INTRODUCTION

Nature has been a source of medicinal agents since the beginning of the civilization (Nostro et al., 2000) and an impressive number of medicinally important drugs have been isolated from natural sources, almost all of them plays a very important role in natural health care system. According to Pierangeli et al., (2009) approximately 80% population of present modern world relies on natural system of health care. Natural products obtained from plants also contributes a lot in primary health care system of the rest 20% people of the developing countries (WHO, IUCN, WWF, 1993). About 119 chemical compounds isolated from plants are importantly used as valuable drug isolating raw material (Mullholland 2000). More than 80,000 plants are proved to be medicinally important when treated against countless infectious diseases.

Any plant is considered to be as drug yielding plant when its one or more organ contains substances that can be used for medicinal and therapeutic means or from which precursor molecules for drugs have been isolated (Sofowora 1982, Medicinal Plant and Traditional Medicine in Africa).

All the plants have an extreme efficiency to synthesize aromatic substances, most of which are phenols or phenol’s oxygen substituted derivatives (Geissman, 1963). Most of these aromatic compounds are secondary metabolites, out of which more then 12,000 have been isolated, their number estimated to be less then 10% of total (Schultes, 1978). All these active chemical compounds are the most important part of plant’s defense mechanism. In nature these secondary metabolites are specific and varies from species to genera. These secondary metabolites are not used by plants in normal primary metabolic need but they enhance the overall capacity of it to survive and prepare to face challenges by giving them ability to interact with their environment (Harborne, 1993). These substances are fatal towards various microorganisms, Insects and herbivores naturally. Like some terpenoids provides specific odours to its native one, at the same time tannins and quinons are equally responsible for pigment formation quality of plant parts. Many of them are flavouring in nature as the flavour of chili pepers is because of capsaicin a terpenoid. Some main
categories of phytochemicals extracted from medicinal plants are studied to evaluate their medicinal activity.

**Flavonoids** Flavonoids are basically aromatic compounds of phenolic structures which are ubiquitous in photosynthetic cell and are the most important part of fruits, vegetables, nuts, seed, stems, flowers, tea, wine, and honey. Flavones are phenolic compounds containing one carbonyl group. The addition of a 3-hydroxyl group yields a flavonol. For centuries these compounds acts as a principal physiological compound used to treat human as well as plant diseases. The basic structural unit of flavonoids is the 2-phenyl-benzopyrene or flavane nucleus, consisting of two benzene rings linked through a heterocyclic pyrane ring.

There are 14 classes of flavonoids that have been identified on the basis of their chemical structure and position of various substituent’s on different ring. The flavonoid compounds are thought to be a very important part for plants defense mechanism. This ability comes from the reaction of flavonoids with extracellular and other soluble proteins, as well as with microorganisms cell protein.

**Alkaloids** Alkaloids are heterocyclic nitrogen containing compounds well known for their medicinal value. Majority of alkaloids are considered to be basic in nature. It is an estimated value that more than 3,000 alkaloids have been found in nature and frequently isolated from some 4,000 species of plants, most frequently herbaceous dicots, relatively few monocots and gymnosperms contains alkaloid. It was 1804, when first alkaloid from the opium poppy (*Papaver somniferum*) was isolated. Other well known alkaloids include nicotine, quinine, strychnine, atropine, colchicine, mescaline and lycoctonine. Most alkaloids are present only in plant shoots, but nicotine is the one which is present only in plant roots.

The physiological role of alkaloids in the plants is unknown, and it has been suggested that they are not so much important from the metabolic point of view. But there are, several example in which they prove protective to the plant (Robinson, 1979; Harborne, 1988). Several alkaloids are avoided by grazing animals and certain alkaloids are effective against leaf juice sucking insects and also against certain microorganisms. Some alkaloids are used by danaid butterflies as medium for
synthesis of their courtship pheromones. It is interestingly notified that, larkspur is not avoided by cattle, even when other forage is available, and the lycoctonine an alkaloid in it accounts for more cattle deaths in the United States than any other toxin in any other poisonous plant (Keeler, 1975).

**Terpenes** terpenes are also referred to as isoprenoids and their derivatives containing additional elements, usually containing oxygen, are called terpenoids. Terpenes are widespread in nature, mainly in plants as constituents of essential oils. Terpenoids represent the largest class of secondary metabolites up to 22,000 in number. The simplest terpenoid is isoprene hydrocarbon (C₅H₈), a volatile gas evolved by plants during their photosynthesis process which protect cell membranes from the adverse effects of high temperature and light. On the basis of the number of isoprene units terpenoids are classified for example, monoterpenoids consist of two isoprene units, sesquiterpenoids (three units), diterpenoids (four units) and six units containing terpenoid is called as triterpenoids.

![Figure 1- Isoprene unit](image)

Monoterpenoids are used as spices, seasonings, condiments and perfumes which are toxic as well as fatal towards insects and at the same time also harmless to human beings. Some examples are sparmint (*Menthe* spp.), basil (*Ocimum* spp.), oregano (*Origanum* spp.), rosemary (*Rosemarinus* spp.), sage (*Salvia* spp.), savory (*Satureja* spp.), thyme (*Thymus* spp.), Black pepper (*Piper* spp), cinnamon (*Cinnamom* spp.) and bay leaf (*Laurus* spp.). Gossypol is the example of diterpenoids produced by cotton (*Gossipium hirsutam*) that is well known for its strong antifungal and antimicrobial potential. Triterpenoids are similar to steroid hormones in their molecular structure. When plants such as spinach (*Spinacia oleracea*), produced Phytoectysones, similar to insect molting hormones, they attack on normal larval development and increase insect mortality. Class of triterpenoids called limonoids is responsible the fresh smell of lemon and orange peels. Terpenoid azadirachtin, is isolated from neem trees,
(Azadirachta indica). Some insects are repelled by concentrations as low as a few parts per million, this varies from species to species.

