CHAPTER 1

‘Every great advance in science has issued from a new audacity of imagination.’

~John Dewey
Medicinal plants have been used as a possible source, for traditional treatments of many human diseases for thousands of years in many parts of the world. In rural areas of the developing countries, they continue to be used as the primary source of medicine (Chitme \textit{et al.}, 2003). About 80% of the people in developing countries use herbal medicines for their health care (Kim, 2005). The natural products derived from medicinal plants have proven to be an abundant source of biologically active compounds, many of which have been the basis for the development of new lead chemicals for pharmaceuticals. With respect to diseases caused by microorganisms, the increasing resistance in many common pathogens to currently used therapeutic agents, such as antibiotics and antiviral agents, has led to renewed interest in the discovery of novel anti-infective compounds. As there are approximately 500 000 plant species occurring worldwide of which only 1% has been phytochemically investigated, there is great potential for discovering novel bioactive compounds from the plants (Bajpai \textit{et al.}, 2005)

There have been numerous reports of the use of traditional plants and natural products for the treatment of oral diseases. Many plant-derived medicines used in traditional medicinal systems have been recorded in pharmacopeias as agents used to treat infections and a number of these have been recently investigated for their efficacy against oral microbial pathogens (Arora and Kaur, 1999).

Numerous studies have shown that aromatic and medicinal plants are sources of diverse nutrient and non-nutrient molecules, many of which display antioxidant and antimicrobial properties which can protect the human body against both cellular oxidation reactions and pathogens. Thus, it is important to characterize different types of medicinal plants for their antioxidant and antimicrobial potential (Mothana and Lindequist, 2005, Bajpai \textit{et al.}, 2005; Wojdylo \textit{et al.}, 2007).
Aromatic and medicinal plants are known to produce certain bioactive molecules which react with other organisms in the environment, inhibiting bacterial or fungal growth (antimicrobial activity) (Chopra et al., 1992; Bruneton, 1995). The substances that can inhibit pathogens and have little toxicity to host cells are considered candidates for developing new antimicrobial drugs.

Spices and herbs have been used for thousands of centuries by many cultures to enhance the flavor and aroma of foods. Scientific experiments since the late 19th century have documented the antioxidant properties of some spices, herbs, and their components (Zaika, 1988; Bajpai et al., 2005). Many studies reported the activities of spices and herbs on food borne pathogenic microorganisms (Arora and Kaur, 1999; Yano et al., 2006).

In fact, plants produce a diverse range of bioactive molecules, making them a rich source of different types of medicines. Higher plants, as sources of medicinal compounds, have continued to play a dominant role in the maintenance of human health since ancient times (Farombi, 2003). Over 50% of all modern clinical drugs are of natural product origin (Stuffness and Douros, 1982) and natural products play an important role in drug development programs in the pharmaceutical industry (Baker et al., 1995). There has been a revival of interest in herbal medicines. This is due to increased awareness of the limited ability of synthetic pharmaceutical products to control major diseases and the need to discover new molecular structures as lead compounds from the plant (Duncan, 1987; Cordell et al., 1991; Aftab, and Sial, 1999).

Recently there has been a renewed interest in improving health and fitness through the use of more natural products. Herbs and spices are an important part of the human diet. They have been used for thousands of years to enhance the flavor, color and aroma of food. In addition to boosting flavor, herbs and spices are also known for their preservative and medicinal value (Desouza et al., 2005) which forms one of the oldest sciences.
A spice is a dried seeds; fruit, root or bark used in significant quantities as a food additive for flavor, color, or a preservative that kills the harmful microorganism or prevent their growth (Scully, 1995).

A conventional classification of spices is based on degree of taste as:

- **Hot spices**
- **Mild spices**
- **Aromatic spices**
- **Herbs and aromatic vegetables**

This classification is shown in Table 1.1. Though the term spice can be used to incorporate herbs, the difference between herbs and spices can be described as follows:

- Herbs may be defined as the dried leaves of aromatic plants used to impart flavour and odour to foods with, sometimes, the addition of colour. The leaves are commonly traded separately from the plant stems and leaf stalks.

- Spices may be defined as the dried parts of aromatic plants with the exception of the leaves.

The various parts of plants used to produce the range of herbs and spices are illustrated in Table 1.2. Herbs and spices have been used in food since antiquity.

Table 1.1 Conventional classifications of spices
(Source:http://www.monkeypuppet.net/gardening/handbook_herbsandspices_vol1.pdf)

<table>
<thead>
<tr>
<th>Classes</th>
<th>Spices</th>
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<tbody>
<tr>
<td>1.Hot spices</td>
<td>Chillies, Cayenne pepper, black and white peppers, ginger, mustard.</td>
</tr>
<tr>
<td>2.Mild spices</td>
<td>Paprika, coriander.</td>
</tr>
<tr>
<td>3.Aromatic spices</td>
<td>Allspice, cardamom, cassia, cinnamon, clove, cumin, dill, fennel, fenugreek, mace and nutmeg.</td>
</tr>
<tr>
<td>4.Herbs</td>
<td>Basil, bay, dill leaves, marjoram, tarragon, thyme.</td>
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</tbody>
</table>
From about 100 species of higher plants, there are 125 clinically useful drugs of known constitution have been isolated. About 5000 plant species have been studied in detail and it has been estimated that they can be use as a possible sources of new drugs. The bulk production of plant based drugs is one of the most important tasks for the pharmaceutical industry (Turner, 1996; Paterson and Anderson, 2005).

### 1.1 History

The use of medicinal plants as a source of medicine is based on the experience of many generations of traditional physicians and herbal practitioners found in the different ethnic societies. The utilization of medicinal plants in modern medicine suffers from the fact that although plants are used at the time being to prevent or to cure diseases, but scientific evidence in term of modern medicine is lacking in many cases. Only very few medicinal plants has attracted the attention of scientists and have been subjected to scientific investigations for the exposure of new medicinal compounds of therapeutic importance (Said, 1969; Fendall, 1974).

