CHAPTER 1

INTRODUCTION
INTRODUCTION

The use of plants as medicines predates written human history. A large amount of archaeological evidence exists which indicates that humans were using medicinal plants during the Paleolithic, approximately 60,000 years ago (Sumner et al., 2000). Plant samples gathered from prehistoric burial sites are an example of the evidence supporting the claim that Paleolithic peoples had knowledge of herbal medicine. Ethnobotany (the study of traditional human uses of plants) is recognized as an effective way to discover future medicines. In 2001, researchers identified 122 compounds used in modern medicine which were derived from "ethnomedical" plant sources; 80% of these have had an ethnomedical use identical or related to the current use of the active elements of the plant (Fabricant et al., 2001). Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies, including aspirin, digitalis, quinine, and opium (Swain et al., 1968).

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, some of them alkaloid such as poppy, henbane, and mandrake (Kelly, 2009). The Chinese book on roots and grasses “Pen T’Sao,” written by Emperor ShenNung circa 2500 BC, treats 365 drugs (dried parts of medicinal plants), many of which are used even nowadays such as the following: Rheurhisoma, camphor, Theae folium, Podophyllum, the great yellow gentian, ginseng, jimson weed, cinnamon bark, and ephedra (Bottcher, 1965, Wiart, 2006). The Indian holy books Vedas mention treatment with plants, which are abundant in India. Numerous spice plants used even today originate from India: nutmeg, pepper, clove, etc (Tucakov, 1971). The Ebers Papyrus, written circa 1550 BC, represents a collection of 800 prescriptions referring to 700 plant species and drugs used for therapy such as pomegranate, castor oil plant, aloe, senna, garlic, onion, fig, willow, coriander, juniper, common century, etc (Glesinger, 1954; Tucakov,1964)

The earliest mention of the medicinal use of plants has been found in Rigveda, which was written between 4000 and 1600 BC. Atharvaveda describes varied use of drugs while ‘Ayurveda’ which is considred as an upaveda includes utilization of medicinal
plants for restoring normal physical fitness. Materialization of ‘SushrutaSamhita’ and ‘CharakaSamhita’ (1000 BC) incorporates compressive chapters on the therapeutic use of various plant species.

Interest in traditional drugs is not new but has been spurred over period of time by methodological advances in Phytochemistry, growing number of ethno-botanical studies and an upsurge of interest in renewable resources and traditional medicines.

As reported by National Medicinal Plant Board, India has 15 Agroclimatic zones and 17000-18000 species of flowering plants of which 6000-7000 are estimated to have medicinal usage in folk and documented systems of medicine, like Ayurveda, Siddha, Unani and Homoeopathy. About 960 species of medicinal plants are estimated to be in trade of which 178 species have annual consumption levels in excess of 100 metric tons. Medicinal plants are not only a major resource base for the traditional medicine & herbal industry but also provide livelihood and health security to a large segment of Indian population. The domestic trade of the AYUSH industry is of the order of Rs. 80 to 90 billion (1US$ = Rs.50). The Indian medicinal plants and their products also account of exports in the range of Rs. 10 billion. There is global resurgence in traditional and alternative health care systems resulting in world herbal trade which stands at US$ 120 billion and is expected to reach US$ 7 trillion by 2050. Indian share in the world trade, at present, however, is quite low (Grover, 2002).

*Commiphora wightii* (Arn.)Bhandari has been used for its cardio vascular benefits in Bangladesh, India and Pakistan since very long time ago (Deng, 2007). In the middle 1990s, guggul was introduced into the Western world (Singh *et al*., 1994). Guggul is available in the United States and other Western countries as an over-the-counter dietary supplement (Deng, 2007). Guggul has been a key component in ancient Indian Ayurvedic system of medicine. But has become so scarce because of its overuse in its two habitats in India where it is found —Gujarat and Rajasthan that the World Conservation Union (IUCN) has enlisted it in its Red Data List of endangered species (Soni, 2008). Guggul produces a resinous sap known as gum guggul. The extract of this gum, called gugulipid, guggulipid or guglipid, has been used in UNANI & Ayurvedic medicine, a traditional UNANI medicine, for nearly 3,000 years in India (Indian herb, 2002). The active ingredient in the extract is the steroid guggulsterone, which acts as
an antagonist of the farnesoid X receptor, once believed to result in decreased cholesterol synthesis in the liver. However, several studies have been published that indicate no overall reduction in total cholesterol occurs using various dosages of guggulsterone, and levels of low-density lipoprotein ("bad cholesterol") increased in many people (Szapary et al., 2003 and Sahni et al., 2005)

Guggal is also used for treating rheumatoid arthritis, neurological disorders, skin infections, bone fractures, inflammation, obesity, cardiovascular diseases, lipid disorders and obesity in humans. The resinous portion of guggal carries significant anti-inflammatory, anti-rheumatic and hypocholesterolemic/hypolipemic activity. It is also a rich source of steroids which may find use as an alternative raw material for the synthesis of important corticosteroid drugs such as dexamethasone and betamethasone.

