SPICES AS ANTIMICROBIAL AGENTS: A REVIEW
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ABSTRACT
The sources of drug are classified as plant, animal, minerals and food sources. The products from plants are used in many ways by human in there day today life. The best and the most important use are as food and as spices. It does not matter which ever the civilization, what ever be the race and color of humans the main food comes from the plant. The spices are the vegetative substances used for to flavor the food. They are also used as preservative and are useful for the humans in many other ways. A spice can be dried seed, fruit, root, bark, or vegetative substance used in nutritionally insignificant quantities as a food additive for flavor, color, or as a preservative that kills harmful bacteria or prevents their growth. It may be used to flavor a dish or to hide other flavors. In the kitchen, spices are distinguished from herbs, which are leafy, green plant parts used for flavoring or as garnish. The above article is an effort to bring out the importance of some daily used spices as antimicrobial agents.

KEYWORDS: Spices, Antimicrobial agents, Ginger, Garlic, Coriander.

INTRODUCTION
Plants and there products have been used by humans in many ways, and the best use is as food and spices. Irrespective of race, civilization and culture the use of plant product as spice is prominent. Spices are the agents which provide flavor to our food. They can be roots, seeds, leaves or other part. May be used in dried form or as fresh. Either in the process of cooking or after it, to garnish or to mask the other undesired flavor. Use is the same but the application may be different. The uses of spice are not limited up to flavoring agents. They possess potent medicinal properties such as antimicrobial activity, antioxidants, anticancer, motion sickness vomiting of pregnancy, anorexia, bronchitis and rheumatic complaints, as a post-operative antiemetic. The medicinal character which is taken under review is antimicrobial activity. The antimicrobial character can be demonstrated in static or cidal manner. The main advantage of using the herbal antimicrobial drug is the side effects are reduced. The side effect such as damage of the normal intestinal flora, bone marrow depression, dysentery, local inflammation, damage to liver and kidney. The above side effects are over come to great extent by using the herbal drugs either be in the form of spices.

Zingiber officinale

Pharmacognosy and uses of Zingiber officinale
Ginger or Zingiber officinale, Roscoe belonging to the Family Zingiberaceae, is a Ginger produces clusters of white and pink flower buds that bloom into yellow flowers. Because of its aesthetic appeal and the adaptation of the plant to warm climates, ginger is often used as landscaping around subtropical homes. It is a perennial reed-like plant with annual leafy stems, about a meter (3 to 4 feet) tall. Traditionally, the root is gathered when the stalk withers; it is immediately scalded, or washed and scraped, to kill it and prevent sprouting. Its roots are used as spice in cooking throughout the world. The ginger plant has a long history of cultivation known to originate in China and then spread to India, South East Asia, West Africa and the Caribbean. The main constituents are sesquiterpenoids with (−)-zingiberene as the main component. Other components include β-sesquiphellandrene bisabolene and farnesene which are also sesquiterpenoids, (−)-β-sesquiphellandrene, cineol and citral.) mature. Ginger roots are fibrous and nearly dry. They can be cooked as an ingredient in many dishes. They can be stewed in boiling water to make ginger tea, to which honey is often added as a sweetener; sliced orange or lemon fruit may also be added. The juice of ginger roots is extremely potent and is often used as spice to flavour dishes such as seafood, mutton, snacks or stew. Powdered dry ginger roots (ginger powder) are typically used to add spiciness to ginger bread and other recipes. Ginger is also made into candy and used as flavoring for cookies, crackers and cakes as well as flavour in ginger ale—a sweet, carbonated, non-alcoholic beverage, ginger bread, ginger snaps, ginger cake and ginger biscuits.
The comparative antibacterial activity of honey, methanol effect of
Though all the test organisms were susceptible to the extract samples. The inhibitory potency of the extracts on the negative bacteria were assessed for possible inhibition by the extract samples. The inhibitory potency of the extracts on the zone of inhibition measurement between 6-3mm, E. coli was the most inhibited where an inhibitory measure of 20mm was recorded with honey, 18mm with ginger ethanol extract and 32mm with the mixture of honey and ginger ethanol extract. While some of the commercial antibiotics (positive control) were not effective on the test organisms, gentamycin and streptomycin were effective with inhibitory result ranging between 8-25mm 8.

Allium sativum

Pharmacognosy and use of Allium sativum
The common name of Allium sativum is garlic. Its close relatives include the onion, shallot, leek, chive and rakkoyo. Dating back over 6,000 years, garlic is native to central Asia, and has long been a staple in the Mediterranean region, as well as a frequent seasoning in Asia, Africa, and Europe. It was known to Ancient Egyptians, and has been used throughout its history for both culinary and medicinal purposes. Allium sativum grows in the wild in areas where it has become naturalised. The "wild garlic", "crow garlic", and "field garlic" of Britain are members of the species Allium ursinum, Allium vineale, and Allium oleraceum, respectively. In North America, Allium vineale (known as "wild garlic" or "crow garlic") and Allium canadense, known as "meadow garlic" or "wild garlic" and "wild onion", are common weeds in fields. One of the best-known "garlics", the so-called elephant garlic, is actually a wild leek (Allium ampeloprasum), and not a true garlic. Single clove garlic (also called pearl or solo garlic) originated in the Yunnan province of China. Garlic is easy to grow and can be grown year-round in mild climates. While sexual propagation of garlic is indeed possible, nearly all of the garlic in cultivation is propagated asexually, by planting individual cloves in the ground. In cold climates, cloves are planted in the fall, about six weeks before the soil freezes, and harvested in late spring 9-12.

