

Anti-microbial activities of Indian spices with special reference to Bishops weed, Cumin and Star anise.



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Abstract: Spices have been in use traditionally as insect repellent and antiseptic agents. Studies with various spices and herbs have shown from our laboratory to have inhibitory effect on the growth of various types of microorganism. These include cumin, cinnamon, black cumin, clove, onion, Bishop's weed, chilli, garlic, celery, basil, tejpat, nutmeg, small cardamom, caraway, turmeric, tamarind, aniseed, black pepper, horse radish, pomegranate seeds, cambodge, mustard, rosemary, thyme, oregano and star anise. Further studies with Cumin, bishops weed and star anise have shown to contain cuminaldehyde, thymol and anethole respectively as the active anti-microbial components. This review justifies the traditional uses of spices as antiseptic and disinfective agents.

Introduction

Spices are obtained from a large number of different plants. They are parts of plants such as roots, buds, flowers, fruits, barks and seeds. Most spices owe their flavouring properties to their volatile oils and in some cases to their fixed oils or resin contents which are called oleoresins. Spices are used as flavouring agents in a number of foods like curries, bakery foods, pickles, beverages, etc. Some spices possess antioxidant properties, while others are carminative. Some spices are used as preservatives in pickles and chutneys while others possess strong anti-microbial properties and so they prevent food spoilage.

spices also possess important physiological and medicinal properties.

India is well known as one of the largest producers, consumers and exporters of spices and spice products. India grows over 50 spices in different parts as compared to 86 spices in the world. India consumes considerable quantities of spices and still exports around 218,000 to 225,000 tons of spices each year. Traditional uses of spices has established its role in Ayurvedic and homeopathic medicine. The important spices of India as listed by Spices Board, India are given below in Table 1.

Table 1 List of spices identified by Spices Board, India

Spice	Botanical Name		
1. Cardamom (small)	<i>Electtaria cardamomum</i> Linn	15. Cinnamon	<i>Cinnamomum zeylanicum</i> Blume
(large)	<i>Amomum subulatum</i> Roxb	16. Cassia	<i>Cinnamomum aromaticum</i> Nees
2. Pepper	<i>Piper nigrum</i> Linn	17. Garlic	<i>Allium sativum</i> Linn
3. Chilli	<i>Capsicum frutescens</i> Linn	18. Currey leaf	<i>Murraya koenigii</i> Linn
4. Ginger	<i>Zingiber officinale</i> Rose	19. Komam	<i>Garcinia indica</i> choisy
5. Turmeric	<i>Curcuma longa</i> Linn	20. Mint	<i>Mentha piperita</i> Linn
6. Coriander	<i>Coriandrum sataivum</i> Linn	21. Mustard	<i>Brassica jaucea</i> Linn
7. Cumin	<i>Cuminum cyminum</i> Linn	22. Parsley	<i>Petroselinum crispum</i>
8. Fennel	<i>Foeniculum vulgare</i> P. miller	23. Pomegranate seed	<i>Punica granatum</i> Linn
9. Fenugreek	<i>Trigonella foenum graecum</i> Linn	24. Saffron	<i>Crocus sativus</i> Linn
10. Celery	<i>Apium graveolens</i> Linn	25. Tejpat	<i>Cinnamomum tamala</i> Nees
11. Aniseed	<i>Pimpinella anisum</i> Linn	26. pepper long	<i>Piper longum</i> Linn
12. Bishop`s weed	<i>Trachyspermum anisum</i> Linn	27. Star anise	<i>Illicium verum</i> J D Hooker
13. Caraway	<i>Carum carvi</i> linn	28. vanilla	<i>Vanilla fragrans</i> Ames Syn.
14. Dill	<i>Anethum graveolens</i> linn	29. Sweet flag	<i>Acorus calamus</i> Linn
		30. Greater Galanga	<i>Alpinia galanga</i> Linn
		31. Horse radish	<i>Armoracia rusticana</i> Gaertner