Guggul is medicinally important and is used in the treatment of hypercholesterolemia and cardiovascular diseases (Singh et al., 1994; Deng, 2007), it is also shown to have anticancerous activity (Xiao and Singh, 2008). The major components of gum guggul are conjugates of terpenes, lactones, steroids that are produced constitutively as secondary metabolites (El Ashry et al., 2003) for defence against pests (Becerra, 1997). Fructans, polysaccharides and phenolics are also present in huge quantities in the plant.

The plant has high amount of phytochemical compounds which are having multiple medicinal uses. So exploitation of guggal by the pharmaceutical companies has increased. Because of the it’s specific ecological limitations, limited distribution, low germination rate and low seed reproducibility rate the plant is depleting in the nature. The plant also has a very slow growth and multiplication rate in the natural environment. As a result of these factors the plant is kept in the IUCN red data list of endangered species. So this plant requires a detailed study which will include a suitable protocol for proper multiplication and conservation of this plant.

PLANT TISSUE CULTURE

*Commiphora wightii* (Arn.)Bhandari being a Red Data Book enlisted endangered species several techniques have and are being developed to conserve it. Plant tissue culture is an
important technique used for the plant multiplication and which has also proved helpful in conserving several endangered species.

*In vitro* cell and tissue culture methodology is envisaged as a mean for germplasm conservation to ensure the survival of endangered plant species, rapid mass propagation for large-scale re-vegetation and for genetic manipulation studies. Plants Combinations of *in vitro* propagation techniques (Fay, 1992) and cryopreservation may help in conservation of biodiversity of locally used medicinal plants.

Plant research often involves growing new plants in a controlled environment. These may be plants that we have genetically altered in some way or may be plants of which we need many replicas. These things can be accomplished through tissue culture of small tissue pieces from the plant of interest. These small pieces may come from a single mother plant or they may be the result of genetic transformation of single plant cells which are then encouraged to grow and to ultimately develop into a whole plant. Tissue culture techniques are often used for commercial production of plants as well as for plant research.

Tissue culture has emerged as a potent tool for rapid multiplication and propagation of trees (Durzan, 1986) and has been successfully employed for the propagation of various tree species (Mascarenhas and Muralidharan, 1989). The drawbacks of seedlings and cuttages can be overcome to a great extent through biotechnological intervention such as micropropagation which would result in uniform good quality planting material of any elite lines. Successful micropropagation of woody plants is relatively a recent practice (Thorpe, 1990; Bajaj, 1997).

*In vitro* conservation of *Aldrovandavesiculosa L.*, an endangered plant species, has been successfully conducted at Hiroshima University, Japan (Katsuhiko et al., 1997). *Leontopodiumalpinum L.* (Composite), native to Romania, being extremely ornamental, and alsocontaining precious secondary metabolites has been excessively collected and was on the verge of extinction. The species was successfully micropropagated, and the *in vitro* conservation protocolfor the species developed (Zapartan, 1996). Plant tissue culture and conservation techniques havebeen also recently developed and applied to an endemic and threatened Spanish plant species *Minuartiavalentina L.* (Ibanez et al., 1998),
and to a rare Scottish plant Primula scotia L. (Benson et al., 2000). *Lilium speciosum* Thunb. var. *gloriosoides* Baker, a native perennial bulbous plant only known at altitudes of 150-600 m in Northern Taiwan is a high value ornamental specimen which is becoming rare. Mass propagation of this plant was done by *in vitro* propagation (Chang *et al.*, 2000).

