PROPERTIES AND UTILITY OF COMMONLY USED NATURAL SPICES – A REVIEW

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ABSTRACT

Economic losses to Indian food industry due to spoilage of food and food products caused by microorganisms and rancidity are of much concern. To prevent such microbiological and oxidative deteriorations in food many chemicals and antioxidants can be used, but for their residual effects can cause human health problems and damage to lipids in foods. So to combat these undesirable effects of chemicals and antioxidants, some natural preservatives could be used. Spices are considered to act as natural preservative and attributed to some active antimicrobial and antioxidant principles contained in their oils. Therefore the studies for properties and utility of some commonly used natural spices like clove (Syzygium aromaticum), cinnamon (Cinnamomum zeylanicum Nees), black pepper (Piper nigrum L.), garlic (Allium sativum L.), and ginger (Zingiber officinale Roscoe) have been reviewed here.

Key words: Preservatives, Natural, Spices, Cloves, Cinnamon, Black pepper, Garlic, Ginger

India’s food retail business is set for a boom. The industry is likely to grow by over 400 % in the next 5 years and the share of international trade in the sector is projected to double by the year 2015 (Kumar, 2009). But oxidative rancidity is the greatest problem in storage of food and warmed-over flavour in cooked food products. This oxidative deterioration of food involves the oxidation of unsaturated fatty acids (Sato and Hegarty, 1971). Antioxidants are used during food manufacture to minimize free radicals damage to lipids in foods (St. Angelo, 1992) and generation of reactive oxygen species beyond the antioxidant capacity of a biological system give rise to oxidative stress. There are suggestions that oxidative stress plays a role in heart diseases, malaria, neurogenerative disease, AIDS, cancer and in the aging process (Riemersma et al., 1991 and Yoshikawa, 1993). Microorganisms also play a major role in the deterioration of food and food products. The recent trend at consumer level world over is the demand of fresh food without any chemical preservative. Therefore, many food research scientists had recently concentrated in the area of natural antibacterial and antioxidants. Spices are considered to act as natural preservative, Besides improving texture and flavour of foods (Ayres et al., 1980). Pruthi (1980) reported that species act as preservative in foods, due to volatile oil and oleoresins. The preservative quality of spices, either in the form of powders, extract or oil (Saleem and Al-Delaimy, 1982; Sethi and Anand, 1984; Madsen and

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Bertelsen, 1995; Moramatasu et al., 1998; Rajkumar and Berwal, 2003) is attributed to the presence of some active antimicrobial, antioxidant and antimycotic principles.

1. CLOVE (Syzygium aromaticum):

**History:**

Centuries before Christ, courtiers in the presence of their emperors sucked cloves to perfume their breath. This custom began in the early days of the Han dynasty in China and was carried on for centuries. Portuguese women in the East Indies used to distill a liquor from the green cloves for its effectiveness in consoling the heart and for its fragrant aroma. Early physicians prescribed cloves as an aid to digestion believing that clove strengthened the stomach, liver and heart. In the early seventeenth century, cloves were dried unopened flower bud of an evergreen tree, borne in clusters of 10 to 15 and indigenous to the Moluccas or Spice Islands in what is now eastern Indonesia. The flower stalks are the clove stems of commerce.

Clove is considered to be the most fragrant of all aromatic spices. The aroma of ground cloves has been characterized as being spicy, peppery, sweet, fruity, phenolic, woody and musty. The flavour has been similarly characterized as warm, spicy, fruity, astringent and slightly bitter with a warm numbing effect.

**Extractives:**

According to Pruthi (1980), cloves contain essential oil ranging from 15-20 per cent, of which 85-92 per cent is eugenol—the major active principle that inhibits the growth of microorganisms. The essential oil is primarily extracted from clove buds, but some is also obtained from the stems and leaves.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage of Eugenol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clove buds</td>
<td>17% (93% eugenol)</td>
</tr>
<tr>
<td>Clove stems</td>
<td>6% (83% eugenol)</td>
</tr>
<tr>
<td>Clove leaves</td>
<td>2% (80% eugenol)</td>
</tr>
</tbody>
</table>

In addition to eugenol, the oil contains caryophyllin, tannin, gum and resin. Eugenol 2 methoxy-4-allyl phenol gives the pleasant odor to cloves and contributes to the sharp burning flavor. In addition to the natural extractives of cloves, it contains mono, di and tri-glycerides, lecithin and lactic acid (Farrell, 1985).