### Table 1.2: Plant organs as spices.

<table>
<thead>
<tr>
<th>Plant organs</th>
<th>Spice crops</th>
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<tbody>
<tr>
<td>1. Aril</td>
<td>Mace of nutmeg</td>
</tr>
<tr>
<td>1. Barks</td>
<td>Cassia, cinnamon</td>
</tr>
<tr>
<td>2. Berries</td>
<td>Allspice, black pepper, chilli</td>
</tr>
<tr>
<td>3. Buds</td>
<td>Clove</td>
</tr>
<tr>
<td>4. Bulbs</td>
<td>Onion, garlic, leek</td>
</tr>
<tr>
<td>5. Saffron</td>
<td>Pistil (female part of flower)</td>
</tr>
<tr>
<td>6. Kernel</td>
<td>Nutmeg</td>
</tr>
<tr>
<td>7. Leaf</td>
<td>Basil, bay leaf, mint, marjoram, sage, curry</td>
</tr>
<tr>
<td>8. Rhizome</td>
<td>Ginger, turmeric</td>
</tr>
<tr>
<td>9. Latex from rhizome</td>
<td>Asafoetida</td>
</tr>
<tr>
<td>10. Roots</td>
<td>Angelica, horse-radish</td>
</tr>
<tr>
<td>11. Seeds</td>
<td>Ajwan, aniseed, caraway, celery, coriander, dill, fennel, fenugreek, mustard, poppy seed</td>
</tr>
</tbody>
</table>

Source: [http://www.monkeypuppet.net/gardening/handbook_herbsandspices_v01.pdf](http://www.monkeypuppet.net/gardening/handbook_herbsandspices_v01.pdf)
Many useful drugs from plants have been isolated and characterized. Out of the 119 plant derived drugs, 74% were discovered as a result of chemical studies designed to isolate the active principle responsible for the use of plants in traditional medicine (Farnsworth, 1989; 1990).

In the last 50 years, the development and introduction of new drugs, their antibiotics have led to success in the control of many diseases. The drugs derived from plants still form the mainstay of medical treatment in the developing countries and according WHO it is estimated that 80% of the world inhabitants still rely chiefly on traditional medicines for primary health care. In spite of the fact that about 25% of modern medicine are derived from plants (Farnsworth and Morris, 1976; Balick, 1990; Akerele, 1992).

1.1.1 Early History

Since 50,000 BC humans were relay on the use of spices. Around 2000 BC, the spice trade developed throughout the Middle East with cinnamon and Piper, and in East Asia (Korea, China) with herbs and pepper. The Egyptians used herbs for their need for exotic herbs helped to stimulate world trade. By 1000 BC, China, Korea and India had medical systems based upon herbs. Early uses were connected with magic, medicine, religion, tradition, and preservation (Buccellta et al., 1983). Nutmeg, has a Sanskrit name which originates from the Banda Islands in the Molukas, in South Asia. Sanskrit is the ancient language of India, showing how old the usage of this spice is in this region. Historians believe that nutmeg was introduced to Europe in the 6th century BC (Burkill, 1966).

1.1.2 Middle Ages History

Through plantations all spices were imported in Asia and Africa, which made them expensive. The Republic of Venice had the monopoly, from 8th century to 15th century on spice trade with the Middle East, and along with it the neighboring Italian city-states. The trade made the region rich. It has been estimated during late middle ages that around one thousand tons of pepper and one thousand tons of the other common spices were imported into
Western Europe each year. The value of these goods was the equivalent of a yearly supply of grain for 1.5 million people (Adamson, 2004).

1.1.3 Early Modern Period

In 1499, the control of trade routes and the spice-producing regions were the main reasons that Portuguese navigator Vasco-da-Gama sailed to India. With the discovery of the New World came new spices, including all spice, bell and chili peppers, vanilla, and chocolate. This development kept the spice trade, with America as a late comer with its new seasonings, profitable well into the 19th century (Corn, 1999).

The present study was undertaken to explore the potential of the following spices –

- *Nigella sativa* Linn.
- *Piper nigrum* Linn.
- *Pimpinella anisum* Linn.
- *Trachyspermum ammi* (Linn.) Sprague

1.2 *Nigella sativa* L. – A Global Healer

<table>
<thead>
<tr>
<th>Classification</th>
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<tbody>
<tr>
<td><strong>Kingdom</strong></td>
<td>Plantae</td>
</tr>
<tr>
<td><strong>Division</strong></td>
<td>Magnoliophyta</td>
</tr>
<tr>
<td><strong>Class</strong></td>
<td>Magnoliopsida</td>
</tr>
<tr>
<td><strong>Order</strong></td>
<td>Ranunculales</td>
</tr>
<tr>
<td><strong>Family</strong></td>
<td>Ranunculaceae</td>
</tr>
<tr>
<td><strong>Genus</strong></td>
<td>Nigella</td>
</tr>
<tr>
<td><strong>Species</strong></td>
<td>Sativa</td>
</tr>
<tr>
<td><strong>Binomial name</strong></td>
<td><em>Nigella sativa</em> L.</td>
</tr>
</tbody>
</table>

*Nigella sativa* L. is an annual herbaceous flowering plant and belongs to the family *Ranunculaceae* and native to southwest Asia. (Al-Jassir, 1992) The seeds are small and black in color and possess aromatic odor and taste (Fig 1.1). It grows to 20–30 cm (7.9–12 in) tall, with finely divided, linear leaves (Fig 1.2). The flowers are delicate, and usually colored pale blue and white, with 5–10 petals (Hashim and El-Kiey, 1962; Nergiz and Otleş 1993) (Fig 1.3). The fruit is a large and inflated capsule composed of 3–7 united follicles, each containing numerous seeds (Fig 1.4). The seeds are tiny and hairy (1-2 mm long), black, 3 sided and look a bit like pieces of flint under a
microscope. *Nigella sativa* L. is sometimes mistakenly confused with the fennel herb plant (*Foeniculum vulgare*). The flowers grow terminally on its branches while the leaves grow opposite each other in pairs, on either side of the stem. Its lower leaves are small and petiole and the upper leaves are long (6-10cm) (Source: http://en.wikipedia.org/wiki/Nigella_sativa).

### 1.2.1 Origin

For thousands of years by various cultures and civilizations *Nigella sativa* L. (black cumin) has been used, around the world as a natural healing aid and as a good supplement in maintaining good health. Black cumin seeds were discovered in Tutankhamen's tomb, implying that it played an important role in ancient Egyptian practices (Nicholson and Shaw, 2000). The exact role of *Nigella sativa* L. in Egyptian culture is not known, however, items entombed with a king were of importance as they were carefully selected to assist him in the afterlife (Pommerening, 2005).

### 1.2.2 Composition

The oil of *Nigella sativa* L. can be divided into a solid and a volatile phase. The seeds contain both fixed and essential oils, proteins, alkaloids and saponin. The fixed, or fatty, oil is rich in unsaturated fatty acids, mainly linoleic acid (50 – 60 %), oleic acid (20 – 25 %), eicosadienoic acid (3 %) and dihomolinoleic acid (10 %) which is characteristic for the genus. Saturated fatty acids (palmitic, stearic acid) amount to about 30 % or less. Commercial *Nigella* oil may also contain parts of the essential oil, mostly thymoquinone, by which it acquires an aromatic flavour, but its content of the essential oil depends largely on the manufacturing, filtering, filling, and storing processes (Ramadan and Morsel, 2002; Nickavar *et al.*, 2003).