**PHYTOCHEMISTRY**

In recent years phytotherapy is rapidly evolving throughout the world. Phytochemicals are the naturally occurring biochemicals in the plant that gives plant their colour, flavour, smell and texture. Plant produces both primary and secondary metabolites in its body. Primary metabolites are involved in growth, development and reproduction of the plant. It mainly helps in maintaining the normal physiological process in the plant. Secondary metabolites are organic compounds that are not directly involved in the normal growth, development, or reproduction of an organism. Secondary metabolism facilitates the primary metabolism in plants. Secondary metabolites are often restricted to a narrow set of species within a phylogenetic group. Secondary metabolites often play an important role in plant defense against herbivore and other interspecies defenses. Secondary plant metabolites are also used in signaling and regulation of primary metabolic pathways. Plant hormones, which are secondary metabolites, are often used to regulate the metabolic activity within cells and oversee the overall development of the plant. As mentioned above in the history tab, secondary plant metabolites help the plant to maintain an intricate balance with the environment, often adapting to match the environmental needs. Plant metabolites that color the plant are a good example of this, as the coloring of a plant can attract pollinators and also defend against attack by animals.

Secondary metabolites are used in pharmaceuticals for production of drugs. Medicinal plants continue to be a major source of drugs and natural products on the basis of their therapeutics (Lown, 1993) in virtually all cultures (Anwannil and Atta, 2006). The plants possess potent bioactive compounds capable of preventing and treating most oxidative related diseases, diabetes, cancer (Dahanuka *et al.*, 2000) and have often been used in folkloric medicine (Wang *et al.*, 2007). In developing countries, the use of medicinal plants in the treatment of infectious disease and diabetes are rife and reasons include the high cost of effective drugs (Okeke *et al.*, 1999). However, potential indigenous plants
exploited for medicinal purposes have to undergo basic phytochemical screening and bioassay as first step towards the ultimate development of drugs (Odebiyi and Sofowora, 1978). Secondary metabolite exerts in general a profound physiological effect on their accumulation during different seasons and environment.

Secondary metabolite consists of various compounds like flavonoids, tannins, phenols, saponins, steroids, terpenoids etc.

**FLAVONOIDS**

Flavonoids are present almost universally in higher plants and contribute to the flower and fruit colour. They impart mostly red, yellow, blue and violet colour to plant organs. Chemically they are phenolic compounds and most of them have flavone nucleus with two side aromatic rings. Flavones occur as glycosides in plants. These compounds appear to play vital role in defence against pathogens and predators and contribute to physiological functions (Brenda, 1998). Flavonoids are plant-based compounds with powerful antioxidant properties found in many fruits and vegetables like blueberries and grapes. Flavonoids have medicinal properties that include the ability to defend against cancer, viruses, not to mention anti-microbial, anti-histamine and anti-inflammatory characteristics. Flavonoids were referred to as Vitamin P (Benthsath et al., 1937) (probably because of the effect they had on the permeability of vascular capillaries) from the mid-1930s to early 50s, but the term has since fallen out of use (Mobh, 1938).

According to the IUPAC (McNaught, 1997) nomenclature they can be classified into:
- flavonoids or bioflavonoids.
- isoflavonoids, derived from 3-phenylchromen-4-one (3-phenyl-1,4-benzopyrone) structure
- neoflavonoids, derived from 4-phenylcoumarine (4-phenyl-1,2-benzopyrone) structure.

The three flavonoid classes above are all ketone-containing compounds, and as such, are anthoxanths (flavones and flavonols). The three cycle or heterocycles in the flavonoid backbone are generally called ring A, B and C. Ring A usually shows a phloroglucinol substitution pattern.
SAPONINS

Saponins are a class of chemical compounds found in particular abundance in various plant species. More specifically, they are amphipathic glycosides grouped phenomenological by the soap-like foaming they produce when shaken in aqueous solutions, and structurally by having one or more hydrophilic glycoside moieties combined with a lipophilic triperpene derivative (Hostettmann, 1995 and “Saponins”, 2009). Saponins are mainly produced by plants and animals and some bacterias (Riguera, 1997; Yoshiki et al., 1998).

STEROIDS

Phytosterols (referred to as plant sterol and stanol esters) are a group of naturally occurring compounds found in plant cell membranes. Phytosterols are similar to cholesterol which occur in plants and vary only in carbon side chains and/or presence or absence of a double bond. Because phytosterols are structurally similar to the body’s cholesterol, when they are consumed they compete with cholesterol for absorption in the digestive system. As a result, cholesterol absorption is blocked, and blood cholesterol levels reduced. Stanols are saturated sterols, having no double bonds in the sterol ring structure. More than 200 sterols and related compounds have been identified (Akhisa, 1991). Free phytosterols extracted from oils are insoluble in water, relatively insoluble in oil, and soluble in alcohols.