**Antimicrobial Properties:**

Clove oil is known to contain essential oils that possess antimicrobial activities (Deans and Ritchie, 1987). Bullerman et al. (1977) reported that eugenol the active principal component of clove oil, at 125 ppm inhibited the growth and toxin production of Aspergillus parasiticus in candies and baked foods. Hitokoto et al. (1980) also found inhibitory effects of clove on growth and toxin production of Aspergillus flavus and Aspergillus versicolor. Menon and Garg (2001) reported inhibitory effects of clove oil on Listeria monocytogenes in meat and cheese and recommended that the effect was more pronounced with 1 per cent concentration level of clove oil as compared to 0.5 per cent at both 30 °C and 7 °C temperature. Suresh et al. (1992) found that eugenol possessed

**Proximate composition:** (100g, edible portion)

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount (g)</th>
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<td>Fat</td>
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<td>Ash</td>
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<td>105 mg</td>
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<tr>
<td>Potassium</td>
<td>1102 mg</td>
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<tr>
<td>Sodium</td>
<td>243 mg</td>
</tr>
<tr>
<td>Zinc</td>
<td>1 mg</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>81 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>1 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>530 IU</td>
</tr>
<tr>
<td>Other Vitamins</td>
<td>In significant</td>
</tr>
</tbody>
</table>

(Farrell, 1985)
inhibitory effect against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus sp.*, *Micrococcus sp.*, *Enterobacter sakazaki* and *Klebsiella pneumoniae*, which were all resistant to antibiotics.

In another study, Sabah *et al.* (2004) reported that clove oils were very effective and sensitive against the growth of *Clastridium perfringes*, *E. coli*, *Enterobacter sakazaki* and *Klebsiella pneumoniae*. Essential oils from clove showed various degrees of inhibition against *Aspergillus niger*, *Saccharomyces cerevisiae*, *Mycoderma sp.*, *Lactobacillus acidophilus* and *Bacillus cereus* as determined by paper disc agar diffusion method (Meena and Sethi , 1994). Clove is reported to have antibacterial (Suresh *et al.*, 1992; Sirnik and Gorisek, 1983), antymycotic (Azzouz and Bulerman, 1982; Karapinar, 1990; Moramatasu *et al.*, 1998) and yeast inhibitory (Farag *et al.*, 1989) activity. Two methoxy-4-2-propenal in clove is the major chemical compounds responsible for such properties. Clove exhibited minimum inhibitory concentration (MIC) of 0.86, 1.12, 1.08 and 0.92% (w/v) against *P. chrysogemum*, *P. expansum*, *P. verrugosum*, *Asp. Flavus* and *Asp. parasiticus*, respectively (Rajkumar and Berwal, 2003).

**Antioxidant Properties:**

Earliest research on spices as antioxidants was done by Chipault *et al.* (1952). They worked on 72 different spices and found 32 spices capable to retard the oxidation of lard. Klatanabe and Ayano (1974) examined the antioxidative activities of 11 different ground spices. Amongst, clove showed highest antioxidative activity in both water and ethanol soluble fractions. Studies in a model system indicated that clove is very effective in arresting the buildup of secondary oxidation product mainly formed during refrigeration storage of cooked products.

**Effectiveness and Other uses:**

Whole cloves or the ground form of the spice may be used with fruit or many sweet dishes and vegetable juices, as well as with some meats. It has some typical uses in baked apple dishes, pastry spice, cakes, cookies, fruit soups, pickles and also preserves meat like baked ham, sausages, hamburger, pork shoulder roast, mincemeat, sauerbraten and stews, sweet rolls along with some vegetables like beets, carrots, pumpkin, sweet potato and winter squash.

It is considered as an antiseptic and often employed as preservative (Fabin *et al.*, 1939). It also possesses some local anesthetic action and being favorite remedy for toothache (Kirtikar and Basu, 1933). Yadav *et al.* (2004) found pH values remained comparatively lower than in control after treatment with clove extracts at both temperatures of 4 0C and 37 0C.

