to evaluate the antioxidant capacity of some major dietary flavonoids, with Vit.C as a positive control.

Mastaloudis et al., (2004), used comet assay to determine whether six weeks of supplementation with Vitamin C and Vitamin E can alleviate exercise induced DNA damage

Balakrishnan et al., (2008) and Sindhu and Manoharan, 2010, demonstrated DMBA-induced DNA damage in the bone marrow cells of golden syrian hamsters

Mendiola-Cruz et al., (1999), studied the involvement of cytoprotectors in removal of DNA lesions such as radiation-induced base modification through a process of incision, excision, replacement, of lesion at the sites of damage and rejoining DNA strand

Hofer et al., (2000) and Muller et al., (1996), stated that the Misjoined or un repaired DNA double strand breaks can produce deletion, translocations and acentric
or dicentric chromosomes. Damage to chromosomes is also manifested as breaks and fragments, which appears as micronuclei in the rapidly proliferative cells.

1.3 OBJECTIVES OF THE PRESENT STUDY

The prime objectives of the present study are to evaluate the pharmacological potential of *S. grandiflora* leaves and to give a scientific validation in terms of phytochemical analysis. To achieve this target the following objectives are laid. They are

(i) To extract the phytochemicals from *Sesbania grandiflora* leaves using solvents viz., petroleum ether, chloroform, methanol, ethanol, and acetone

(ii) To evaluate the pharmacological properties of the extracts.

(iii) To estimate the phytochemicals present in all extracts

(iv) To separate the chemical compounds present in biologically active extract.

(v) To elucidate the structure of the separated phytochemicals using advanced techniques and

(vi) To evaluate the biological activities such as antimicrobial, antioxidant, anti-inflammatory, anticancer activities and antigenotoxic effect.