32. Caper	<i>Capparis spinosa</i> Linn	43. Basil	<i>Ocimum basilicum</i> Linn
33. Clove	<i>Syzygium aromaticum</i> Linn	44. Poppy seed	<i>Papaver somniferum</i> Linn
34. Asafoetida	<i>Ferula asafoetida</i> Linn	45. All Spice	<i>Pimenta dioca</i> Linn
35. cambodge	<i>Garcinia cambogia</i> Gaertner	46. Rosemary	<i>Rosmarinus officinalis</i> Linn
36. Hyssop	<i>Hyssopus officinalis</i> Linn	47. Sage	<i>Salvia officinalis</i> Linn
37. Juniper berry	<i>Juniperus communis</i> Linn	48. Savory	<i>Satureja hortensis</i> Linn
38. Bay leaf	<i>laurus nobilis</i> Linn	49. Thyme	<i>Thymus vulgaris</i> Linn
39. Lovage	<i>Levisticum officinale</i> Koch	50. Oregano	<i>Origanum vulgare</i> Linn
40. Marjoram	<i>Marjorana hortensis</i>	51. Tarragon	<i>Artemisia dracunculus</i> Linn
41. Nutmeg	<i>Myristica fragrans</i> Houttuyn	52. Tamarind	<i>Tamarindus indica</i> linn
42. Mace	<i>Myristica fragrans</i> Houttuyn		

(source : Indian Spices Board)

Use of Some Spices as Traditional and Folklore Medicines

Spices have been used as traditional medicines for ages. Ayurvedic and homoeopathic medicine have used spices as one of their major ingredients in most of their preparations. Besides improving texture and flavour of foods, spices are considered to act as preservatives. However, these substances are important also in some different context too. Practices in Ayurvedic and Homoeopathic medicines have revealed that spices possess remarkable medicinal properties. They are used for treating a variety of intestinal disorders and are also used as anti-diuretic, analgesic, anti-diabetic, anti-inflammatory, anti-pyretic, anti-arthritis, anti-ulceric, anti-spasmodic, anti-oxidant and anti-histaminic agents. In this respect, some major spices like chilli, pepper, ginger, garlic, bishops weed, cumin, coriander, turmeric, mustard, asafoetida, fenugreek, onion, fennel, anise, cinnamon, tamarind etc play a major role. Some of the traditional uses of the major spices are mentioned in Table 2 and are also described below.

Table 2 Traditional uses of major spices

Spice	Uses
Anise:	insecticide, breath freshener, digestive, for cough
Asafoetida :	insect repellent, carminative
Basil:	insect repellent, flatulence, nausea
Bishops weed:	digestive, antiseptic
Caraway:	flatulence
Chili:	pain, cold, asthma
Clove:	toothache
Coriander:	digestive
Cumin:	breath freshener
Dill:	sedative, digestive
Fennel:	digestive, diuretic, eyebath
Fenugreek:	yellow dye, digestive, breath freshener,
Garlic:	antiseptic, diuretic
Ginger:	digestive, cold
Horseradish:	chest troubles
Hyssop:	insect, moth repellent, chest trouble, gargle, brushes
Linage:	diuretic, digestive
Marjoram:	digestive, asthma
Onion:	asthma, cough, cold attack
Parsley:	green dye
Pepper:	cold, pain, headache
Poppy seed:	pain,
Rosemary:	digestive nervousness, diuretic
Sage:	insect repellent, coughs, digestive, mouthwash
Saffron:	yellow dye, scent, nervousness
Thyme:	insect repellent, cold, digestive, cuts brushes
Turmeric:	yellow dye, preservative, skin smoothening

The seeds of Ajowain (Bishops weed) are used in prevention of flatulence, colic dyspepsia, diarrhoea, cholera and hysteria. It also relieves rheumatic and neuralgic pains. Anise fruit is used as an ingredient in cordial liquors and is largely employed as a flavouring agent in the preparation of sweets, cake, cookie, soups, stews and breads. The fruits of aniseed are considered to be carminative, diuretics and antiseptic (Pruthi, 1976).