**2. CINNAMON (Cinnamomum zeylanicum Nees):**

**History:**

Cinnamon is perhaps the oldest spice. From the days before Moses, cinnamon has been one of the spices burned in incense at religious ceremonies. At one time it was more valuable than gold because of its preservation qualities and it was sought for embalming by the Egyptians over 3600 years ago and was one of the more profitable spices in the Dutch East India spice trade. Cinnamon has been used as a spice for a long period of time in East Asian countries. Especially, its shoot has been known as an important medicinal source, which is effective to relieve fever and disturbed urination (Kim *et al.*, 1998).

Cinnamon is indigenous to the hot and moist climate of Sri Lanka which still maintains about 70 per cent or more of the world market. The balance is produced in Southern India, Sumatra and Borneo. The spice is reddish-brown and has a warm, spicy, aromatic and woody aroma with similar flavour characteristics. It also has a pungent, burning and slightly bitter persistence with an aftertaste that is warm, spicy and very pleasing.
Proximate composition: (100g, edible portion)

<p>| | | | | | | | | | |</p>
<table>
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<tr>
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<td>3.2 g</td>
<td>Sodium</td>
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<tr>
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</tr>
<tr>
<td>Ash</td>
<td>3.6 g</td>
<td>Niacin</td>
<td>1 mg</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Calcium</td>
<td>1228 mg</td>
<td>Vitamin A</td>
<td>260 IU</td>
<td></td>
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<tr>
<td>Iron</td>
<td>38 mg</td>
<td>Other Vitamins</td>
<td>Negligible</td>
<td></td>
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</table>

Extractives:

Cinnamic aldehyde is the major active principal extracted from cinnamon and makes up 65 to 75 per cent of the oil’s components. The remainder being l-linalool, furfural, methyl amyl ketone, nonyl aldehyde, benzaldehyde, hydrocinnaic aldehyde, cumin aldehyde, raisin, caryophyllene, l-phellandrene, p-cymene and l-α-pinene.

Antimicrobial Properties:

Cinnamon spice is known to contain essential oils that possess antimicrobial activity, such as cinnamic aldehyde, tannins and eugenol (Chang, 1995). Bullerman et al. (1977) reported that cinnamic aldehyde the principle component of cinnamon oil, at 150 ppm inhibited the growth and toxin production of Aspergillus parasiticus in candies and baked goods. Oh et al. (1996) reported that among 78 oriental medicinal plant species, methanol extract of Cinnamomum cassia bark revealed potent growth-inhibitory activity toward Clostridium perfringens. They also reported that the biologically active component cinnamic aldehyde of cinnamon showed inhibitory effect on B. fragilis. With the addition of food additives, it’s antimicrobial activity was slightly enhanced (Hsieh et al., 2001). It has been demonstrated that cinnamon contain such inhibitory materials that completely inhibits the growth of toxigenic Aspergillus strains (Hitokoto et al., 1980).

Morozumi (1978) carried out a chemical study on the inhibitor of cinnamon and identified it as o-methoxycinnamaldehyde. He pointed out that this substance has a strong inhibitory effect on the growth of dermatophytes such as Microsporum, Trichophyton and Epideramophyton. He isolated and purified o-methoxycinnamaldehyde from powdered cinnamon and reported that the compounds inhibit the growth and toxin production of mycotoxin-producing fungi. The substance also completely inhibited the growth of Aspergillus parasiticus and A. flavus at 100 µg/ml and A. ochraceus and A. versicolor at 200 µg/ml. In another study, Smith-Palmer et al. (1998) found that cinnamon have antimicrobial property against Campylobactor jejuni, Salmonella enteritidis, Escherichia coli, Staphylococcus aureus and listeria monocytogenes.