**Saponins**  saponins are special class of triterpenoids in which isoprene units are glycosylated (triterpenoids with attached sugar group). Because of soap like properties they can damage the cell membrane of invading fungal pathogen. For example, The Oat variety that contains avenacins a class of triterpenoids saponins is resistant towards *Gaeumannomyces graminis* a potent pathogen of oat crop. Some fungal pathogens have developed counter defenses towards these terpenoids examples are : *Botrytis cinera*, *Fusarium oxysporum* and *Saptoria lycopersici* these all are capable of degrading saponins and may attack on susceptible saponin-producing plants.

**Phenolics** phenolic compounds are widespread in plants. Phenolic compounds are another large group of plant secondary metabolites. These compounds are the major source of plant defense mechanism. Phenolic compounds are basically originated through shikimic acid and malonic acid pathways. Some of the types of phenolic compounds includes flavonoids, anthocyanins, phytotoxins, tannins, lignins and furanocoumarins. Flavonoids are the largest class of phenolics. These are used by plants to protect themselves from harmful uv- radiation of sun. Anthocyanins are the colour producing flavonoid produced by various plant parts like flowers, fruits and many showy leaves. The another class phytotoxins are isoflavonoids with antibiotic and antifungal properties that are produced in response to pathogens attack. These toxic molecules have ability to disturb pathogen metabolism or damage cellular structure. Examples include medicarpin produced by alfalfa (*Medicago sativa*), rishitin produced by both tomatoes and potatoes (the Solanaceae family), and camelexin produced by Arabiodopsis thaliana.

![Figure-2-Cyanin glycoside an Anthocyanin](image1) ![Figure-3-Medicarpin a phytoalexin](image2)
**Tannins** Tannins are water soluble class of flavonoids, stored in vacuoles. Tannins are proved to be fatal for insects because it has a tendency to inactivate digestive proteins, including trypsin and chymotrypsin by binding itself to the salivary and digestive gland proteins. Insect, as well as herbivores that predate on high amounts of tannins lost their tendency to gain weight and may eventually die.

**Lignin** Lignin is a chief component of secondary walls of plant cells. These are highly branched heterogenous polymer, made up off hundreds and thousands of phenolic monomers. It is a chief component of wood. however lignin provides an excellent physical barrier to various plant pathogens because of its rigid, insoluble and virtually indigestible nature.

From various experiments it has been proved that no single secondary metabolite is responsible for complete defense in plants but the potentiality of resistance lies on the combined action of all the secondary metabolites step by step process.

**Himalayan description**

Himalaya is a Sanskrit word which literally means “Abode of Snow”. The Himalayas have a great wealth of medicinal plants. The central Himalayan region covers the overall new state of India, that gives us an excellent opportunities for studying the traditional knowledge systems of Himalayas. In India previous references of the curative properties of plants appear in some details in Rigveda, which is said to be the oldest and written between 3,500-1,600 B.C. A large number of drugs and their properties with uses are conserved in Ayurveda.

The entire Himalayan ranges can be divided into three major botanical regions, the western, the central and the eastern Himalayas. The Indian Himalayan region alone supports about 18,440 species of plants (Angiosperms: 8000 spp., Gymnosperm: 44 spp., Pteridophytes: 600 spp., Bryophytes: 1736 spp., Lichens: 1159 spp. and Fungi: 6900 spp.) (Singh and Hajra, 1996) of which about 45% are having medicinal properties. According to Samant et al.,(1998), out of the total species of vascular plants, 1748 plant species (1,685 angiosperms spp., 12 gymnosperms spp. and 51 pteridophytes spp.) are medicinal. Uttarakhand is a storehouse of a rich variety herbs, medicinal and aromatic plant species.
Therapeutic uses of Himalayan herbs are known since ancient period, references of which are available in Charaka Samhita and Sushruta Samhita. People of village areas till present time are entirely depending on the forest resource for fulfilling their daily needs including healthcare and medicine. They have developed their own traditional health care system based on locally available plants. Nepali jaributi, Lepcha and Tibetan are some locally developed medicinal system for herbal health care. Out of earlier described 1748 medicinal plant species from the Indian Himalayan Region (IHR), some 701 species are alone present in Uttarakhand state (West Himalaya) (Nautiyal et al., 2000; Singh and Singh 1997). In this region a large number of medicinal plants are being utilized for drug and pharmaceutical industries from the wild (Mehta, 2001).

Himalayas is a rich source of many drug yielding, aromatic, oil yielding plants, fiber, fodder yielding plants. Many of these plants possess alkaloids, glycoside alkaloids, resins and other secondary metabolites for which they have been badly exploited to fulfill the daily drug need of common people. With the modern techniques of photochemistry, pharmacology and advance in medical science, a number of active chemical compounds of medicinal plants were isolated and recommended as valuable drugs in modern medicine system (Ved Prakash, 2001).

Pithoragarh town, a valley, is relatively warm during summer and cool during winter. In the coldest months of December and January, the tropical and temperate mountain ridges and high locations receive snowfall and have an average temperature of 5.5–8.0 °C (41.9–46.4 °F). Pithoragarh district has simply variation in temperature due to the large variations in altitude. The temperature rises from mid-March through mid-June. The areas above 3,500 metres (11,500 ft) remain in a permanent snow cover. Regions lying at 3,000–3,500 metres (9,800–11,500 ft) become snow covered for four to six months. At some places like the river gorges at Dharchula, Jhulaghat, Ghat and Sera, temperatures reach 40 °C (104 °F). The annual average rainfall is 36.7 centimetres (14.4 inch) (From Pithoragarh wikipedia).