Asafoetida gum resin possesses anti-spasmodic, carminative, expectorant and stimulant properties (Pruthi, 1976). Basil has insect repellent and antiseptic properties. It is also used in flatulence and nausea (Pruthi, 1976). The seeds of black cumin are considered as carminative, stimulant, appetiser, diuretic, emenagogue, galactagogue, anthelmintic and used in the treatment of mild cases of fever (Singh and Singh, 1996; Khan *et al.*, 1996).

Cardamom is mainly used as a flavouring agent for sweet meats, beverages, etc. The oil from the seeds is used for the treatment of inflammation of the eyelids (Singh and Singh, 1996). Cardamom has anti-microbial activity. Seeds have inhibitory effect against microbes. The terpenoid constituents are responsible for the antifungal and antibacterial effects (Parthasarathy *et al.*, 2011). Caraway seeds, leaves and roots are considered useful in strengthening the power of digestion and is useful in relieving flatulence, and nausea (De, 2004). The oil derived from this spice has strong antibacterial properties. Cassia is used for flavouring of bakery, confectionery and food products and also used in perfumery and cosmetics (Pruthi, 1976).

The celery oil is used in the flavouring of different kinds of food like canned soups, meats, sausages and particularly the tonics and sauces. Celery seeds are used as respiratory stimulant in asthma and for cure against liver diseases (Pruthi, 1976). Chilli is used in most culinary preparations to impart flavour and colour to the food. It is also used in sauces and prickles as a preservative. *Capsicum* was used by Native Americans to cure cramps as well as diarrhea. Other folk uses of *capsicum* include appetite stimulation, treatment of gastric ulcers and rheumatism, and restoration of hair growth. *Capsicum* is known for stimulating the circulation and altering temperature regulation and is also used in high fevers. The extract of chilli has been used as antioxidant and analgesic for treatment of headaches, toothache, backache, acute pain etc (Maggi and Meli, 1988; De & Ghosh, 1988 & 1994, De, 2001 & 2004). It has also been shown to protect the pulmonary system from damage by gaseous irritants (De 1989 & Ghosh, 1991, 1992, 1993) and also cyclophosphamide induced clastogenicity (De., 1997).

Cinnamon has been used for the treatment of rheumatism, neuralgia, headache, toothache, dyspepsia, flatulence, diarrhea, nausea, vomiting, inflammation, pyrexia, gonorrhoea, tuberculosis and enteric fever (Matsuda *et al.*, 1987). Clove oil is used in the confectionaries besides being used in relieving toothaches, headaches and

rheumatic pains (De, 2004).

The fruits of Coriander are used in flavouring liquors, cocoa preparations and in confectionery. It is also used as the valuable ingredient in perfumes. The leaves of coriander are stimulant and used as tonic for strengthening digestion and relieving flatulence. They also increase secretion and discharge of urine and reduce fever (Chevallier, 1996). Cumin is generally used as an additive in increasing flavour of different food preparations and liquors. The oil of cumin specially is used as a carminative, stomachic, and astringent. It is useful against diarrhoea and dyspepsia (Brown, 1995).

Curry leaf is a tonic, stimulant and carminative. It helps to improve growth of hair (Chevallier, 1996). It is used as antidiabetic, antioxidant, anti-microbial, anti-inflammatory, hepatoprotective, anti-hypercholesterolemic, nootropic and anti-amnesic activities. Both dill seeds and leaves are frequently used in food preparations. It has carminative, stomachic, aromatic, stimulant, diuretic properties and controls menstrual flow. The essential oil derived from dill seeds are sometimes used for manufacture of soap and as insecticidal agent (Chopra *et al.*, 1986). Fennel is widely used for flavouring soups, sauces, pastries, confectioneries, bread rolls, liquors, meat dishes, and seasoning of prickles. The leaves of fennel are digestive, appetizing and stimulating. The seeds are sweet, laxative, Aphrodisiac and arrest bleeding (De, 2004a).