The antimicrobial substance of cassia bark has been identified to be trans-cinnamic aldehyde which showed insecticidal and fumigant activities against Melchoris ursulus (Park et al., 2000). Hartung et al. (1973) reported a decrease in the growth of Aspergillus parasiticus and aflatoxin production in raisin bread containing cinnamon. Kim, et al. (2004) reported about the inactivation of Escherichia coli 0157: H7 by cinnamic aldehyde purified from Cinnamomum cassia shoot. Antimicrobial activity of essential oils depends not only on their components but also on the chemical structure of these components (Guenther,
1961; Farag et al., 1989). Frazier (1991) stated that oil of cinnamon is an effective inhibitor of yeasts and bacteria and in high concentrations permits mold growth but inhibits asexual spore formation. Friedman et al. (2004) found antibacterial activities of cinnamon oil against antibiotic resistant Bacillus cereus vegetative cells and spores, Escherichia coli and Staphylococcus aureus. Okazaki and Ohshima (1953) also concluded that cinnamic aldehyde exhibited the highest antifungal properties. The antibacterial effect of cinnamon was studied in raw chicken meat mince and found effective against Aeromonas hydrophilla (Yadav et al., 2004). The inhibitory effect of the cinnamon extract was greater with more acidic pH values but lowered with increased pH values.

Effectiveness and Other uses:

Ground cinnamon bark, cinnamon oil and/or the oleoresin of cinnamon is used commercially in the manufacture of perfumes, confectioneries, ice creams, beverages, flavour enhancer in syrups, chewing gums, cakes, cookies, pies and other baked goods, pickles, relishes and spiced goods. It also used as preservative in apple butter, mincemeat, sauces, icings, curries, condiments, soup bases and in seasonings for bologna, blood sausage, boiled ham, spiced luncheon loaf and many others. Cinnamon, the dried bark is used in the pharmaceutical trade as a carminative and as an antidiarrhetic.

3. BLACK PEPPER (Piper nigrum L.):

History:

The history of pepper is as old as the history of spice trade. Pepper began moving westward from India over 4000 years ago. Throughout recorded history, pepper has been considered the most precious of spices. Peppercorns were so costly that they were used as a substitute for money. Plato declared that while pepper was small in quantity than it was great in virtue. Hippocrates, as early as 400 BC, declared that black pepper assisted the gastric juices to function. The black pepper is an unripened dried fruit of a tropical and perennial climbing vine that grows as high as 6-7 meters (about 20 ft.). It is indigenous to the hot jungle forests of the far eastern tropics (20 degree on either side of the equator). Perhaps, Lampong pepper is in greatest supply and the most popular grade of pepper in the spice trade today.

The volatile oil of pepper has a moderate initial impact and a fresh irritating, terpinaecous, sweet odor with a musty and slightly wood note upon drying out. It has a warm flavour, sweetly spicy, woody, fruity, and musty with a pleasantly warm aftertaste.

Extractives:

Black pepper yields about 1.5% volatile oil and over 6% oleoresin. Pepper oil is primarily a mixture of hydrocarbons consisting of 70-80% monoterpenes, 20-30% sesquiterpenes and less than 4% oxygenated compounds. The higher level of monoterpenes and lower level of α-and β-pinene content considered as fresher pepper oil. Phenolic compounds like flavonoids (mainly quercetin and luteolin), phenolic acids, capsaicinoids, tocopherols, carotenoids, ascorbic acid, nitrates and nitrites were found in fresh peppers (Daood et al., 1995).

Antimicrobial Properties:

Fabin et al. (1939) were amongst the earlier to describe the preservative action of black pepper and cayenne pepper. They reported the inhibition of Clostridium botulinum by white and black pepper (piper nigrum).

Gonzalez et al. (1996) found that oregano (Origanium sp.), 3 varieties of paprika (Sweet, semisweet and pungent forms) of
capsicum annum and 2 varieties of pepper (white and black, piper nigrum) were not very effective in preventing Staphylococcal growth and enterotoxins. They also found that the use of a spice mixture (garlic + oregano + paprika) could not improve the inhibitory effects of the species alone. However, the antimicrobial effect of paprika at concentration higher than 5 per cent level was reported against lactobacilli and pediococci strains.

**Antioxidant Properties:**

Jalay et al. (1987) studied the antioxidant activity of 10 spices commonly used in the formation of fermented meat sausages and found second highest antioxidant index (A.I.) in case of black pepper at 2 per cent levels, followed by ginger and rose petal, when aqueous based microbiological broth is used.