The fatty acid composition chemically extracted oil is remarkably constant across samples; however, it is strikingly different from that of the cold pressed natural stressing the importance of the extraction process on composition. Storage, especially under the influence of electromagnetic radiation such as light, can alter the composition markedly (Nualkaew *et al.*, 2004) so the oil should be preferably stored in light-tight containers. Oxygen also impairs the quality of the stored oil (Luetjohann, 2003) this influence is
attributable to free oxygen radicals, which exhaust the radical scavenging potential of the oil in storage and thus diminish its biological efficacy.

In the essential oil (avr.0.5 %, max. 1.5 %), thymoquinone was identified as the main component (up to 50 %) besides p-cymene (40 %), a-pinene (up to 15 %), di-thymoquinone and thymohydroquinone. Other terpene derivatives were found only in trace amounts: Carvacrol, carvone, limonene, 4-terpineol, citronellol. Furthermore, the essential oil contains significant (10%) amounts of fatty acid ethyl esters. On storage, thymoquinone yields dithymoquinonene and higher oligocondensation products (nigellone) (Michelitsch and Rittmannsberger, 2003).

The thymoquinone content of the oil as an expression of the amount of volatile oil retained during the manufacturing process can be determined with a simple polarographic method (Michelitsch and Rittmannsberger, 2003) providing a means of quality control for commercially distributed preparations of *Nigella sativa* L. oil.

### 1.2.3 Medicinal uses

*Nigella sativa* L. in Islam, it is regarded as one of the greatest forms of healing medicine available, in the Unani Tib-e-Nabvi system of medicine, *Black cumin* is regarded as a valuable remedy for the cure of diseases (Source: [http://www.crescenlife.com/dietnutrition/Kalonji.htm](http://www.crescenlife.com/dietnutrition/Kalonji.htm)). In the Middle East and Southeast Asian countries, the seeds have been traditionally used to treat ailments including asthma, bronchitis, rheumatism and related inflammatory diseases, to increase milk production in nursing mothers, to promote digestion and to fight parasitic infections.
Its oil has been used to treat skin disease eczema and when the oil is little bit warm it is used to treat cold symptoms. Many researchers have recently also studied it's effectiveness towards cancer, and it's said to have many anti-cancer compounds. Its many uses have earned Black cumin seed the Arabic approbation 'Habbatul barakah', meaning the seed of blessing (Source: http://www.crescenlife.com/dietnutrition/Kalonji.htm).

It’s therapeutic used was initiated after the advent of Islam, since; Prophet Muhammad (sallallahu alaiyhi wassallam) mentioned its therapeutic efficacy and potential of cure. It is stated in the books of SEERAT that Nabi-e-Akram (sallallahu alaiyhi wassallam) himself used to take these seeds for therapeutic purpose but with the syrup of Honey (Source: http://www.crescenlife.com/dietnutrition/Kalonji.htm).

Khalid Bin Saad states that he was travelling with Ghalib Bin Jabr, when he fell ill during the journey. Ibn Abi Ateeq (nephew of Hazrat Aisha (R.A.)) came to meet us. On seeing the patient, he took 5 or 7 seeds of Kalonji and ground it, mixed it in olive oil and dropped in both nostrils; Hazrat Aisha (R.A.) told us that Prophet Muhammad (sallallahu alaiyhi wassallam) stated that there was cure in black seeds for all ailments except sam. I asked him, what was Sam? He said “Death”. Ghalib Bin Jabr became healthy with that treatment. (Source: http://www.crescenlife.com/dietnutrition/Kalonji.htm).

Over 200 studies have been carried out since 1959, at international universities and articles published in various journals have shown remarkable results supporting its traditional uses (source: http://www.nigella-satva-research.com/nigella-sativa-uses.). Recent research on the Nigella sativa L. as an anti-biotic, anti-tumor, anti-inflammatory, anti-histaminic, anti-bacterial, anti-bronchial and immune boosting agent has shown great promise.
Fig. 1.1: The seeds of *Nigella sativa* L. (Kalonji).

Fig. 1.2: The plant of *Nigella sativa* L.

Fig. 1.3: The flower of *Nigella sativa* L. (Kalonji).

Fig. 1.4: The mature capsule of *Nigella sativa* L. (Kalonji).

(Source: [http://www.crescentlife.com/dietnutrition/kalonji.htm](http://www.crescentlife.com/dietnutrition/kalonji.htm))
1.2.3.1 Pharmacological activities: The popularity of the plant was highly enhanced by ideological belief in the herbs as a cure for multiple diseases. Due to the sayings of the Holy Prophet Mohammed (Peace be upon him) that the plant is full of medicinal value (Ghaznavi, 1996; Gilani et al., 2001) it gained immense popularity. Consequently, Kalonji has been extensively studied particularly in the Islamic world which justifies its broad traditional therapeutic value.

1.2.3.2 Hypoglycemic effects: Al-Awadi and Gumaa (1987) studied a plant mixture of *Nigella sativa* L. and other medicinal plant for its blood glucose lowering effects in rats and found it effective. The aqueous extract and *Nigella sativa* L. oil were found to lower the blood glucose level significantly after oral administration in rabbits (Akhtar and Shan, 1993; Meral et al., 2001). Farah et al., (2002) studied the possible insulinotropic properties of *N. sativa* L. oil in Streptozotocin plus Nicotinamide-induced diabetes mellitus in hamsters. The result showed that the hypoglycemic effect of *Nigella sativa* L. oil was, at least partly, because of stimulatory effect on beta cell function with consequent increase in serum insulin level and possesses insulinotropic properties in type II like model. In another study, the hypoglycemic effect of *Nigella sativa* L. was supposed to be mediated by extra pancreatic actions rather than by stimulated insulin release (El-Dakhakhny et al., 2000). A recent clinical study on human volunteers showed that 1 gm of *N. sativa* L. seeds twice daily caused a decrease in blood glucose level after 2 weeks of oral treatment (Bamosa et al., 1997).

1.2.3.3 Effects on Immune system and Cancer: The seeds of *N. sativa* L. and its oil have been used as a tonic to promote health and prevent disease. They reported to exhibit immunopotentiating (Hailat et al., 1995), immunomodulating and interferon-like activities. The ethanolic extract was found to inhibit cancer cells and endothelia cells progression in vitro (Medenica et al., 1997; Swamy and Tan, 2000). The protective effect of *N. sativa* L. grains as nutraceuticals was
studied on the oxidative stress and carcinogenesis induced by methylnitrosourea in Sprague Dawley rats (Mabrouk et al., 2002). The alcoholic extract also showed the cytotoxic activity and was found to cure oral cancers (Salomi et al., 1989). Topical application of the seed extract inhibited skin carcinogenesis in mice and intraperitoneal administration (100 mg kg\(^{-1}\) body weight) delayed the onset of papilloma formation (Salomi et al., 1991). In another study, the aqueous and alcoholic extracts of *N. sativa* L. alone or in combination with \(\text{H}_2\text{O}_2\) as an oxidative stressor, were found to be effective *in vitro* in inactivating MCF-7 breast cancer cells (Farah and Begum, 2003). In recent study, the anti-tumor effect of thymoquinone was investigated both *in vivo* and *in vitro* in male Swiss albino rats on fibrosarcoma induced by 20-methylcholangantherene and it was found to inhibit tumor incidence and tumor burden significantly. The possible modes of actions were discussed as its antioxidant activity (Bardary and Gamel-el-Din, 2001).