Fenugreek has been used for treatment of fatigue, small pox, gastric trouble, gout, flatulence, loss of appetite, irregular menstruation and sexual weakness. Fenugreek is also used in the treatment of dysentery, diarrhea, chronic cough, enlargement of spleen and liver, rickets and diabetes (De, 2004; Chopra *et al.*, 1986). Garlic is carminative and gastric stimulant and thus aids in digestion and absorption of food. It is also recommended in cases of pulmonary tuberculosis, rheumatism, sterility and impotency (Chevallier, 1996).

Ginger is used in the dry, preserved and green forms. It is used widely as a flavouring agent, also in the perfume industry, and for its anti-inflammatory, digestive, etc properties (Chopra *et al.*, 1986). The ginger component 6-gingerol, a phenolic alkanone, has been suggested to have antioxidant and anti-inflammatory effects by inhibiting cyclooxygenase and lipoxygenase pathways (Basu and Doeve, 2011). Greater Galanga has uses against sore throat and cold attacks (Pruthi, 1976). Horseradish is used mainly in chest troubles (Singh and Singh, 1996).

Hyssop is used as insect and moth repellent and as gargle in cold attacks (Pruthi, 1976). Kokam is anti-helmintic and cardiogenic and useful in piles, dysentery, tumours, pains and heart complaints (Singh and Singh, 1996). Lovage has diuretic and digestive properties and is helpful in indigestion, heatburn, lung congestion, mild coughs, sore eyes, sore throat etc (Chopra *et al.*, 1986).

Mace is used in different pharmaceutical preparations for dysentery, stomachache, flatulence, nausea, vomiting, malaria, rheumatism. It is used in soaps, dental pastes, chewing gums, chewing tobacco, etc (Chopra *et al.*, 1986). Marjoram has digestive properties and also used in asthma, hysteria and paralysis. It is also used as perfumes and in soap and liquor industries (Singh and Singh, 1996). Mint is used in dental preparations and as antiseptic, carminative, stimulant and diuretic (Pruthi, 1976).

Mustard is good remedy for acute coryza with discharge and lacrimation, sneezing and cough, dry mouth etc (Singh and Singh, 1996). Nutmeg is stimulant, carminative, astringent and aphrodisiac and used against dysentery, stomach, flatulence, nausea, vomiting, malaria, rheumatism, sciatica, and early stages of leprosy (Chopra *et al.*, 1986). The oil of Oregano possesses carminative, diuretic and diaphoretic properties (Pruthi, 1976).

Onion is effective in asthma, cough and cold attacks (Chopra *et al.*, 1986). Parsley has diuretic, carminative and antipyretic properties. It is used in urinary problems (Pruthi, 1976). Besides its uses in culinary preparations, pepper is considered a powerful remedy for various disorders prescribed as an effective cure for dyspepsia, malaria, delirium tremens, hemorrhoids etc (Singh and Singh, 1996). Pepper Long is used to increase digestive power and heal throat complications, cough, bronchitis, asthma etc (Singh and Singh, 1996).

Pomegranate seeds heals diarrhoea, dysentery, dyspepsia and digestive disorders (Pruthi, 1976). Poppy seed is used for getting relieve from all kinds of pain, diarrhoea, dysentery and scalds (Chopra *et al.*, 1986). Rosemary has digestive and diuretic properties and used in nervousness (Singh and Singh, 1996). Saffron is mainly used for colouring food stuffs. However, it is used against fevers, melancholia and enlargement of spleen and liver (De, 2004).

Sage is used as a mild tonic, astringent and carminative (Chopra *et al.*, 1986). Sage contains 1-3% of volatile oil that may be responsible for pharmacological activity, which include anti-depressant, anti-inflammatory, anticholinesterase, and estrogenic (Perry *et al.*, 2003). Savory has carminative and stimulating (Pruthi J S, 1976). Star anise is used as antiseptic and carminative properties. It also gives relief against sore throats (De *et al.*, 2003). Medicinal uses of sweet flag are in the treatment of epilepsy, mental ailments, diarrhea, dysentery, bronchial catarrh, glandular disorders, liver troubles, rheumatism and eczema (De, 2004).