Medicinal plants extracts have been used and studied extensively for their antimicrobial activity and have been demonstrated as good plant disease control agents (Singh, 2000).
Water extracts of plant parts are known to possess germicidal properties and have been used for the treatment of human and cattle diseases. In recent years screening of plant extracts for control of fungal, bacterial and viral diseases has been extensively done. (Datar, 1999; Sindhan et al., 1999). The wideness and richness of plant varieties in Pithoragarh region provides an excellent source of antimicrobial substitute in the form of plant constituents.

In present study medicinal plants have been selected to know their antimicrobial activity. The description of these plant species is as follows;

1.1. SELECTED PLANT SPECIES

1.1.1. *Acorus calamus*

*Acorus calamus* is a perennial tall monocot of the family Acoraceae, in the genus *Acorus*. It is commonly called as sweet flag or calamus (Sylvan and Alvin, 1979 and 2009). Having some common names including "rush" and "sedge," it is neither a rush nor sedge (Balakumbahan et al., 2010). Its scented leaves and scented rhizomes have traditionally been used as medicine and also to make fragrances, and its dried rhizome powder has been used as a substitute for ginger, cinnamon and nutmeg for seasoning edible items (Balakumbahan, 2010 and Simonetti, 1990).

1.1.2. Habitat

The basis of the location based difference of *Acorus* sp. is because of genome differences. *Acorus calamus* var. *americanus* Wulff commonly contains diploid number of chromosomes that is responsible for their distribution from North America to Siberia. The triploid *A. calamus* var. *calamus* (=*vulgaris* L.), which is sterile one is widely distributed throughout Europe, temperate India, and the greater Himalayan region. Eastern and tropical Southern Asia including Japan and Taiwan comprises tetraploid variety, *A. calamus* var. *angustatus* Bess (Bown 1988; Rost 1979).
1.1.3. Vernacular names

1.1.4. Botanical Description

(a) Taxonomic Classification

Kingdom: Plantae, Plants
Subkingdom: Tracheobionta, green plants
Super division: Spermatophyta, seed plant
Division: Magnoliophyta, dicotyledons
Class: Liliopsida
Subclass: Arecida
Order: Arales
Family: Acoraceae
Genus: Acorus
Species: Acorus calamus

(b) Morphology

Acorus calamus L., (sweet flag) is not very common but widespread natured, marshy plant of aquatic habitats in both temperate and subtemperate regions. Sweet flag has long, erect, narrow, scented leaves arising from a branched, underground rhizome. A number of plants seen above in a population that may arise from a single plant connected by an well developed extensive underground rhizome. The rhizome is whitish to pink in colour and blessed with pleasant odor, smell like citrus, although it has a bitter taste. The inflorescence of Acorus calamus consists of a leaf-like spathe and a spike-like spadix, protruding from the middle of the spathe, that is heavily covered with yellow and green flowers.

1.1.5. Chemistry

The chief chemical compounds present in the essential oil of sweet flag are phenylpropanes, mono-terpenes, and thermolabile sesquiterpenoids (Rost and Bos,
Some other are methyleugenol, cis-methylisoeugenol, 3-asarone, geranylacetate, f-farnesene, shiyobunone, epishyobunone, isoshyobunone, and 20% of the essential oil (Rost and Bos, 1979). The other percent includes a and y-asarone, calamenene, asaronaldehyde, acorenone, cala-menone, n-heptanic acid, calanendiol, numerous sesquiterpenes, and some trace compounds (Mazza, 1985a; Perry and Metzger, 1980). While a-asarone is similar to mescaline in chemical structure which is an alkaloid in the hallucinogenic peyote cactus [Lophophora williamsii (Salm-Dyck) J. Coulter] (Lewis and Elvin-Lewis, 1977) or amphetamines (Elliott, 1976), and f-asarone is similar to the alkaloids myristicin and kava (Piper methysticum, Forster, 1977 : Lewis and Elvin-Lewis, 1977).

1.1.6. Medicinal uses
Sweet flag has a very long history of medicinal use in both in Chinese and Indian herbal traditions (Mukherjee et al., 2007). The whole plant including leaves, stems, and roots are used in various Siddha and Ayurvedic medicines ("Vasambu", Tamilnadu.com., 2013). It is widely used in modern herbal medicine as its sedative, laxative, diuretic, and carminative properties (Simonetti, 1990). In Ayurveda it is useful to counter the side effects of all hallucinogens (Dr. Vasant K. Lad, Ayurveda). Sweet Flag, known as "Rat Root" is one of the most widely and frequently used herbal medicines amongst the Chipewyan people (Johnson et al; 1995).

Acorus calamus has neuroprotective effect against stroke and chemically induced neurodegeneration in rats. Specifically, it has protective effect against acrylamide induced neurotoxicity (Shukla et al., 2006). Roots and leaves both are equally responsible for the antioxidant activity of A. calamus (Ganjewala, 2011), and antimicrobial and insecticidal activities as well. Acorus calamus may prove to be an effective against cattle tick, Rhipicephalus (Boophilus) microplus (Balakumbahan, et al., 2010).
1.2.1. *Allium carolinianum*

*Allium carolinianum* belongs to the family Liliaceae.