Among spices, paprika had one of the lower redox potentials (Palic et al., 1993), which could lead us to expect high antioxidants content. Antioxidants such as phenolic compounds-flavonoids, mainly quercetin and luteolin, phenolic acids, capsaicinoids, tocopherols, carotenoids, ascorbic acid, nitrates and nitrites (Daood et al., 1995) were found in fresh peppers (Capsicum annum) may be used in almost all foods except those with a sweet flavour.

**Effectiveness and Other uses:**

Pruthi (1980) reported that whole peppercorns are spicy additions to meats, soups, fish and pickles. Ground pepper is especially popular in eggs, salads, soups, sauces, gravies and vegetables. Pepper was considered to be stimulant and an aid to digestion.

Black pepper or one of its extractives is used in dehydrated and canned soups, pickling spice mixes, non alcoholic beverages and practically all meat seasonings like those of bologna, fried chicken, fresh pork sausage, liver sausage, pizza loafs, spiced luncheon loaf, meat loaf and meatballs. The alkaloid principal factor of Piperine contributed to pregnancy (Farrell, 1985).

4. GARLIC (*Allium sativum* L.):

**History:**

Garlic had been known for centuries before the Christian era. Its color is brownish-yellow and its odor is pungent and disagreeable. It has since long been recognized all over the world as a valuable condiment for foods and a popular remedy for various diseases and physiological disorders. Pliny, Virgil and Hippocrates mentioned garlic as a treatment for a variety of ailments. However, not until the 1940’s did scientific evidence appear to establish that garlic indeed did possess antimicrobial medicinal properties (Cavallito and Bailey, 1944). According to Unani and Ayurvedic system as practiced in India, garlic is carminative and is a gastric stimulant. In modern allopathy, it is being used in a number of patented medicines and other preparations (Pruthi, 1976).
Extractives:

The volatile oil of garlic amounts to less than 0.2% by weight of the fresh garlic. These researches were the first to isolate the major antimicrobial components from freshly ground garlic bulblets by steam distillation of ethanolic extracts (Cavallito and Bailey, 1944). They identified this compounds as allicin or diallyl thiosulphinic acid. The constituents of the oil are 60% diallyl disulfide, 20% diallyl trisulfide, 6% allyl propyl disulphide and smaller quantities of diethyl, polysulfide, allinn and allicin. The true garlic odor is said to be derived from the diallyl disulfide. Commercial undiluted oil of garlic has 200 times the strength of dehydrated garlic or 900 times the strength of fresh garlic (Farrell, 1985).

Antimicrobial Properties:

Spices that are both very popular and have a known antimicrobial effect include clove and garlic (Pszezola, 2001) and these were effective against the growth of *Clostridium perfringens* (Sabah et al., 2004). It is reported that garlic contains essential oils and the active principal of garlic oil is allicin (diallyl disulfide and diallyl trisulfide) which possess antimicrobial activity (Cavallito and Bailey, 1944; Holt and Gomez-Almonte, 1995).

Garlic extract is also known as a food preservative (Krishnamurthy and Srinivasamurthy, 1956) and fresh garlic ground with meat prolongs the shelf life of fresh meat (Al-Delaimy and Barakat, 1971). DeWit *et al.* (1979) reported that garlic oil inhibit the toxin production by *Clostridium botulinum* in meat slurry. It exhibits antibacterial (Adetumbi *et al.*, 1986), antifungal (Barone and Tansey, 1977) arvicultural (Amonkar and Banerji, 1971) and enzyme inhibitory effects (Wills, 1956). Al-Delaimy and Ali (1970) reported that 4% fresh garlic extract inhibited the growth of *Escherichia coli*, *Shigella dysenteriae*, *Salmonella typhi* and *Staphylococcus aureus* but *S. aureus* is less sensitive to garlic extract than *E. coli* (Woo, 1973). Several physiological processes in micro-organisms are known to be affected by allicin including RNA synthesis (Feldberg *et al.*, 1988). Garlic has been shown to possess insecticidal, antimicrobial, antiparasitic and antitumor properties (Moore and Atkins, 1977).