Tamarind is used to relieve pain and swelling in sore eyes and conjunctivities (Chevallier, 1996). Tarragon has aperients, stomachic, stimulant and febrifuge properties (Pruthi, 1976). Thyme is used for treatment of bronchitis and whooping cough (Singh and Singh, 1996). Turmeric is used in cooking, in cosmetics, as natural dye for colouring wool and silk. It has antiseptic as well as anticarcinogenic properties (Chopra *et al.*, 1986). Vanilla is mainly used in

perfume industry and for flavouring food products (Chevallier, 1996).

Anti-Microbial Activity of Some Important Spices

Spices and herbs have been used for thousands of centuries by many cultures to enhance the flavor and aroma of foods. Early cultures also recognized the value of using spices and herbs in preserving foods and for their medicinal value. Scientific experiments since the late 19th century have documented the anti-microbial properties of some spices, herbs, and their components. Studies in the past decade confirm that the growth of both gram-positive and gram-negative food borne bacteria, yeast, and mold can be inhibited by garlic, onion, cinnamon, cloves, thyme, sage, and other spices (Karapinar and Aktug, 1975; Hosono, 1996). Effects of the presence of these spices / herbs can be seen in food products such as pickles, bread, rice, and meat products.

Besides possessing the therapeutic properties mentioned above, spices are also reported to exhibit anti-microbial activity against a variety of pathogenic and non pathogenic bacteria and fungi. Some of these spices, either in the form of powder, extract or extracted oil are known to control microbial spoilage of food. It is now well established that plants too have the antibiotic principles in the pool of secondary metabolites. (Chatterjee and Pakrashi, 1994)

The essential oil of small cardamom has been studied as antimycotic agent against mycotoxigenic moulds (Indian Pharmaceutical Codex, 1953). It has been observed that large cardamom also inhibited growth of some bacteria like *Salmonella enteritidis*, *Pseudomonas fragi*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Proteus vulgaris* and fungi like *Aspergillus niger* and *A. flavus* (Adegoke and Skura, 1994). Clove oil has been found to be active against many nonpathogenic and pathogenic bacteria and fungi. The antimycotic activity of eugenol, the main fungicidal component of clove has been reported to be active against growth of the pathogens like *Escherichia coli*, *Clostridium difficile*, *Clostridium perfringens*, *Salmonella typhimurium* and *Salmonella enteritidis* thus improving gut health (Thapa *et al.*, 2012). It has been found that oil of mustard is anti-microbial in nature. This oil exerts bactericidal action against *Vibrio cholerae*. It inhibits the growth of *Brucella* and *Mycobacterium*, *Trychophyton*, *Achorion* and *Epidermophyton* (Meena and Sethi, 1994).

It has been established that coriander inhibits the growth of *Aspergillus niger*, *Saccharomyces cerevisiae*, *Mycoderma*, *Lactobacillus*, *Bacillus cereus* and others and also that of other food spoiling fungi. Alcohol extracts of nutmeg shows anti-microbial activity against *Micrococcus aureus* (Pruthi, 1976). Reports are available on anti-microbial activity of essential oil of mint on *Candida* species. (Hofling *et al.*, 2010). Anti-microbial action of essential oil from thyme has been also reported (Juven *et al.*, 1994). The viable count of *Salmonella typhimurium* decreased upon addition of thyme oil especially under anaerobic

conditions. Thyme oil has been used in dentistry for its anti-microbial properties (Meeker 1988).

Chilli has been shown in our laboratory to possess anti-inflammatory, antioxidant, analgesic properties (De and Ghosh, 1988, 1994, 1997, 2004, De *et al.*, 2001) and also anti-microbial properties (De *et al.*, 1999). It has been found to possess anti-microbial property and is effective against *E. coli*, *Bacillus cereus* and *Streptococcus pyogenes* (Meena and Sethi, 1994). Capsaicin from chilli acts as a potent inhibitor of the gastric pathogen, *Helicobacter pylori* (Jones *et al.*, 1997).