1.2.3.4 **Effects on Nervous system:** *N. sativa* L. seeds revealed promising narcotic analgesic activity mediated possibly through opioid receptors (Vohora and Dandiya, 1992). The oil from the seeds exhibited CNS depressant and potent analgesic effects. It was found to potentiate pentobarbitone-induced sleeping time (Khanna et al., 1993). Aqueous extract in mice revealed an analgesic effect, which peak after 2 hours and sustained for 4 hours (Khan et al., 1999). The aqueous and methanolic extracts of *Nigella sativa* L. seeds produced an alteration in the general behavior patterns, significant reduction of spontaneous motility, reduction in normal body temperature and significant analgesic action against hot plate and pressure tests, suggesting the CNS depressant action (Al-Naggar, 2003).

1.2.3.5 **Effects against Microorganisms:** The plant extract and its constituent have been extensively studied for their antimicrobial effect against a wide range of bacterial, fungal and parasitic organisms. The methanolic extract of *N. sativa* L. seeds was found to exhibit anti-plaque action by potently inhibiting *Streptococcus mutans*, thus also
preventing dental caries (Namba et al., 1995). The alcoholic and ether extract showed in vitro antibacterial activity against Gram positive and Gram negative bacteria (Sokmen, 1999). In another study, it was found to exhibit antibacterial activity especially against Bacillus pumilus, B. subtilis, Streptococcus mutans, taphylococcus lutea, Staphylococcus aures and Pseudomonas aeruginosa (El-Kamali et al., 1998). The ethanolic extract was found to possess’ anticestodal effect in children (Akhtar and Riffat, 1991) and the essential oil showed in vitro antifungal against Aspergillus species and Carvularia lumanta (Agarwal et al., 1979) as well as against pathogenic yeast Candida albicans (Hanafy and Hatem, 1991). The aqueous extract of the seeds possess potent in-vivo antifungal activity against Candidiasis in mice (Khan et al., 2003).

1.2.3.6 Effect against Inflammation: Traditionally, the fixed oil expressed from seeds of N. sativa L. is of great use in skin eruptions, paralysis, hemiplegia, back pain, rheumatism and related inflammatory diseases on external application. The crude fixed oil of N. sativa L. and thymoquinone both have been found to inhibit the eicosanoid generation and membrane lipid peroxidation, through the inhibition of cyclooxygenase and 5-lipoxygenase pathways of arachidonate metabolism, thus responsible for the anti-inflammatory activity (Houghton et al., 1995). The aqueous extract and essential oil were showed positive result in animal models for anti-inflammatory, analgesic and antipyretic activities (Al-Ghamdi, 2001; Mutabagani and El-Mehdy, 1997).

1.2.3.7 Effect on Gastrointestinal system: The seeds of Nigella sativa L. have been used in wide range of gastrointestinal disorder (Nadkarni, 1976). The alcoholic extract of N. sativa L. was investigated to evaluate the antiulcer activity (Rajkapoor et al., 2002). The volatile oil and ethanolic extract of N. sativa inhibited the spontaneous movements of the rabbit jejunum (Aqel, 1993) and aqueous-methanolic extract showed the spasmylytic effect, thus providing scientific basis for its traditional use in diarrhea (Gilani et al., 2001). In another study,
hepatoprotective effect of *Nigella sativa* L. oil and its constituent thymol were shown in some models of mice and rodents (Mahmoud et al., 2002; Janbaz et al., 2003).

1.2.3.8 Effect on the Respiratory system: *N. sativa* L. powdered seeds have been traditionally used to alleviate respiratory disorder, e.g., asthma, bronchospasm and chest congestion (Usmanghani et al., 1997). Nigellone, an active ingredient of kalonji, was shown to be an effective prophylactic agent in asthma and bronchitis with higher efficiency in children than in adults and also found to inhibit effectively the histamine release from the mast cells (Chakravarty, 1993). The effects of the volatile oil and thymoquinone were investigated and compared on the respiratory system of the urethane-anesthesized guinea pigs (El-Tahir et al., 1993)

1.2.3.9 Effect on the Cardiovascular system: The essential oil from the seeds of *Nigella sativa* L. exhibited a depressant action on the frog heart and a relaxant effect on isolated smooth muscles of rat (Agarwal et al., 1979). The crude extract of *N. sativa* L. was found to significantly lower blood pressure in hyperstensive rats similar to that of nifedipine (Zaoui et al., 2000) seed treatment was found to lower the levels of serum cholesterol (Hassanin and Hassan, 1996) and also found to produce protection against cisplatin-induced falls in hemoglobin levels and leukocyte counts (Nair et al., 1991). The methanol soluble portion of black cumin oil, showed inhibitory effects on arachidonic acid-induced platelet aggregation and blood coagulation (Enomoto et al., 2001).

1.3 *Piper nigrum* Linn.

<table>
<thead>
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<th>Classification</th>
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<tbody>
<tr>
<td>Kingdom</td>
<td>Plantae</td>
</tr>
<tr>
<td>(unranked)</td>
<td>Angiosperms</td>
</tr>
<tr>
<td>(unranked)</td>
<td>Magnoliids</td>
</tr>
<tr>
<td>Order</td>
<td>Piperales</td>
</tr>
<tr>
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<td>Piperaceae</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Piper</em></td>
</tr>
<tr>
<td>Species</td>
<td><em>Nigrum</em></td>
</tr>
<tr>
<td>Binomial name</td>
<td><em>Piper nigrum</em> L.</td>
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</table>
Piper nigrum L. is a flowering vine in the family Piperaceae, (Fig.1.5) cultivated for its fruits, which is usually dried and used as a spice and seasoning. The fruit, known as a peppercorn when dried, is approximately 5 millimeters (0.20 in) in diameter, (Fig.1.6) dark red when fully mature, (Fig.1.7) and, like all drupes, contains a single seed. Peppercorns, and the powdered pepper derived from grinding them, may be described simply as pepper, or more precisely as black pepper, white pepper, or green pepper. Green peppercorns are simply the immature black peppercorns (Fig.1.8). A single stem will bear 20 to 30 fruiting spikes (source: http://en.wikipedia.org/wiki/Black-pepper).