TANNINS

Any of a group of astringent vegetable principles or compounds, chiefly complex glucosides of catechol and pyrogallol, as the reddish compound that gives the tanning properties to oak bark of the whitish compound that occurs in large quantities in nutgalls. Tannins may be classified chemically into two main groups, hydrolysable and condensed. Hydrolyzable tannins (decomposable in water, with which they react to form other substances), yield various water-soluble products, such as gallic acid and protocatechuic acid and sugars. Gallotannin, or common tannic acid, is the best known of the hydrolysable tannins. Tannins are fairly frequently encountered in food products of
plant vegetable origin such as tea and many fruits and are found to have antimicrobial activities (Lewis and Ausubel, 2006).

**PHENOLS**

Phenolic compounds are plant secondary metabolites that constitute one of the most common and widespread groups of substances in plants. As stated by Harborne (1989), the term "phenolic" or "polyphenol" can be precisely defined chemically as a substance which possesses an aromatic ring bearing one (phenol) or more (polyphenol) hydroxyl substituents, including functional derivatives (esters, methyl ethers, glycosides, etc.): as a general rule, the terms phenolics and polyphenols refer to all secondary natural metabolites arising biogenetically from the shikimate-phenylpropanoids-flavonoids pathways, producing monomeric and polymeric phenols and polyphenols.

Natural phenolic compounds play an important role in cancer prevention and treatment. Phenolic compounds from medicinal herbs and dietary plants include phenolic acids, flavonoids, tannins, stilbenes, curcuminoids, coumarins, lignans, quinones, and others. Various bioactivities of phenolic compounds are responsible for their chemopreventive properties (e.g., antioxidant, anticarcinogenic, or antimutagenic and anti-inflammatory effects) and also contribute to their inducing apoptosis by arresting cell cycle, regulating carcinogen metabolism and ontogenesis expression, inhibiting DNA binding and cell adhesion, migration, proliferation or differentiation, and blocking signaling pathways.

**TERPENOIDS**

The terpenoids sometimes called iso-prenoids, are a large and diverse class of naturally occurring organic chemicals similar to terpenes, derived from five-carbon isoprene units assembled and modified in thousands of ways. Most are multicyclic structures that differ from one another not only in functional groups but also in their basic carbon skeletons. These lipids can be found in all classes of living things, and are the largest group of natural products.

Plant terpenoids are used extensively for their aromatic qualities. They play a role in traditional herbal remedies and are under investigation for antibacterial, antineoplastic,
and other pharmaceutical functions. Terpenoids contribute to the scent of eucalyptus, the flavors of cinnamon, cloves, and ginger, the yellow color in sunflowers, and the red colour in tomatoes. Well known terpenoids include citral, menthol, camphor, salvinorin in the plant *Salvia divinorum* the cannabinoids found in cannabis, ginkgolide and bilobalide found in *Ginkgo biloba* L., and the curcuminoids found in turmeric and mustard seed.

**HPTLC (High Performance Thin Layer Chromatography)**

Recently people have more interest in herbal drugs than synthetic medicines for which the medicinal plants are highly esteemed all over the world as rich source of phytochemicals. So their detailed studies through new techniques and the extraction of it from the plants have attained great attention. There are more than 4,20,000 distinct plant species, yet less than 10% of them have been fully analyzed. The isolation and purification of these distinct species is a major goal of the biotechnology and pharmaceutical industries with screening procedures for phytochemical analysis. HPTLC is an excellent tool for the qualitative/quantitative analysis of the isolated metabolites in botanical samples.

The principle of TLC is known for more than 100 years now (Beyerinck, 1889). HPTLC is an enhanced form of TLC where better resolution is achieved and more accurate quantitative measurements can be taken. HPTLC has many advantages. It is fast, flexible, cheap and highly reproducible. This instrument being sophisticated and being controlled by integrated software ensures to the highest degree the usefulness, reliability and reproducibility of the generated data. The instrument is technically simple to learn and operate, lower analysis time, less cost per analysis, low maintenance cost and visual detection is possible as it is an open system. The ability to choose solvent for the mobile phase is not restricted by low UV transparency of the need for ultra-high purity. There is no interference from the previous sample as fresh stationary phase and mobile phase are used for each analysis. Accuracy and precision of quantification is high because samples and standards are chromatographed and measured under the identical experimental conditions on a single TLC/HPTLC plate.
In this technique there is a use of stationary phase which is a thin layer (0.25-2.0mm) of silica on a metal foil or a glass plate. The sample is applied with the help of an automated applicator as a thin streak. Sample is applied by spraying with the help of nitrogen gas. Since the mass distribution is uniform over the full range of the bands, densitometric estimation can be done by scanning. The plate is then developed in a saturated chamber containing the developing solvents. Once the mobile phase reaches the front end of the plate, retardation factor (Rf) is calculated as,