Cumin, clove, thyme, cinnamon contain different anti-microbial agents (Agnihotri and Vaidya, 1996). Ginger inhibits the growth of many microbes. There is also report on anti-microbial activity in *Zingiber officinale* (Gull *et al.*, 2012). Carvacrol, the main fungicidal component of savory has been found to inhibit the growth of some fungus like *Cladosporium herbarum* and *Penicillium glabrum*. Anti-microbial activities of basil and rosemary essential oils have been found against multidrug-resistant clinical strains of *Escherichia coli* (Sienkiewicz *et al.*, 2013).

Some of the spice essential oils including basil and coriander have been found to be highly inhibitory to selected pathogenic and spoilage microorganisms and may provide alternatives and supplements to conventional anti-microbial additives in food (Elgayyar *et al.*, 2001). Essential oils from spices like ginger, coriander, basil, etc. has been found to show various degrees of inhibition against *A. niger*, *S. cerevisiae*, *Mycoderma* spp. (Meena and Shethi, 1994). Inhibitory effects of anethole and eugenol on the growth and toxin production of *A. parasiticus* have also been observed (Karapinar & Aklog, 1987).

Garlic extract exhibits insecticidal properties (Meriga *et al.*, 2012) and also inhibits growth of clinically important drug resistant pathogenic bacteria (Gull *et al.*, 2012). The mycotoxin production of *Aspergillus parasiticus* and *A. fumigatus* were inhibited by garlic and onion extracts (Hassan and Mahmoud, 1993). The high antimycotic activities of four different spices viz. *Chinese cassia*, clove, thyme oil and cinnamon, may be used for preservation of agricultural commodities (El-Maraghy, 1995). Reports of bacterostatic and fungistatic activities of volatile oil from cinnamon has been found in literature (Becerril *et al.*, 2012). Inhibition of growth and germination of *Clostridium botulinum* by essential oil of clove, thyme, black pepper, garlic, onion, cinnamon have been recorded (Ismail, 1990).

Major Active Components Isolated From Three Important Spices

Various spices and herbs had been screened in our laboratory for anti microbial properties and the spices found to have potent inhibitory effects on various microorganisms included cumin, cinnamon, black cumin, clove, onion, Bishop's weed (ajowain), chilli, garlic, celery, basil, tejpat, nutmeg, small cardamom, caraway,

turmeric, tamarind, aniseed, black pepper, horse radish, pomegranate seeds, cambodge, mustard, rosemary, thyme, oregano and star anise (De *et al.*, 1999, 2003).

Among these spices three spices were studied in details for anti-microbial properties. These three spices are available in the market in plenty at very cheap price and is a common commodity in every household. Very little studies on anti-microbial properties have been carried out. Hence, the need for detailed studies on these three spices:

I. Major Anti-microbial component in Bishop's weed (*Trachyspermum ammi*)

Bishop's weed (Ajowain in hindi) is used in traditional medicine as an effective common cold remedy and has a remarkable power to open up clogged and congested nasal passages. Moreover, the seeds are also effective in bronchitis and asthma (Chevallier, A. 1996).

The oil from Bishop's weed is employed as an antiseptic, aromatic and carminative (De *et al.*, 2002 & Gupta and Banerjee, 1970). It is occasionally used to perfume disinfectant soap and as an insecticide (Pandey *et al.*, 2009, Kirtikar and Basu, 1975). The oil is reported to be as an expectorant in emphysema, bronchial pneumonia, respiration ailment and also seems to possess anti-diuretic and antioxidant effects (De, 2004, De *et al.*, 2002, Bairwa *et al.*, 2012).

In our laboratory crude extractives of bishop's weed (*Trachyspermum ammi*) was screened for anti-microbial spectrum against pathogenic and non pathogenic bacteria and fungi. When the presence of anti-microbial activity in the crude extractive was confirmed, the plan was designed to isolate the compound(s) responsible for such activities in a chemical state of purity using bioassay directed purification processes. The chemical structure of the isolated compound was deduced with the help of the respective spectral data and previously detected antibiotic activities of the compound in crude extractives were confirmed and precisely quantitated.