From the Tamil/ Malayalam word “pippali” the word "pepper" is ultimately derived for long pepper (Iyengar, 1925). The English word for “Pepper” is derived from the old English “Pipor”. In the 16th century, Pepper started referring the new word chili peppers as well. “Pepper” was used in a figurative sense to mean "spirit" or "energy", in the early 20th century; this was shortened to pep (Harper, 2005).

1.3.1 The Plant

Black pepper is a perennial climbing vine grown for its berries extensively used as spice and in medicine. India is a leading producer, consumer and exporter of black pepper in the world. During 2005-06, 16,700 tones of black pepper products worth Rs. 14,050 lakhs were exported to various countries accounting for 6.0 % of export earnings among spices. Black pepper is cultivated to a large extent in Kerala and Karnataka and to a limited extent in Tamil Nadu and other states. The crop is grown in about 2, 46,000 hectares with a production of 69,000 tones annually. Kerala and Karnataka account for a major portion (92 %) of production of black pepper in the country (Parthasarathy, 2008).

1.3.2 History

Pepper has been used as a spice in India since prehistoric time times. Pepper is native to India and has been known to Indian cooking since at least 2000 BCE. Miller (1969) notes, that while pepper was grown in Southern Thailand and in Malaysia, its most important source was India, particularly
the Malabar Coast, in what is now the state of Kerala. Peppercorns were a much prized trade good, often referred to as "black gold" and used as a form of commodity money. The term "Peppercorn rent" still exists today.

The ancient history of black pepper is often interlinked with that of long pepper, the dried fruit of closely related *Piper longum*. The Romans knew of both and often referred to either as just "piper". In fact, it was not until the discovery of the New World and of chile peppers that the popularity of long pepper entirely declined. Chile peppers, some of which when dried are similar in shape and taste to long pepper, were easier to grow in a variety of locations more convenient to Europe.

Until well after the Middle Ages, virtually all of the black pepper found in Europe, the Middle East, and North Africa travelled there from India's Malabar region. By the 16th century, due to the Portuguese influence, pepper was also being grown in Java, Sunda, Sumatra, Madagascar, Malaysia, and elsewhere in Southeast Asia, but these areas traded mainly with China, or used the pepper locally (Dalby, 2002). Ports in the Malabar area also served as a stop-off point for much of the trade in other spices from farther east in the Indian Ocean.

Black pepper, along with other spices from India changed the course of world history. It was in some part the preciousness of these spices that led to the Portuguese efforts to find a sea route to India during the age of discovery and consequently to the Portuguese colonial occupation of that country, as well as the European discovery and colonization of the America (Turner, 1996).

1.3.3 Varieties

Black pepper is produced from the still-green unripe drupes of the pepper plant. The drupes are cooked briefly in hot water, both to clean them and to prepare them for drying. The heat ruptures cell walls in the pepper, speeding the work of browning enzymes during drying. The drupes are dried in the sun or by machine for several days, during which the pepper around the seed shrinks and darkens into a thin, wrinkled black layer. Once dried, the
spice is called black peppercorn. Black peppercorn is considered spicier than white peppercorn.

1.3.3.1 White pepper

White pepper consists of the seed of the pepper plant alone, with the darker colored skin of the pepper fruit removed. This is usually accomplished by a process known as retting, where fully ripe peppers are soaked in water for about a week, during which the flesh of the pepper softens and decomposes. Alternative processes are used for removing the outer pepper from the seed, including decortications, the removal of the outer layer through mechanical, chemical or biological methods.

(Source: http://www.hindustanbusinessline.com)

White pepper is sometimes used in dishes like light colored sauces or mashed potatoes, where ground black pepper would visibly stand out. They have differing flavor due to the presence of certain compounds in the outer fruit layer of the drupe that are not found in the seed.

1.3.3.2 Green pepper

Green pepper, like black, is made from the unripe drupes. Dried green peppercorns are treated with sulfur-dioxide, canned or freeze-drying, in a way that retains the green color. Pickled peppercorns are also green unripe drupes preserved in brine or vinegar. Fresh, unpreserved green pepper drupes are used in some Asian countries. Their flavor has been described as piquant and fresh, with a bright aroma. They decay quickly if not dried or preserved (Ochef, 2005).

1.3.3.3 Orange pepper and Red pepper

A product called orange pepper or red pepper consists of ripe red pepper drupes preserved in brine and vinegar. Ripe red peppercorns can also be dried using the same color-preserving techniques used to produce green pepper (Katzer, 2006). Pink pepper from Piper nigrum L. is distinct from the more-common dried pink peppercorns, which are the fruits of a plant from a different family, the Peruvian pepper tree, Schinus molle, and its relative the Brazilian pepper tree, Schinus terebinthifolius.
1.3.4 Medicinal uses

Various sources from the 5th century onward also recommend pepper to treat eye problems, often by applying salves or poultices made with pepper directly to the eye. Black pepper was believed to cure many common diseases of human beings such as constipation, diarrhea, pneumonia, ear ache, gangrene, heart disease, hernia, hoarseness, indigestion, insect bites, insomnia, joint pain, liver problems, lung diseases, oral abscesses, sunburn, tooth decay and tooth aches (Turner, 1996).

Nevertheless, Black pepper either powdered or its decoction is widely used in traditional Indian medicine and as a home remedy for relief from sore throat, throat congestion, cough etc.

Pepper is known to cause sneezing. Some sources say, that piperine is a substance present in black pepper, irritates the nostrils, causing the sneezing (source: http://www.en.wikipedia.org/wiki/Black-pepper) Few controlled studies have been carried out to answer the question. It has been shown that piperine can dramatically increase absorption of selenium, vitamin B, beta carotene and curcumin as well as other nutrients (Duke, 1993).

As a medicine, pepper appears in the Buddhist Samannaphala Sutta, as one of the few medicines allowed to be carried by a monk (Bhikkhu, 1990). Safrol, is a mildly carcinogenic compound present in small amount in pepper. Also, it is eliminated from the diet of patients having abdominal surgery and ulcers because of its irritating effect upon the intestines, Lichtenberge et al., (1998) being replaced by what is referred to as a bland diet.
Fig. 1.5: The flowering vine of *Piper nigrum* L.(Black pepper).

Fig. 1.6: The peppercorns of *Piper nigrum* L.(Black pepper).

Fig. 1.7: Pepper plant with partially mature peppercorns.

Fig. 1.8: Pepper plant with immature peppercorn.

However, extracts from black pepper have been found to have antioxidant properties (Gulcin, 2005) and anti-carcinogenic effects, especially when compared to chili (Nalini et al., 2006).

Piperine, present in black pepper acts as a thermogenic compound. Piperine enhances the thermogenesis of lipid and accelerates energy metabolism in the body and also increases the serotonin and beta-endorphin production in the brain. Piperine and other components from black pepper may also be helpful in treating vitiligo, (Lin, 2007) although when combined with UV radiation should be staggered due to the effect of light on the compound (Soumyantha et al., 2006).