1.2.2. Habitat

*A. carolinianum* widely distributed over central and southern Asia (Xinjiang, Xizang, Tibet, Afghanistan, Bhutan, India, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan, Uzbekistan). It grows at elevations of 3000–5000 m. hilly slopes (*Flora of China*). It becomes native towards E. Asia - Himalayas from Afghanistan to Nepal.

1.2.3. Vernacular names

Jangli Lahsun, Jimboo.

1.2.4. Botanical Description

(a) Taxonomic Classification

**Kingdom:** Plantae - Plant  
**Subkingdom:** Viridaeplantae, green plants  
**Phylum:** Tracheophyta, Vascular Plants  
**Subphylum:** Euphyllphytina  
**Infraphylum:** Radiatopses  
**Class:** Magnoliopsida - Dicotyledons  
**Subclass:** Liliidae  
**Superorder:** Lilianae  
**Order:** Asparagales  
**Family:** Amaryllidaceae  
**Subfamily:** Allioideae  
**Genus:** Allium  
**Species:** *A. carolinianum*

(b) Morphology

Bulbs of *Allium carolinianum* are cylindrical to ovoid normally egg shaped, outer coats coriaceous, and acquired dull brown colour, while inner one is membranous. Scapes are 15 to 50 cm tall, and base covered with leaf bases. Leaves are few in
number, usually 5-6, broadly linear to lanceolate, falcate, not fistular, apex obtuse. Inflorescens is umbel and round type off, 1.5-3 cm across. The perianth is of tepals having preety pink to rose coloured, lanceolate, 6-7 mm long. Filaments are longer than the tepals, entire, connate at the base. In gynoecium style exserted, stigma capitate. Capsules ± globose; seeds elliptic, oblong or ovate, capsule 3.5 mm long, surface granulate. Its flowering time is July to August (Flora of China), (Line drawing, Flora of China Illustrations vol.), (Nasir & Ali, 1980-2005. Flora of Pakistan).

1.2.5. Chemistry
Allium spp. generally contains a large number of sulfur compounds. Some examples are allicin, diallyl disulfide, diallyl trisulfide, s-methyl-L-cysteine sulfoxide s-propyl-L-cysteine sulfoxide, alliinase, mucilage, albumin and other compounds are alliin (S-allyl-L-cysteine sulfoxide), high concentrations of trace minerals (particularly selenium), vitamins, glucosinolates, enzymes (alliinase, peroxidase, and myrosinase) etc. These compounds have high medicinal value.

1.2.6. Medicinal uses
Although no specific medicinal use has been seen for this species, members of this genus are very healthy additions to the diet. Presence of sulphur compounds give them onion flavour and when used on a regular basis as diet they help in reducing blood cholesterol levels, also tonify digestive and circulatory system (Philbrick and Gregg, 1979). Its flower head is used to treat anxiety. Leaves are used as vegetables in some traditions. There are no medicinal uses listed for Allium carolinianum. In short the species Allium carolinianum is used to enhance flavour in food.

1.3.1. Arctium lappa
Arctium lappa commonly called as burdock ("USDA GRIN taxonomy") genus in the Asteraceae family, usually cultivated in gardens rich in nitrogen component. Its roots are used as a vegetable.
1.3.2. Habitat
Burdock is widely distributed in Europe, Northern Asia and North America. It is very common along roadsides and in all waste places [Kemper, (2010) Jeelani, & Khuroo, (2012)]. Burdock is native to the temperate regions of the old world, widely distributed from Scandinavia to the Mediterranean, and from the British Isles through Russia, and the Middle East to China and Japan, including India also. This species is present almost everywhere and is usually found in disturbed and fragile areas, mostly where nitrogen content is abundant in soil. It is commonly cultivated in Japan.

1.3.3. Vernacular names
_Arctium lappa_ commonly called as beggars button, burdock, cockle-bur, cockle-button, common burdock, cuckold-dock, great but, great clotbur, greater burdock, hardock, hare burr, hurr-bur, stick-button and bat weed (Kemper, 2010).

1.3.4. Botanical Description
(a) Taxonomic Classification
  **Kingdom:** Plantae-Plants
  **Subkingdom:** Tracheobionta-Vascular plant
  **Superdivision:** Spermatophyta-Seed plant
  **Division:** Magnoliophyta-Flowering plant
  **Class:** Magnoliopsida-Dicotyledons
  **Subclass:** Asteridae
  **Order:** Asterales
  **Family:** Asteraceae
  **Genus:** Arctium _L._- burdock
  **Species:** _Arctium lappa_ _L._ greater burdock

(b) Morphology
Burdock has multiple branches stem system, each of which is clustered by many crimson-violet flower heads that produce the famous burrs that give burdock its name. The flowering time is mid summer from July to September. The plant is biennial which rather grows tall and reaches from three to nine feet in height. The medicinally important part is fleshy roots that can grow up to 3 feet (0.91m) deep. Root has very hard, horny, brown, longitudinally wrinkled bark and a white soft
interior. The plant is readily propagated from seed in moist, rich soil and under full sun (Kemper, 2010).

1.3.5. Chemistry
The chemical constituents is in the form of volatile oil (phenylacetaldehyde, benzaldehyde, and 2-alkyl-3-methoxy-pyrazines), lignans: (neoarchtiin A, and arctigenin), sesquiterpene lactones, polyynes (chief components are trideca-l, ll-dien-3, 5,7,9-tetraen), some sulfur derivatives, caffeic acid derivatives: including chlorogenic acid, isochlorogenic acid, polysaccharides (fructose), mucilage's (xyloglucans, acidic xylans), triterpenes: including alpha-amyrin, omega-taraxasterol, acetic acid ester, phytosterols: beta-sitosterol, stigmasterol, campesterol and their esters, and tannins sulfur rich acetylenic compounds were also isolated from A. lappa [( Chan, 2011);(Kemper, 2010);(Fleming, 2000);(Jeelani et al., 2012);(Washino et al., 1986);(Schulte, 1967); (Kato & Watanabe, 1993); (Wang & Yang, 1992) ; (Park et al., 2007) ; (Matsumoto et al., 2006) ; (Maruta et al., 1995)].