The MIC values of the anti-microbial compound purified from bishop's weed against different micro-organisms were found to be similar to that of standard thymol and the IR spectra, NMR and of the purified compound had overlapping nature with that of thymol. The study confirmed the presence of thymol as the major anti-microbial component in bishop's weed (De & De, 2007).

Literature survey show that thymol is also known as isopropyl-*m*-cresol and thymic acid. The combustible white crystals are slightly soluble in water and soluble in alcohol and ether and melts from 48 to 51°C and boils at 233°C.

Some other plant sources of thymol are thyme (*Thymus vulgaris* Linn) and celery (*Apium graveolens* Linn) essential oils. Thymol has been used as antibacterial root canal filling material (Seven, 1989) and also as mouth wash for its antibacterial actions (Ross, 1985). Thymol is a

powerful antiseptic and has an agreeable odour. It is useful in a variety of fungal infections of the skin. It has been used as an intestinal antiseptic and antihelminthic. It is an ingredient of deodorant, mouth washes, toothpastes and many pharmaceutical preparations. It is mainly used as a fungicide, preservative, flavoring, and reagent and in perfumes.

II. Major anti-microbial component in Cumin (*Cuminum cyminum*)

Cumin has a warm, spicy taste, with a biting edge and is used in preparation of fruit pies and cookies, cheese dips, cottage cheese, sandwich spreads, eggs, fish, casseroles, salad dressings, tomato-based sauces, poultry and meats like roast pork, sausage and meat loaf (Singh and Singh, 1996).

Cumin has a variety of medicinal properties. Cumin is an aromatic, astringent herb that benefits the digestive system and acts as a stimulant to the sexual organs. It has been used in the treatment of minor digestive complaints, chest conditions and coughs, as a pain killer and to treat rotten teeth (Brown, 1995). The oil of cumin specially is used as a carminative, stomachic, and astringent (Pruthi, 1976). It is useful against diarrhea and dyspepsia. It may be used also as externally as poultice to relieve stitch and pains in the side.

Cumin's essential oil content—comprised mostly of cuminaldehyde and other aldehydes—ranges from 2 to 6%. While this oil is responsible for cumin's strong aroma and flavor, it's also very volatile—as much as half of it may be lost during the grinding process alone. The oil can also be used in perfumery and for flavouring liquors and cordials. The cuminaldehyde is sometimes used in perfumery and cumene for sterilization. It has antidiarrhoeal, antidysenteric, aromatic, astringent, carminative, diuretic, stimulant, and stomachic (Chopra and Chopra, 1986). The compound is beneficial in hoarseness of voice, irritation due to worms in the abdomen and useful in eczema. The residue, left after extraction of volatile oil, contains 17.2 percent protein and 30 percent fat. It can be used as cattle feed.

Cumin has multiple medicinal applications in veterinary medicine. Recently, cumin seeds have been found to show anti-fertility effects in female albino rats (Keshri *et al.*, 1995). Antidiabetic activity of dietary cumin seeds in streptozotocin induced diabetic rats has been shown (Jagtap and Patil, 2010).

Cumin can be used as a potent natural biofungicide in the greenhouse (Lu *et al.*, 2013). Thymoquinone (TQ), extracted from *Nigella sativa*, is reported to possess anticancer and hepatoprotective effects (Talib and Abukhader, 2013).

Alcohol extract of cumin (*Cuminum cyminum*) was tested in our laboratory against different test organisms for preliminary screening of its anti-microbial activity (De *et al.*, 2003). Pronounced inhibition of growth has been

observed in the case of *A. tumefaciens*, *H. oryzae* and *B. subtilis* with cumin extract. The major anti-microbial component present in cumin was subjected to bioassay directed purification by solvent extraction and TLC. The IR and NMR spectra of the isolated compound were compared with standard cuminaldehyde and were found to be identical. The IR spectrum and NMR and GC-MS data clearly indicated its identity with that of pure cuminaldehyde (p-isopropyl benzaldehyde). The MIC values of the anti-microbial compound purified from cumin against different micro-organisms were found to be similar to that of standard cuminaldehyde (De *et al.*, 2003).