The crude extracts of dried fruits of *P. nigrum* L. both aqueous and ethanolic have been found to possess larvicidal effect against the IV larval instars of the mosquito *Cx. quinquefasciatus*. The biological activity of the PnAE and PnEE might be due to the various compounds including potentially insecticidal compounds (Freeborn and Wymore, 1929; Su and Horvat, 1981).

Black pepper (*P. nigrum* L.) is used to treat asthma, chronic indigestion, colon toxins, obesity, sinus congestion, fever, intermittent fever, cold extremities, colic, gastric ailments and diarrhea. It has been shown to have antimicrobial activity (Perez and Anesini, 1994; Dorman and Deans, 2000). Both aqueous and ethanol extracts of black pepper screened for antibacterial activity against a penicillin G resistant strain of *Staphylococcus aureus*, showed antibacterial activity, which was determined by the agar-well diffusion method, using cephalosporin as a standard antibiotic (Perez and Anesini, 1994). Piperine, [1-[5-[1,3-benzodioxol-5-yl]-1-oxo-2,4, pentadienyl piperidine, a pungent alkaloid present in *P. nigrum* L., enhanced the bioavailability of various structurally and therapeutically diverse drugs. A concise mechanism of its bioavailability
enhancing action is poorly understood. However, data suggests that piperine is absorbed very fast across the intestinal barrier; it may form non-polar complexes with drugs and solutes thus increasing permeability across the barriers (Khajuria et al., 1998). Piperine exerted significant protection against tert-butyl hydroperoxide and carbon tetrachloride hepatotoxicity in mice. Silymarin, a known hepatoprotective drug, was also tested simultaneously for comparison. Piperine showed lower hepatoprotective potency than silymarin (Koul and Kapil, 1993).

Platel et al., (2002) showed that the spice mix of coriander, turmeric, red chilli, black pepper and cumin favorably enhanced the pancreatic lipase, chymotrypsin and amylase activity when consumed via diet. In addition, these spice mix brought about a pronounced stimulation of bile flow and bile acid secretion. Activities of pancreatic lipase, amylase and chymotrypsin were elevated by 40, 16 and 77% respectively. The higher secretion of bile, especially with an elevated level of bile acids and a beneficial stimulation of pancreatic digestive enzymes, particularly lipase, could be two mechanisms by which these combinations of spices aid in digestion and increased performance.

1.4 *Pimpinella anisum* Linn. - An Ideal Medicine

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Aniseed (Pimpinella anisum L.) is a flowering plant in the family Apiaceae native to the eastern Mediterranean region and Southwest Asia. It is known for its flavor, which resembles liquorice, fennel and tarragon. It is a herbaceous annual plant growing to 3 ft (0.91 m) tall. The leaves at the base of the plant are simple, 0.5–2 in (1.3-5.1cm) long and shallowly lobed, while leaves higher on the stems are feathery pinnate, divided into numerous leaves. (Fig. 1.11) The flowers are white, approximately 3 mm diameter, produced in dense umbels. (Fig.1.9) The fruit is an oblong dry schizocarp 3-5 mm long. (Fig. 1.10) It is these seed pods that are referred to as "aniseed" (Katzer, 2006).

1.4.1 Composition

The composition of aniseed varied considerably with origin and cultivation method used. These are typical values for the main constituents (Purthi, 1976).

The aniseed contains; moisture: 9-13%, protein: 18%, fatty oil: 8-23%, essential oil: 2-7%, starch: 5%, N-free extract: 22-28% and crude fibre: 12-25%. Essential oil yielded by distillation is generally around 2-3% and anethole makes up 80-90% of this. The aroma of the essential oil (up to 3% in the fruits) is dominated by trans-anethole (max. 90%). Additional aroma components are estragol (iso-anethole, 2%), anise aldehyde (less than 1%), anise alcohol, p-methoxy-acetophenone, pinene, limonene, γ-himachalene (2%). An unusual compound is the phenol ester 4-methoxy-2-(1-propene-yl)-phenol-2-methyl-butyrate, which is characteristic for anise (5%). Melchior and Kanster (1974) mentioned that anise, especially of Italian origin, may contain small amounts of highly toxic hemlock fruits.
The seed wasteth and consumeth winde, and is good against belchings and upbraidings of the stomacke, alaieth gripings of the belly, provoketh urine gently, maketh abundance of milke, and stirreth up bodily lust: it staieth the laske, (diarrhea) and also the white flux in women.
—John Gerard 1597

1.4.2 Medicinal Uses

Aniseed, like fennel, contains anethole, a phytoestrogen (Albert-Puleo, 1980). Aniseed can be used to relieve menstrual cramps (Muller-Schwarze, 2006). The essential oil is reportedly used as an insecticide against head-lice and mites (Purthi, 1976).

During American Civil War, aniseed was used as an antiseptic. This method was later found to have caused high levels of toxicity in the blood and was discontinued shortly thereafter (Muller-Schwarze, 2006).

Aniseed was used to cure the sleeplessness and if it is chewed with little amount of honey in the morning to freshen the breath (Bostock, 1856). In India, no distinction is made between the aniseed and fennel. Therefore, the name is usually given to both of them is Saunf. Some used the term patli saunf or velayati sauf to distinguish aniseed from fennel.
Fig. 1.9: The flowering of *Pimpinella anisum* L. (Aniseed).

Fig. 1.10: The seeds of *Pimpinella anisum* L. (Aniseed).

Fig. 1.11: Plant with its parts.

The volatile oil of aniseed provides the basis for its internal use to ease griping, intestinal colic and flatulence. It also has a marked expectorant and antispasmodic action and may be used in bronchitis, in tracheitis where there is persistent irritable coughing, and to reduce the symptoms of whooping cough (Collins, 2005). Externally, the oil may be used in an ointment base for the treatment of scabies and lice infestations. Aniseed showed mild oestrogenic effects which is due to the presence of diantheole and photoantheol (Ody, 1993).

*Pimpinella anisum* L. has been used as a stimulating effect of digestion and antiparasitic, antifungal and antipyretic (Afifi *et al.*, 1994). Additionally, the plant and especially its fruit essential oil have been used for treatment of some disease including seizures and epilepsy (Avicenna, 1988; Abdul-Ghani *et al.*, 1987).

Aniseed has been shown to have anticonvulsant effects and has been used for the treatment of constipation (Curtis *et al.*, 1996; Pourgholam *et al.*, 1999; Chicouri and Chicouri, 2000) and possesses muscle relaxant effect (Albuquerque *et al.*, 1995). Recently its oil has been reported to be used as antibiotic substitute in broiler ration (Mehmet *et al.*, 2005).