1.3.6. Medicinal uses
The ripe seed and fresh or dried roots are used for medicinal purpose. Basically roots are used to treat ailments, also in gastrointestinal troubles, have diaphoretic and diuretic as well as have blood purifying properties. Traditionally it was used to treat ichthyosis, psoriasis and scalp seborrhea externally. In Chinese tradition roots were used against carbuncles ulcers and erythema of the skin and throat (Fleming, 2000). In Chinese medicine Arctium lappa is known as aphrodisiac agent, and used to treat sterility and impotence, eventually Native Americans used its root as a herbal preparation to relax women in labor (Lewis & Elvin-Lewis, 1977). Its other parts are used against baldness, arthritis, skin infections, acne, boils, bites, eczema, herpes, impetigo, rashes, ringworm, sore throat, sciatica, poison ivy/oak, as a tonic and mild laxative. In traditional Chinese medicine greater burdock is effective when treated against cold and flu (School of Chinese Medicine database). The root extract of Arctium lappa in different solvents is proved to be very effective as antidiabetic (Silver & Krantz, 1931), anticancer (Foldeak, & Dombradi, 1964), and anti-fatigue (Dong, 2006). The chloroform root extract is used to treat gastrointestinal defects (Santos et al., 2008). The role of Arctium lappa in modern microbiology as an
antimicrobial agent is very significant. It is very effective against various bacterias and fungus (Gentil et al., 2006).

1.4.1. *Asparagus racemosus*
Also known as Satawari, Asparagus means ‘one who possesses a hundred husbands’. It is a climbing Ayurvedic plant (Freeman, 1998).

1.4.2. Habitat
Genus *Asparagus* of 300 species out of which 22 are recorded in India alone is confined across the globe from tropical Africa, Java, Australia, Sri Lanka, Southern parts of China and India, but it is mainly cultivated in India (Basu et al., 1985) (Gomase et al., 2010). Generally it grows on rocky soil, high up in the piedmont plains, at an elevation of 1,300–1,400 metres (Freeman, 1998).

1.4.3. Vernacular names
Sanskrit: Satavari, Hindi: Satavari, Shatawar or Satmuli, Bengali: Shatamuli, Marathi: Shatavari or Shtamuli, Gujarati: Satawari, Telegu: Toala-gaddalu or Pilligaddalu, Tamil: Shimaishadavari or Inli-chedi, Malayalam: Chatavali, Kannada: Majjigegadde or Aheruballi, Madhya Pradesh: Narbodh or atmooli, Kumaon: Kairuwa, Rajasthan: Norkanto or Satawar (Bopana and Saxena, 2007).

1.4.4. Botanical Description

(a) Taxonomic Classification
- **Kingdom:** Plantae - Plant
  - **Subkingdom:** Viridaeplantae, green plants
  - **Phylum:** Tracheophyta, Vascular Plants
  - **Subphylum:** Euphylllophytina
  - **Infraphylum:** Radiatopses
  - **Class:** Magnoliopsida - Dicotyledons
  - **Subclass:** Liliidae
  - **Superorder:** Lilianae
  - **Order:** Asparagales
  - **Suborder:** Asparagineae
Family: Asparagaceae
Subfamily: Asparagoideae
Tribe: Rhododendreae
Genus: Asparagus
Specific epithet: racemosus - Willd.
Botanical name: Asparagus racemosus Willd

(b) Morphology
A. racemosus has small pin-needle like phylloclades (photosynthetic branches) (Vichien, 2003), which are uniform and shiny green in appearance. The plant is a climber, climbs upto 1-3 m high (Goyal et al., 2003). It has an extensively scandent, spinous stem. Roots are numerous in number fusiform, succulent and tuberous type off with a diameter of 0.5 to 1.5 cm, rises from the base of stem which is woody, covered with spines. Simply leaves are modified to small scales in tuft of 2-6 in each node. These scaly leaves are adapted to photosynthesis. Flower system is raceme type off having white, fragrant, solitary and have width of 0.3-0.4 cm. Fruits are berries which are globose and absurcely 3 lobed. Its seed are black in colour with hard, bristle testa (Chako, 1997).

1.4.5. Chemistry
A. racemosus consists of a variety of molecules in which major part is occupied by steroidal saponins (Ravikumar et al., 1987) along with several alkaloids, flavonoids, dihydrophenanthrene derivatives, furan derivatives and some volatile constituents too. Its dried root contains Asparagamine A, a polycyclic alkaloid ( Combinatorial Chemistry and total synthesis of natural products, Structure of Asparagamine A (I), a Novel Polycyclic Alkaloid from Asparagus racemosus ).

Briefly D-gluco-pyranoside, rutin (Saxena and Chaurasia, 2001), a cyclic hydrocarbon racemosol, (Sekine, 1997), some polysaccharides and mucilage are also present. Similarly in shoots, Quercitin-3-glucorinide, and in fruits as well a seeds occupies sitosterol, stigmasterol and some other unidentified saponins (Sharma et al., 1981). Approximately twenty nine steroidal saponins were identified from A. racemosus. A. racemosus also contains an oligospirostanoside named 3-O-[α-L-rhamnopyranosyl-(1→2)-α-L-rhamnopyranosyl(1→4)-O-β-D-glucopyranosyl]-25(S)-
spirosta-3β-oil which on taken orally enhanced cell-mediated immune response in immune compromised animals by potentiated antibody synthesis (Handa et al., 2003).