III. Major anti-microbial component in Star anise (*Illicium verum*)

Illicium verum Hooker.filius or commonly called star anise, is a member of Magnoliaceae. It is distributed in Atlantic, North America and the tropical and subtropical zones in Asia. The fruit is used as a flavoring agent in confectioneries, candies, chewing gums, tobacco, pickles, animal feeds, liquors and pharmaceutical preparations. It is also used in perfumery and soaps. The fruit is chewed to sweeten the breath and help digestion (Wealth of India, 1950).

Star anise oil is a pale yellowish liquid. A genuine sample of the oil derived exclusively from the fruit displays the following properties: the specific gravity at 25°C is 0.984, the refractive index at 25°C is 1.5572, optical rotation ± 0.12 , soluble in 1.5 volumes or more of 90% ethanol. The oil of star anise is stimulant, eupeptic, carminative, mildly expectorant and diuretic (Verghese, 1998). It is found to be useful in flatulence, spasmodic pains and dysentery. It relieves colic and is a common ingredient of cough lozenges. The oil is employed as an applicant in rheumatism and also used as an antiseptic. It is useful against body lice, bedbugs and forms an ingredient of cattle sprays. It is used in fevers and scabies. It is also highly useful in constipation and insomnia.

In our laboratory the oil-free and the ground star anise fruits (*Illicium verum*) indicated most inhibitory effects against the test organisms when eluted with petroleum ether-benzene. The IR, UV, MS and NMR spectra of the isolated compound clearly indicated its identity with anethole. The IR, UV and NMR (^1H and ^{13}C) spectra of the isolated compound were compared with those of standard anethole and were found to be identical. During HPLC the anethole designated compound exhibited a single peak after 16.5 min which was comparable with standard anethole. The compound gave strong absorption in UV at 259 nm. The results strongly indicated the purity of the isolated anethole (De *et al.*, 2001, 2002).

Anti-microbial studies with the isolated compound as compared with standard anethole indicated that both are comparable in inhibiting micro-organism growth. The MIC values indicate that the anethole isolated was as

effective as the standard anethole in not only inhibiting bacterial growth but also fungal and yeast growth.

This study is also in confirmation of the anti-microbial studies where trans anethole was found as the potent anti-microbial agent in *Illicium verum* fruit (Huang *et al.*, 2010).

Conclusion

The active principles in some of the major spices as have been identified are given below in table 3.

Table 3 Active component(s) of spices

<u>Spices</u>	<u>active principle(s)</u>
Chilli	capsaicin
Pepper	piperine
Ginger	gingerol
Clove	eugenol
Cumin	cuminaldehyde
Coriander	linalool
Garlic	allicin, ajoene, allyl Sulphides
Onion	propenyl sulphides
Anise,	anethole
Bishops weed	thymol
Mustard	Allyl isothiocyanate
Cinnamon	Cinnamaldehyde, Eugenol
Sage	Thymol, Eugenol
Oregano	Thymol, Carvacrol
Fennel	anethole
Star anise	anethole

With the demand for naturally occurring anti-microbial (both antifungal and antibacterial) agents and a never ending search for biologically-active natural products, it is therefore of interest to develop a method for the large scale isolation of major bioactive components from concentrated extracts of some important spices with high anti-microbial activities. In this regard, isolation of highly purified anethole from the locally available Indian star anise (*Illicium verum*) species, cuminaldehyde from Black Cumin (*Cumin cyminum*) and thymol from Bishops weed (*Trachyspermum ammi*) species are also essential. The active components in these spices justifies their traditional uses as antiseptic and insect repellent activities. Thus spices have potent future prospects as biopesticides and also in the therapeutic field as anti-microbial agents.

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