\[
R_f = \frac{\text{Distance moved by the analyte from the origin}}{\text{Distance moved by the mobile phase front from the origin}}
\]

Densitometric estimation can be done by scanning in different spectral range from 190-800nm, depending on the type of bands obtained (U.V. visible, fluorescence or visible). A plant may produce innumerable bioactive compounds (Cowan, 1999) such as phenolics, terpenoids, tannins, alkaloids, saponins and steroids.

Major components that are being utilized for the medicinal purpose are Guggulsterone E and Z. Literature has revealed reports are available only for quantification of Guggulsterone E and Z in *C.wightii* gum resin and their related formulations. But there is no literature regarding quantification of Guggulsterone E and Z from different plant parts of *in vivo* and *in vitro* plant and the impact of geographical and seasonal variation in them. In this view the present study describes the development of simple, rapid and validated HPTLC method for the estimation of Guggulsterone E and Z by using an efficient mobile phase in *in vivo* and *in vitro* *C.wightii* with excellent separation of matrix.

**AIM AND OBJECTIVES OF THE PRESENT STUDY**

**Aim:** The main aim of the present study is development of technique for clonal propagation of *Commiphora wightii* (Arn.)Bhandari for conservation and metabolite screening from *in vivo* and *in vitro* plant parts during seasons of pre- monsoon and post-monsoon.
Objectives:

- To collect plant from different zones during different seasons and study their variations in *in vitro* growth.
- To develop a protocol for micropropagation by using various explants in different media compositions and hormonal combinations during different seasons.
- To study seasonal changes in secondary metabolite level in plant by using HPTLC.
PLANT DESCRIPTION

TAXONOMIC POSITION

Kingdom: Plantae
Division: Angiosperm
Class: Dicotyledon
Subclass: Polypetalae
Series: Disciflorae
Order: Geraniales
Family: Burseraceae
Genus: Commiphora
Species: wightii

SCIENTIFIC NAME: Commiphora wightii (Arn.)Bhandari

LOCAL NAMES

DISTRIBUTION

*C.wightii* is widely distributed in tropical regions of Africa, Madagascar and Asia. It is generally distributed in arid regions and is particularly widespread on the Indian side of Thar Desert. In the Indian subcontinent *Commiphora* species occur in Pakistan, Baluchistan and India.

**Plate 1.1. World Distribution of *C.wightii***

1. Afghanistan
2. Pakistan
3. India
4. Africa
5. Madagascar

[Source: Google earth]
Of the total 185 species, only three (C. wightii, C. stocksii and C. berryi) have been found in India. C. wightii occurs in Rajasthan, Gujarat, Maharashtra (Kumar et al., 2004), Some parts of Karnataka and Madhyapradesh (Atal et al., 1975). C.wightii is also reported to occur in Pakistan indigenously in Hyderabad (Sindli) Kalat division (Khan, 1958) and Baluchistan and Sindh (Atal et al., 1975)

Plate 1.2. Distribution of C.wightii in India

1. Rajasthan
2. Gujarat
3. Madhya Pradesh
4. Maharashtra
5. Karnataka

[Source:Google earth]
In the state of Gujarat guggulu is found in whole of Kutch Division, besides Kara hills of Khawada region, in North of Bhuj, Nakhatrana, Dayapar, Rawapar, Lakhpat, Amarapar, Desalpar, Patan and Ambaji (Atal et al., 1975). The forest of the North Gujarat is generally on the eastern hilly portions and has many medicinally important plants which include C.wightii (Pandey et al., 2005). So for present study plant sampling was done from forest and non-forest region of North Gujarat which may help in guggul plantation in this semi-arid zone.