1.4.6. Medicinal uses

*A. racemosus* has medicinal importance in the indigenous system of medicine. The roots are well known for their bitter-sweet, emollient, cooling, nerve tonic, constipating, aphrodisiac, diuretic, carminative and antiseptic qualities (Chaudhary and Kar, 1992). The dried root powder is blessed with galactogogic properties. It is known to stimulate milk production without any adverse effect (Dalvi et al., 1990; Priya and Vijayalakshmi, 1998).

The aqueous root extract possess immunoadjuvant potential (Gautam et al., 2004). Its antioxidant and anti-ADH activity (Kamat et al., 2000 and Wiboonpun et al., 2004) is localized in its root, well known as antitumour and anticancer agent (Senna et al., 1993; Shao et al., 1996; Dhuley, 1997 and Diwanay et al., 2004), and also used to treat ulcers as anti-ulcerogenic source (Datta et al., 2002). It has immense anti-inflammatory activity (Mandal et al., 1998) and antimicrobial activity (Mandal et al., 2000) as well.

1.5.1. *Centella asiatica*

*Centella asiatica*, which is commonly known as centella and gotu kola, is a small, herbaceous, annual plant of the family Mackinlayaceae or subfamily Mackinlayoideae of family Apiaceae (United States Department of Agriculture, Floridata. "*Centella asiatica* “).

1.5.2. Habitat

*Centella asiatica* is globally distributed over tropical and sub tropical regions of India up to an altitude of 600 m. The plant is indigenous to South-East Asia, India, and Sri Lanka, parts of China, the Western South Sea Islands, Madagascar, South Africa, South East USA, Mexico, Venezuela, Columbia and Eastern South America (Jamil et al., 2007).
Now this plant is listed under threatened species by IUCN and also as endangered (Pandey et al., 1993; Sharma and Kumar, 1998).

1.5.3. Vernacular names

1.5.4. Botanical Description

(a) Taxonomy

Kingdom: **Plantae**, Plants

Subkingdom: **Viridaeplantae**, green plants

Phylum: **Tracheophyta**, Vascular Plants

Subphylum: **Euphyllophytina**

Infraphylum: **Angiospermae**, flowering plants

Class: **Magnoliopsida**, Dicotyledons

Subclass: **Asteridae**

Order: **Apiales**

Family: **Umbelliferae**

Subfamily: **Mackinlayoideae**

Tribe: **Notocacteae**

Genus: Centella

Specific epithet: *asiatica* - (L.)

Botanical name: - *Centella asiatica* (L.)

(b) Morphology

*Centella asiatica* (L.) is a prostrate, finely aromatic, stoloniferous, perennial, creeper herb, of 15cm (6 inches) in height. Stem is glabrous, striated and rooting at the nodes. *Centella asiatica* is extensively present in shady, marshy, damp and wet places such
as paddy fields, river banks forming a dense green carpet and rather than clayey soil, the sandy loam (60% sand) is thought to be the most fertile soil for its propagation (Devkota and Pramod, 2009). The leaves are 1-3 in number and originated from each node of stems, petioled (2-6cm) long and 1.5-5 cm wide, orbicular-reniform, sheathing leaf base, crenate margins, glabrous on both sides. Flowers have umbels inflorescens with 3-4 white to purple or pink flowers arranged in each umble, flowering period is April- June. Fruits are borne throughout the growing season in approximately 2 inches long, oblong, globular in shape and strongly thickened pericarp. Seeds are laterally compressed having pedulous embryo (Singh et al., 2010).

1.5.5. Chemistry
The scientific researches have proved that a variety of secondary metabolites have been found in *Centella asiatica*. The chemical composition of *Centella* plant have a very important role in medicinal applications and it is believed due to triterpenes saponins, its chief biologically active components (Loiseau and Mercier, 2000). The triterpenes saponins of *Centella* are composed of many compounds including asiatic acid, madecassic acid, asiaticosside, madecassoside, brahmoside, brahmic acid, brahminoside, thankiniside, isothankunisoder, centelloside, madasiaic acid, centic acid, and cenelic acid (Zheng and Qin, 2007). The asiatic acid, madecassic acid, asiaticosside, madecassoside are the most important biologically active compounds among them (Inamdar et al., 1996). Due to their medicinal and other importance, they have been used as the biomarker components for quality assessment of *Centella* (Zheng and Qin, 2007). However, the content of *Centella’s* triterpene components can be affected by their location as well as in change environmental conditions (James and Dubery, 2009). In addition, it also contains high phenolic contents which contributed by the flavonoids such as quercetin, kaempherol, catechin, rutin, apigenin and naringin and volatile oils such as caryophyllene, farnesol and elemene (Zainol et al., 2003), (Chong and Aziz, 2011) According to Zainol et al., (2003) the highest concentration of phytochemicals was in the leaves relative to the petioles and the roots. *Centella* also contains vitamin C, vitamin B1, vitamin B2, niacin, carotene and vitamin A. The total ash contains chloride, sulphate, phosphate, iron, calcium, magnesium, sodium and potassium (Jamil, Nizami and Salam, 2007) (Bhavana and Jyoti, 2011).
1.5.6. Medicinal uses
In India gotu kola is considered to be as the most significant herb. In Ayurveda, it is said to be as the most effective rejuvenative medicine. It is used as a pure blood purifier and used in skin disorders (Trippett, 1949 and Bletry, 1980). It is used to promote restful sleep (Singh et al., 2008). It is commonly recommended for nervous disorders. As a brain tonic it is said to aid intelligence and memory (Singh, 2008; Subathra et al., 2005; Rao et al., 2005). It improves the adrenal gland by cleansing the blood to treat skin impurities. It is used to relieve stress and depression, energize flagging mental powers (Weijeweera et al., 2006), increase libido, ward off a nervous breakdown and improve reflexes. It rejuvenate the central nervous system and rebuilds energy reserves (Nalini et al., 1992). Gotu Kola can overcome high blood pressure problems and helps the body to defend against various toxins. It is used to treat rheumatism, blood diseases, congestive heart failure (Gnanapragasam et al., 2006), urinary tract infections, In short Gotu Kola is considered to be an adaptogen, antibacterial, antifungal, antioxidant, antidiabetic (Chauhan et al., 2010) diuretic, digestive, nerve, and wound healer (Shukla et al., 1999).