The powder and concoction of aniseed in hot water are used as carminatives, antiseptics, diuretics, digestives, aphrodisiacs, and as a remedy for insomnia and constipation (Kreydiyyeh *et al.*, 2003). Furthermore, it is used to promote digestion, improve appetite, alleviate cramps and nausea, and relieve flatulence and colic. In Unani and Arabian traditional medicine, anise fruit and its oil have been used for the treatment of various conditions including dyspepsia, nausea, abdominal colic, seizures and epilepsy (Said *et al.*, 1996). The phytotherapeutic applications of anise are based on its digestive, carminative, diuretic and expectorating action (Besharati-Seidani *et al.*, 2005). It has been recently reported that the essential oil of anise is highly effective as both larvicidal and ovicidal agents (Prajapati *et al.*, 2005).
1.5 *Trachyspermum ammi* (Linn.) Sprague

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Ajwain (*Trachyspermum ammi* L.) belonging to family *Apiaceae*, is widely used for curing various diseases in both humans and animals. Its other names commonly used in the literature are ajwan, ajowan, Bishop’s wee, carom, or Ethiopian cumin. The most utilizable part of ajwain is the small caraway like fruit, which is particularly popular in Indian savory recipes, savory pastries, snacks and as spice (Anilakumar *et al.*, 2009). *Trachyspermum ammi* L. is a small, erect, annual, herbaceous plant with branched leafy stems, feather like leaves (2.5 cm long), 4-12 ray flower heads bearing 6 -16 flowers.(Fig. 1.12) The fruits are minute, greyish-brown coloured and egg shaped(Fig. 1.13) (Kaur and Arora, 2010).

1.5.1 Flavour and Aroma

Raw ajwain smells almost exactly like thyme because it also contains thymol, but is more aromatic and less subtle in taste, as well as slightly bitter and pungent. It tastes like thyme or caraway, only stronger. Even a small amount of raw ajwain will completely dominate the flavor of a dish (source: http://www.indianfood.about.com/od/thebasic/p/ajwain.htm).

In India, ajwain is never used raw, but either dry-roasted or fried in ghee or oil. This developed a much more subtle and complex aroma, somewhat similar to caraway but little bit brighter smell. Among other things, it is used for making a type of parantha, called *ajwain ka parantha*.

1.5.2 Main Constituent

Ajwain seed analysis has revealed it to contain moisture (8.9%), protein (15.4%), fat (18.1%), fibre (11.9%), carbohydrates (38.6%), tannins, glycosides, saponins, flavone and mineral matter (7.1%) containing calcium, phosphorous, iron and nicotinic acid (Pruthi, 1992). *T. ammi* L. seeds contain 2.5-5% essential oil and the principal constituents of essential oil are phenols-thymol (35-60%), carvacrol (11%). The remainder of the oil is called thymene which contains p-cymene (50 - 55%), beta-pinene (4 - 5%), limonene with gamma-and betaterpinenes (30 - 35%) (Raghavan, 2006).

The essential oil (2.5 to 5% in the dried fruits) is dominated by thymol (2-isopropyl-5-methylphenol, 35 to 60%) α-pinene, p-cymene, limonene and γ-terpinene have been found. Essential oil distilled from aerial parts (flowers, leaves) of ajwain grown in Algeria, however, isothymol (50%) was found to be the dominant constituent before p-cymene, thymol, limonene and γ-terpinene. Isothymol, is not well defined and might refer to both 2-isopropyl-4-methylphenol and 3-isopropyl-6-methylphenol (carvacrol). From South Indian ajwain fruits, almost pure thymol has been isolated (98%), but the leaf oil was found to be composed of monoterpenoids and sesquiterpenoids: 43% cadinene, 11% longifolene, 5% thymol, 3% camphor and others (Minija and Thrippil, 2002).

(Source: http://en.wikipedia.org/wiki/Trachyspermum_ammi)
Fig. 1.12: The flowering of *Trachyspermum ammi* L.

Fig. 1.13: The seeds of *Trachyspermum ammi* L.

(Source: http://en.wikipedia.org/wiki/Trachyspermum_ammi.JPG)
1.5.3 Medicinal uses

Traditionally, ajwain known as a digestive aid which is used to relief abdominal discomfort occur due to indigestion. In southern parts of India, dry ajwain seeds are powdered and soaked in milk, which is then filtered and fed to babies. Many assume it relieves colic in babies, and for children it also improves digestion and appetite. Ajwain can be used as digestive mixture in large animals.

Ajwain with its characteristic aromatic smell and pungent taste is widely used as a spice in curries. Its seeds are used in small quantities for flavouring numerous foods, as preservatives, in medicine and for the manufacture of essential oil for ultimate use in perfumery (Pruthi, 1992).

A study conducted using the essential oil suggests that it has some use in the treatment of intestinal dysbiosis. Hawrelak et al., (2009) reported its benefit to inhibit the growth of undesired pathogens while not adversely affecting the beneficial flora.

*T. ammi* L. has been shown to possess anti-aggregatory effects (Srivastava, 1988); anthelmintic (Lateef et al., 2006); antihyperlipidaemic (Javed et al., 2006); antifilarial (Mathew et al., 2008); insecticidal (Chaubey, 2008); kidney stone inhibitory (Kaur et al., 2009); molluscicidal (Singh et al., 1997; Singh and Singh, 2000); mosquito repellent (Pandey et al., 2009); and nematicidal activities (Park et al., 2007).

1.5.3.1 Antihypertensive, antispasmodic and broncho-dilating activity:

The antihypertensive effect of *T. ammi* L. was evaluated by administered intravenously in vivo, and the antispasmodic and broncho-dilating actions in vitro, the studied revealed that blockade of calcium channel that has been found to mediate the spasmolytic effects
of plant materials and considered that this mechanism contributed to their observed result and supported the traditional use of *T. ammi* in hyperactive disease states of the gut such as colic and diarrhoea as well as in hypertension (Gilani *et al.*, 2005).

1.5.3.2 Hepatoprotective activity: The *in vivo* hepatoprotective actions showed that *T. ammi* L. was 80% protective in mice against a normally-lethal dose of paracetamol (1 g/kg) and it prevented the CCl4-induced prolongation of pentobarbital sleeping time in mice, which tended to normalize the high serum levels of liver enzymes caused by CCl4-induced liver damage in rats (Gilani *et al.*, 2005).

1.5.3.3 Antilithiasis and diuretic activity: An antilithiasis and diuretic action of *T. ammi* L. on inhibiting oxalate urolithiasis induced in rats was studied *in vivo*. The results concluded that the traditional use of *T. ammi* L. in the treatment of kidney stones was not supported by their experimental evidence (Ahsan *et al.*, 1990).