**Plate 1.3. Distribution of *C.wightii* in Gujarat**

1. Lakhpat
2. Dayapar
3. Rawapar
4. Nakhatrana
5. Bhuj
6. Amarapar
7. Desalpar
8. Patan
9. Ambaji

[Source: Google earth]
Plate 1.4: Sample collection site for the current work
CHEMICAL COMPOSITION

Several major chemicals that have been reported in C.wightii till now are listed below: Quercetin, its 3-O-α-L-arabinoside, 3-O-β-D-galactoside, 3-O-α-L-rhamnoside, and 3-O-β-D-glucoronide, elagic acid and pelargonidin 3, 5-di-O-glucoside (flowers); linoleic, oleic, palmitic and stearic acids, campesterol, cholesterol, β-sitosterol, stigmasterol and α-spinasterol (seed oil); myrcene, dimyrcene (comphorene), polymyrcene and caryophyllene (essential oil); lignans, sesamin, pluviatilol, guggulligunans I and II, myricyl alcohol, β-sitosterol, series of long chain polyolesters derived from homologous tetrals (guggultetrols) and ferulic acid (D-xylo-guggultetrol-16 to 22 ferulate), monocyclic diterpenoids, viz., α-camphorene, cembrene, cembrene A, 2-hydroxyl-4, 8, 12 trimethyl-1-isopropyl-3,7,11-cyclodecatriene (mukulol; allyclembrol), cholesterol, three C-27 guggulsterols I, II and III and several pregnanederivaties, Z-guggulsterol, guggulsterol VI, two hypolipaemic agents, viz., Z- and E-giggi;sterpmes (4, 17 (20)-pregnadien-3, 16- diones), 20α- amd 20β-hydroxyl-4-pregn-3-one, 16β-hydroxyl-4, 17 (20) Z-pregnadien-3-one and 16α-hydroxyl-4-pregn-3-one, some aliphatic tetrals-octadecan-1, 2, 3, 4-tetrol, eicosan, 1, 2, 3, 4-tetrol and non-adececan-1, 2, 3, 4-tetrol (gum resin); Z-guggulsterone (oleresin); allyclembrol, amino acids, viz., alanine, arginine, aspartic acid, cystine, glutamic acid, histidine, isoleucine, leucine, lysine, praline, serine, threonine, tryptophan, tyrosine and valine (plant) (Anonymous, 2001).

GUGGULSTERONE

Guggulsterone is the resin of Mukul myrrh tree, a small, thorny plant found predominantly in the rocky, dry regions of India. Gum Guggulu, the yellowish resin produced in the stem of the Commiphora mukul tree is obtained by tapping the tree throughout the year. This resin is the source of the active components, Z-guggulsterone and E-guggulsterone. The use of Guggulsterone was first documented 3000 years ago and it continues to play a major role in Ayurvedic medicine. Because Guggulsterone has been so venerated in India, it has become one of the more famous therapeutic herbs and is now used all over the world. It is reputed to have carminative, antispasmodic, diaphoretic, antisuppurative, emmenagogue (menstrual stimulant) and aphrodisiac qualities and has been used to treat conditions as wide-ranging as ulcers, tonsilitis, hay fever, urinary and thyroid conditions and of course, cholesterol.
problems. Guggulsterone helps the circulatory system to maintain a healthy HDL to LDL ratio. Helps to prevent blood platelet aggregation; dissolves blood clots. Guggulsterone stimulates the activity of white blood cells in the body, contributing to the build-up of the immune system and protecting the body against infections. Guggulsterone also exhibit significant antioxidant activity especially in the cardiovascular system where it helps to prevent damage to the arteries and heart muscle.

Plate 1.5. Structure of Guggulsterone E and Z

A: Structure of Guggulsterone E

B: Structure of Guggulsterone Z
ACTIVITIES


MEDICINAL USES

Guggal has been used in Ayurveda since ages to treat disorders like rheumatism, arthritis, heart ailments, neurological disorders, skin infection, obesity (Bhatt et al., 1989). Guggulgum is known to be hypolipidemic, hypocholesterolemic and anti-obesity (Bhatt et al., 1995, Tripathi et al., 1968, Satyavati et al., 1969 and Urizar et al., 2003) astringent and antiseptic, anti-arthritic, antimicrobial (Ishnava et al., 2010), anti-inflammatory (Gupta et al., 1974 and Kimura, 2001), and anti-cancerous (Xiao et al., 2008). It is also reported for the treatment of thrombosis (Tripathi et al., 1968) and chronic bronchitis (Sinha et al., 2001), nodulocystic acne, spongy gums, chronic tonsillitis and teeth car-ries (Raghunathan et al., 1999).