1.6.1. Origanum vulgare
Oregano (Origanum vulgare) belongs to the mint family Lamiaceae. ("Origanum vulgare L. oregano").

1.6.2. Habitat
Origanum is widely distributed in warm-temperate western and southwestern Eurasia and the Mediterranean region. In India origanum belongs to Himalayan (from Kashmir to Sikkim) region.

1.6.3. Vernacular names
It is sometimes called wild marjoram, and its close relative O. majorana is known as sweet marjoram.

1.6.4. Botanical Description
(a) Taxonomic Classification
Kingdom: Plantae-Plants

  Subkingdom: Viridaeplantae-green plants

  Infrakingdom: Stretophyta- land plants

  Division: Tracheophyta-Vascular plants

Subdivision: spermatophyte-seed plants

  Infradivision: Angiospermae-Flowering plants

  Class: Magnoliophyta

Superorder: Asterance

  Order: Lamiales

Family: lamiaceae-mint family

Genus: Origanum L.

Species: Origanum vulgare L.-origano

(a) Morphology
Oregano is sometimes referred to as wild marjoram related to the herb marjoram. Oregano has usual dichasial cyme inflorescence with purple flowers and spade-shaped, olive-green leaves. It is a perennial ("Origanum vulgare L. oregano", 2011 Plants Database, United States), although in colder climates it is grown as an annual plant, as it often does not survive during winter months (Peter, 2004). Origanum prefers a hot, relatively dry climate, but can survive well in other environments also.

1.6.5. Chemistry
The medicinal value of origanum is localized in its valuable essential oil. Its essential oil is composed primarily of monoterpenoids and monoterpenes, however their concentrations vary and widely depending on geographic location and other varying factors. Approximately 60 different compounds have been identified most common of the are carvacrol and thymol ranging from 0-80% while lesser abundant compounds include p-cymene, γ-terpinene, caryophyllene, spathulenol, germacrene-D, β-fenchyl alcohol and δ-terpineol (Teixeira, 2013).

1.6.6. Medicinal uses
Origanum is used to treat stomach and respiratory defects as well as sore throat (Epikouria Magazine, 2007). Oregano is high in antioxidant activity [( Leono., et al.
(2005); Steinar et al., 1 May 2003)], due to a high content of phenolic acids and flavonoids (Faleiro et al., 2005). In the traditional Austrian medicine Origanum vulgare has been used as tea internally or ointment as externally to treat disorders of the gastrointestinal tract, respiratory tract, and nervous system (Vogi et al., 2013). In ancient medicinal system origanum was used to treat diarrhea, poisonous bites from spiders and scorpions, muscles sores, headaches, fevers and many other ailments. Oregano's oil is very healthy when paired with a healthy diet and active lifestyle (Oreganum vulgare L. United States Department of Agriculture., 2009).

1.7.1. Thymus serpyllum
Thymus serphyllum L. belongs to the family Lamiaceae. It is well known for strongly scented flowers.

1.7.2. Habitat
It is native most to the Europe and North Africa, and widely distributed in Asia.

1.7.3. Vernacular names
Thymus serpyllum, known by the common names like Breckland thyme, (Schauer, 1978) wild thyme or creeping thyme.

1.7.4. Botanical Description

(a) Taxonomic Classification
Kingdom: Plantae-Plants
Subkingdom: Viridaeplantae-green plants
Infrakingdom: Streptophyta- land plants
Division: Tracheophyta-Vascular plants
Subdivision: spermatophyte-seed plants
Infradivision: Angiospermae-Flowering plants
Class: Magnoliophyta
Superorder: Asterance
Order: Lamiales
Family: lamiaceae-mint family
Genus: Thymus
Species: Thymus serpyllum L.
(a) Morphology

Wild thyme is a evergreen shrub. Its leaves are in opposite pairs, nearly stalkless, with linear elliptic round-tipped blades and untoothed margins. The plant sends up erect and flowering in summer. The usually pink or purple flowers have a tube-like calyx and an irregular straight-tubed and hairy corolla. The upper petal is notched and the lower one is larger than the two lateral petals and has three flattened lobes which form a lip. Its flower has four projecting stamens and two fused carpels. Wild thyme has dry, four-chambered schizocarp fruit ("Breckland Thyme: Thymus serpyllum". Nature Gate., 2013).