Its antimycotic activity of garlic (Kumar and Berwal, 1998; Yin and Chang, 1998) has been established through several studies. In addition, garlic extract has been reported to show an in-vitro growth inhibition effect against a large number of yeasts including *Candida spp.* and many species of *Zoopathogenic fungi* including *Coccidioides immitis* (Appleton and Tansey, 1975) and to have a protective effect against in-vivo fungal infections (Prasad and Sharma, 1982). Antiprotozoal, antibacterial and antifungal effects have been substantiated in-vitro and found to be due specifically to allicin and allyl methyl thiosulfinate (Cavallito and Bailey, 1944). Pal and Agnihotri (1994) found antifungal effect of garlic extract against the *Aspergillus species* involved in otomycosis.

**Proximate Composition of power:** (100g, edible portion)

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
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<td>Zinc</td>
<td>3 mg</td>
</tr>
<tr>
<td>Other Vitamins</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>

(Farrell, 1985)
Antioxidant Properties:

Garlic oil has been found to have potent antioxidant activities in various oils (Shahidi and Wanasundara, 1992). Garlic products have been suggested to be beneficial to human health (Dorant et al., 1993) by exerting antioxidant activity (Prasad et al., 1995). Consumption of garlic tablets (Kwai) has been reported to decrease the susceptibility of human low density lipoproteins to oxidation (Phelps and Harris, 1993). Aged garlic extract has recently been shown to protect vascular endothelial cells from H2O2-induced oxidant injury (Yamasake et al., 1994).

Garlic has been shown to reduce radicals generated by the Fenton reaction (Torok et al., 1994). The garlic preparations were powerful scavengers of hydroxyl radicals (OH) and were able to react with hypochlorous acid (HOCl) at a rate sufficient to protect catalyze and alpha-1-antiproteinase against inactivation (Arouma et al., 1997). Aguirrezabal et al. (2000) found that mixture of paprika (3 per cent) and garlic (1 per cent) were as effective as mixture of nitrate, nitrite and ascorbic acid inhibiting lipid oxidation. Yadav et al. (2004) found pH values remained comparatively lower than in control after treatment with garlic extracts at both temperatures of 40°C and 37°C.

Effectiveness and Other Uses:

Garlic bulbs have an antiinflammation as well as hypoglycaemic activity. It is very beneficial against hyperlipemia, indigestion, pneumonia, the common cold, wounds, infections and blood coagulation changes. Coagulation time is also increased together with fibrinolytic activity (Pruthi, 1976).

Mahindru (1982) mentioned that garlic oil kills five species of Indian mosquitoes in the larva stage. The oil is also effective against eggs of housefly. He mentioned that the inhalation of garlic oil or garlic juice has been recommended in case of pulmonary tuberculosis, rheumatism, sterility, impotency, hypertension, hypercholesterinaemia and atherosclerosis.

Its healing capacity and effectiveness against cholera have been recorded as early as 1758. Further 1 mg of allicin has been reported to correspond to 15 oxford units of penicillin (Indian Pharmaceutical Codex).

Garlic is used for flavoring various dishes almost all over the world. In America 50 per cent of the entire output of fresh garlic is dehydrated and is sold for use in mayonnaise products, salad dressings, tomato products and in several preparations. Krishnamurthi and Srinivasamurthy (1956) found it more pertinent to note that there is an increase in the intestinal synthesis of vitamin B1 on the administration of garlic to human subjects as alli-thiamene, formed by the reaction of thiamine (Vit. B1) and allicin which absorbs faster than thiamine in the intestine and thus aid in digestion and absorption of food.

5. GINGER (Zingiber officinale Roscoe):

History:

Ginger was one of the first oriental spices to reach Southeastern Europe in the ancient spice trade. It has been told that around 2400 BC a baker on the isle of Rhodes near Greece prepared the first gingerbread. Great Britain utilizes great quantities of ginger root in the production of ginger beer and ginger alcohol. The pleasant and spicy aroma, flavour penetrating and pungency of ginger makes it indispensable in many food. Syed Ziauddin et al. (1995) found that a-sesquiphellandrene and a-curcumene were found to be major contributors to the ginger flavour.

Extractives:

The pungency of ginger is attributed to zingerone, shogaol, and gingerol. The primary flavoring constituents of the oil include cineol, borneol, geraniol, linalool and
farmasene. The oleoresin of ginger is obtained by percolating ground ginger with acetone, alcohol or petroleum ether then evaporating off the solvent. The extract is an extremely dark, brownish-green, almost black, semisolid containing 28 ml of volatile oil in each 100g. Proteolytically active principle isolated from ginger extract was named zingibain (Greenberg and Winnick, 1940).