1.5.3.4 Antiplatelet-aggregatory: Srivastava, (1988) studied in vitro antiplatelet-aggregatory experiments with blood from human volunteers, it showed that a dried ethereal extract of *T. ammi* L. seeds, inhibited aggregation of platelets induced by arachidonic acid, collagen and epinephrine, the study was intended to support the traditional use of *T. ammi* L. in women post parturition.

1.5.3.5 Anti-inflammatory potential: Anti-inflammatory potential of the total alcoholic extract (TAE) and total aqueous extract (TAQ) of the Ajwain seeds were studied by (Thangam and Dhananjayan, 2003). TAE and TAQ exhibited significant antiinflammatory activity in both the animal models. The weights of the adrenal glands were found to be significantly increased in TAE and TAQ treated animals.

1.5.3.6 Antifilarial activity: *In vitro* activity of a methanolic extract of fruits of *Trachyspermum ammi* L. (Apiaceae) against *Setaria digitata* worms has been investigated. The crude extract and the active fraction showed significant activity against the adult *S. digitata* by both a worm motility
and MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5- diphenyltetrazolium bromide] reduction assays. *T. ammi* L. crude extract exhibited macrofilaricidal activity. The IC50 values for the isolated active principle 2- isopropyl-5-methyl phenol at two incubation periods 24 and 48 hr were 0.024 and 0.002 mg/mL, respectively. The mean percentage mortality of adults (58.93%) in the group treated with 50 mg/Kg was significantly higher than that was obtained in the control group (Mathew *et al.*, 2008).

**1.5.3.7 Gastro protective activity:** Ramaswamy *et al.*, (2010) reported that the *Trachyspermum ammi* L. fruit showed antiulcer activity by using different ulcer models. Animals pre-treated with ethanolic extract showed significant decrease in ulcer index and percentage ulcer protection in all models. The results suggest that the extract showed significant protection by reducing ulcerative lesions when compared with control group of animals.

**1.5.3.8 Detoxification of aflatoxins:** The seed extract of Ajwan showed the maximum degradation of aflatoxin G1 (AFG1). The aflatoxin detoxifying activity of the seeds extract was significantly reduced upon boiling. The result showed detoxification of AFG1 by dialyzed *T. ammi* L. extract showed more than 91% degradation occurred in 24 h and 78% degradation occurred within 6 h after incubation (Velazhahan *et al.*, 2010).

**1.5.3.9 Ameliorative effect:** Anilakumar *et al.*, (2009) investigated the effect of ajwain extract on hexachlorocyclohexane (HCH)-induced oxidative stress and toxicity in rats. The pre-feeding of ajwain extract resulted in increased GSH, GSH-peroxidase, G-6-PDH, SOD, catalase, glutathione S-transferase (GST) activities and decreased hepatic levels of lipid peroxides. It was concluded that HCH administration resulted in hepatic free radical stress, causing toxicity, which could be reduced by the use of dietary ajwain extract.
1.5.3.10 Antimicrobial actions in vitro: The antimicrobial action of *T. ammi* L., in the protection of foodstuffs against microbial spoilage, conducting laboratory assays of antimicrobial efficacy in vitro was studied. The active principles thought to be responsible for the antimicrobial activity of ajwain were reported to be carvacol and thymol (Saxena and Vyas, 1986). Antifungal action of volatile constituents of *T. ammi* seeds on ten fungi (*Acrophialophora fusispora, Curvularia lunata, Fusarium chlamydosporum, F. poae, Myrothecium roridum, Papulaspora sp., Alternaria grisea, A. tenuissima, Drechslera tetramera* and *Rhizoctonia solani*) were found to inhibit the growth of all test fungi by 72-90% (Singh et al., 1979). Caccioni et al., (2000) reported the antibacterial property of phenolic compounds, such as thymol and carvacol, depending on the concentration used.

1.5.3.11 Hypolipidaemic action in vivo: Antihyperlipidaemic effect of *T. ammi* L. seed has been evaluated in albino rabbits. It was concluded that *T. ammi* L. powder at dose rate of 2 g/kg body weight and its equivalent methanol extract were extensively effective in lipid lowering action by decreased total cholesterol, LDL-cholesterol, triglycerides, total lipids (Javed et al., 2002).

1.5.3.12 Digestive stimulant actions in vivo and in vitro: *T. ammi* L. would increase the secretion of gastric acid. The gastric acid secretion was increased nearly fourfold by *T. ammi* L. The addition of *T. ammi* L. to the diet reduced food transit time and also enhanced the activity of digestive enzymes and/or caused a higher secretion of bile acids (Platel and Srinivasan, 2011).

1.5.3.13 Nematicidal Activity: Murthy et al., (2009) reported that Ajwain oil showed nematicidal activity against PWN . Pine wilt disease caused by the pinewood nematode (PWN) *Bursaphelenchus xylophilus*. Amino and hydroxyl groups have been hypothesized as target sites of methyl isothiocyanate sin nematodes (Singh et al., 2004). Some essential oils have been reported to interfere with the neuro-modulator octopamine (Choi et al., 2007) or GABA-gated chloride channels of insect pests.
Thymol and carvacrol were very effective against PWN. These studies confirm that the nematicidal activity of Ajwain oil was mainly attributed to the activity of thymol and carvacrol (Wright, 1981). Nematicidal activity of ajwain essential oils was 0.431mg/ml reported by Kwon et al., (2007).

1.5.3.14 **Anthelmintic Activity:** Anthelmintic activity of *T. ammi* L., shows its effect against specific helminths, e.g. *Ascaris lumbricoides* in humans and *Haemonchus contortus* in sheep (Kwon et al., 2007). *T. ammi* L. exert anthelmintic activity by interference with the energy metabolism of parasites through potentiation of ATPase activity and thus loss of energy reserves (Kostyukovsky et al., 2002). The plant has also been reported to possess cholinergic activity with peristaltic movements of the gut, thus helping in expulsion of intestinal parasites which might also be a contributory factor to its anthelmintic activity (Tamurab and Iwamoto, 2004; Jabbar et al., 2006).

**1.6 Objectives of the Present Study**

- To study some important Indian spices for the evaluation of their medicinal potential.
- To extract the compounds of interest in different solvents of varying polarity.
- To purify and identify compounds of medicinal value from these spices.
- To evaluate these spices for biological activities.
- Screening of these spices for the antimicrobial property.
- To evaluate the free radical scavenging activities of these plants.
- To propose some of these spices as a possible source of pharmaceuticals for future use.

**1.7 Significance of the Work**

The significance of the present work is to evaluate the importance of spices as plant remedies for various diseases, which are possible source of medicinal lead compounds. There is a need for proper and systematic phytochemical and pharmacological investigations to isolate bioactive compounds from spices and to check their biological activities as they are important ingredients of Indian cuisines.
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