1.7.5. Chemistry

The aromatic and medicinal properties of the Thymus species have made it one of the most popular herbs. The genus Thymus has various species and varieties and their essential oils have been studied earlier (Guillen and Manzanos, 1998). Researches were performed to analysis the chemical composition of the oils from the plants belonging to the genus Thymus, including T. serpyllum, T. algeriensis and T. vulgaris (Stahl-Biskup, 1991; Houmania et al., 2002; Dob et al., 2006; Kizil and Uyart, 2006; Saad et al., 2010). The major compositio of the Thymus serpyllum oil contains thymol followed by carvacrol and p-cymene respectively.

1.7.6. Medicinal uses

Thymus serpyllum is acknowledged for its use in home remedies. T. serpyllum is aromatic, antiseptic, diaphoretic, analgesic, carminative, expectorant and diuretic, also it acts as an emmanagogue, carminative, and stimulant, also being used in mouth washes, gargles, cough and colds (Farooqi et al., 2005; Andrew, 2004). Its essential oil contains various compounds that are very powerful, proven as disinfectants and known to build up the immune system and fighting responses towards infections. The oil relieves rheumatism, and is also used to treat hear loss (Aziz and Rehman, 2008). In microbiology the thyme oil and its solvents extracts are used to against various pathogens (Kavita et al., 2011).
1.8.1. *Viola canescens*

*Viola* is a genus of flowering plants of family Violaceae. It is the largest genus in the family, containing between 525 and 600 species (Ning *et al.*, 2012).

1.8.2. Habitat

*Viola canescens* is a nearly prostrate herb found in the Himalayas, from Kashmir to NE India, at altitudes of 1500-2400 m. Basically it is native to India, China and Bhutan. It is widely present in the temperate and tropical zones, restricted only to the mountainous areas (Singh *et al.*, 2005).

1.8.3. Vernacular names

Commonly it is called as Himalayan white violet. In Urdu, it is called Banafsha (Barkatullah *et al.*, 2012). In India it is called Ratmundi or Vanaksha (Rana *et al.*, 2014). In Himachal Pradesh, it is called Gugluphul (Kumar *et al.*, 2013), Banaksha (Rani *et al.*, 2013), and Banfasa (Negi and Chauhan, 2009). In Uttarakhand, it is commonly called Vanfsa (Rana *et al.*, 2010). In Nepal it is locally called Ghatteghaans (Adhikary *et al.*, 2011).

1.8.4. Botanical Description

(a) Taxonomic Classification

**Kingdom:** *Plantae*-Plants

**Subkingdom:** *Viridaeplantae*-green plants

**Infrakingdom:** *Streptophyta*- land plants

**Division:** *Tracheophyta*-Vascular plants

**Subdivision:** *spermatophyte*-seed plants

**Infradivision:** *Angiospermae*-Flowering plants

**Class:** Rosids

**Order:** Malpighiales

**Family:** Violaceae

**Genus:** Viola

**Species:** *Viola canescens L.*
(b) Morphology

*Viola canescens* has pale violet, often almost white, flowers ranging 1-1.8 cm across, with a short blunt spur, and hairy sepals, on erect stalks 5-15 cm. long. Sepals are five in number, petals are up to 1.5 cm long, and about 4 mm broad, obovate, obtuse, upper two are wedge-shaped, while two lateral ones are narrower and bearded at the base, marked with dark coloured streaks. Its lower most petals is the shortest, patterned with dark coloured stripes. Usually its Leaves are ovate-heartshaped to kidney-shaped with a blunt tip. Leaves are thick and hairy. Leaf stalks covered with hairs that oriented towards base stipules, are lance-shaped. Its flowering time is March to June (Adnan and Hischer, 2010).

1.8.5. Chemistry

Many species contains antioxidants called anthocyanins. The chemical components found in *V. canescens* include methyl salicylate alkaloid violin, glycoside viola quercitrin, saponins, and glucosides (Rana *et al.*, 2010). In 1828 Boullay, discovered an alkaloid in its roots known as violin which are similar to emetine, but had different properties from emetine. It exists in the plant with malic acid in combined form. Some scientists believe that it is remarkably active and may be poisonous.

1.8.6. Medicinal uses

*V. canescens* is effective when used as carminative, demulcent, astringent, antipyretic, diaphoretic, and purgative properties. Plant is anticancerous in action and is used to treat nervous disorders (Ahmad *et al.*, 2012; Hussain *et al.*, 2011; Adnan and Hischer, 2010). In many other areas, plant extract is used against eczema, epilepsy, rheumatism, and stomach acidity and as a cure for respiratory problems (Hamayun *et al.*, 2006). The leaf paste of *V. canescens* with brown sugar is used to cure cough and other respiratory problems (Ahmed *et al.*, 2013). The whole plant of *V. canescens* is used against malaria (Shah *et al.*, 2014: Rani *et al.*, 2011). In Uttarakhand, the extract of the whole plant is used against leucorrhoea, regulating menstruation, and headache. It is also effective against bronchial asthma, cough and also famous as aphrodisiac. Paste of plant is externally used as antiseptic when applied on cuts, wounds, and boils (Rana *et al.*, 2010).
Major objectives of the study

- To determine *in–vitro* antifungal activity of aqueous and solvents (acetone, ethanol, petroleum ether) extracts of selected medicinal plants against *Fusarium f.sp. lycopersici*.
- To find out Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC).
- To determine *in-vitro* tomato seed germination percentages after treatments with effective medicinal plants extracts.
- To test *in-vitro* SVI (Seedling Vigor Index) of tomato seedlings after plant extract treatments.
- To test plant extract potential in pot conditions.
- To determine shoot & root lengths of seedlings in pot treatments.
- To evaluate fresh and dry weight of experimented pot seedlings.
- To find out pre and post-emergence damping–off percentage.