Antimicrobial Properties:

Ginger extract was reported to inhibit *E. coli*, *Streptococcus faecalis*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Clostridium perfringens* in meat and meat product (Salzer, 1982).

Use of ginger extract in beef patties has reduced the psychrotrophic aerobic counts during their storage at 5-7°C for 6 days. Ginger treated samples had mean bacterial counts of 6.8 cfu/g compared to control which has 8.2 cfu/g (Negbenebor et al., 1995). Neveena et al. (2001) found inhibitory effect of ginger on few pathogenic microorganisms and improving the shelf life of meat and meat products. Azzouz and Bulleman (1982) also found the increased antifungal effects of ginger in combination with commercial antifungal agents in small amounts. Along with antifungal agents, hurdles like temperature (33°C), pH (5.0) and water activity (0.99) results in minimal growth of *A. flavus* and *A. parasiticus*. Moreover, the efficiency increases with decrease of water activity (Holmquist et al., 1983).

Antioxidant Properties:

Since the synthetic phenolic antioxidants are very volatile and easily decomposes with possibility of having toxic effects on both lungs and liver (Takahasi, 1992). Stick legislation on the use of synthetic antioxidants and consumer preferences has shifted the attention to natural antioxidants (Depkevicious et al., 1998).

Several investigations in Japan reported that ginger or ginger extract added to lard or other foods showed reasonably strong antioxidant property (Saito et al., 1976). Ginger extract was effective in retarding the development of rancidity in salted pork patties and its effectiveness was directly related to the concentration (Lee et al., 1986). They concluded that extent of retardation of TBA value was proportionate to the amount of ginger extract added to the product. Shogaol and zingerone found in ginger exhibited strong antioxidant activates (Kikuzake and Nakatini, 1993). Incorporation of ginger extract in curing solution for production of smoked spent hen meat was reported to exhibit antioxidant activity (Naveena, 1999). Antioxidant properties of ginger reside with its oil fractions, which include diverse group of phenolic compounds (Mendiratta and Naveena, 2001). The antioxidant effectiveness of ginger extract gradually increased with maximum values at pH 7.0 at low concentrations of extract. (Lee et al., 1986).
Effectiveness and Other Uses:

The pleasant and spicy aroma of ginger makes it indispensable in many food preparations like alcoholic beverages e.g. ginger brandy, ginger candies, curried meats, sauces and pickle etc. It’s use for manufacture of ginger oil, oleoresin, essences and tinctures have been emphasized by Pruthi (1976). He developed a number of vitamin products from spent or exhausted ginger (after the recovery of volatile oil) such as vitaminised ginger powder. Moreover the recovery of starch protein from ginger residues left after the recovery of oleoresin, recommended by the author is worth commercial exploitation.

Mahindru (1982) reviewed the medicinal value of ginger. According to Ayurvedic medical system, it is considered to be carminative stimulant and given in dyspepsia and flatulent colic. Besides its use in tinctures and as flavourants, it also has aphrodisiac values and is prescribed as an adjunct to many tonic and stimulating remedies. Veterinary uses of ginger are as stimulant and carminative in indigestion of horses and cattle, in spasmodic colics of horses and to prevent griping by purgatives (Purthi, 1980).

More recently, ginger rhizome was investigation as a new source of plant proteolytic enzymes by Japanese researchers and it contain a powerful enzyme, which can be used for tenderizing meat (Thompson et al., 1973). Proteolytically active principle isolated from ginger extract was named zingibain (Greenberg and Winnick, 1940). Ginger is used in many prepared meat items like frankfurters, Knockwurst, bologna, pork sausage, liver sausage, salami, pressed sausage, pressed ham, Dutch loaf, Braunschweiger, liverwurst, baked liver loaf, fried chicken and pork patties. Reduction in number of protein bands in the spent hen meat treated with ginger extract was also reported by Naveena (1999).

It is concluded from this review that commonly used natural spices like clove, cinnamon, black pepper, garlic and ginger have very effective antimicrobial and antioxidant properties including some medicinal values. These can be used in food industry to increase the quality and shelf life of processed foods.

REFERENCES

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