Garlic is also claimed to help prevent heart disease (including atherosclerosis, high cholesterol, and high blood pressure) and cancer. Garlic is used to prevent certain types of cancer, including stomach and colon cancers. In fact, countries where garlic is consumed in higher amounts, because of traditional cuisine, have been found to have a lower prevalence of cancer. The known vasodilative effect of garlic is possibly caused by catabolism of garlic-derived polysulfides to hydrogen sulfide in red blood cells (RBCs), a reaction that is dependent on reduced thiols in or on the RBC membrane. Hydrogen sulfide is an endogenous cardioprotective vascular cell-signaling molecule. A randomized clinical trial funded by the National Institutes of Health (NIH) in the United States and published in the Archives of Internal Medicine in 2007 found the consumption of garlic in any form did not reduce blood cholesterol levels in patients with moderately high baseline cholesterol levels. Allium sativum has been found to reduce platelet aggregation and hyperlipidemia 13-21.
Botanical classification
Kingdom : Plantae
Clade : Angiosperms
Order : Asparagales
Family : Amaryllidaceae
Subfamily : Aloeideae
Genus : Allium
Species : A. sativum

Effect of garlic on H. pylori with comparison with omeprazole
In the above study the antibacterial effect of raw home mad garlic, marketed garlic tablet alone with the omeprazole was determined against the known ulcer causing microorganism H. pylori. Dilution of raw and marketed tablet of garlic was made using distilled water. The sensitivity was determined using agar plate and blood agar plate. The concentration of raw and commercial garlic used were from 1000 to 17500mg/l. MIC values for the three commercial garlic tablets were similar (40,000 mg/L). In this study, a growth inhibitory effect of garlic on H. pylori was observed. In addition, a synergic effect was found for the combination of garlic and omeprazole. How-ever, no synergic or antagonistic effect was observed between garlic and amoxycillin, clarithromycin or metro-nidazole.

Activity against isolates of extracted carious teeth
In the above study performed the antibacterial activity was detected against seven bacterial species (Streptococcus mutans, Lactobacillus acidophilus, Norcadia asteroides, Pseudomonas aeruginosa, Actinomycetes viscosus, Staphylococcus aureus and Veillonella alcaligens) isolated from 240 extracted, carious teeth, the bacterial isolate were prepared by suspending a loop full of each microbial growth in about 10 ml of nutrient broth. After incubation at 37°C for 12 h, the turbidity was adjusted to be visually comparable with a 0.5 McFarland’s standard giving a bacterial load of about 1 - 2 × 108 cfu mL⁻¹. From the finding of the above study the result stated that there was a considerable inhibition effect using garlic. The study also resulted the use of lime and garlic for the treatment.

Antibacterial activity of garlic extract on different microorganism varying temperature and pH
The antibacterial effects of aqueous garlic extract against 17 multidrug-resistant gram-positive and gram-negative bacterial isolates, including Staphylococcus aureus, Salmonella typhi, Pseudomonas aeruginosa, Escherichia coli, and Proteus spp., were studied. Antibacterial activity of different concentrations of aqueous garlic extract by well-diffusion method was characterized by inhibition zones of 15 Gram-positives and two Gram-negative pathogenic bacteria. The maximum zone of inhibition was observed in Bacillus subtilis and the minimum was observed for Proteus sp. The minimum inhibitory concentration (MIC) was in the ranges of 6–11 mg/mL and 7–21 mg/mL, in Gram-positive and Gram-negative organisms respectively. The MIC values at 24 and 48 hours were not significant in the tested isolates. Further analysis revealed the antimicrobial efficacy of aqueous garlic extract is time and temperature dependent. Antibacterial efficacy of aqueous garlic extract maintained at room temperature was for maximum 7 days. At 20°C temperatures the activity was maintained for 90 days. In summary, the AGE showed a wide spectrum activity and appears to satisfy all of the criteria for antibacterial agents. These results suggest that garlic can be used to protect food and consumers from the risk of contamination from pathogenic microorganisms.

Activity against enteric pathogens using garlic varieties
The above study was performed against the enteric microorganisms namely Escherichia coli, Proteus m irabilis, Salmonella typhi, Shigella flexineri and Enterobacter aerogenes. The activity was done using two varieties of garlic that is ophiocordon and sativum. Aqueous extract was made and used for to evaluate the potential of garlic varieties against the above microorganisms. The antibacterial activity of Allium sativum L (ophiocordon and sativum) was evaluated by agar well diffusion method. The above study resulted that both the garlic (aqueous) extracts showed growth inhibition activities at the concentrations of 200mg to 500mg. Proteus mirabilis was sensitive to aqueous extracts of ophiocordon at higher concentrations (400 and 500mg). E. aerogenes was not susceptible to the aqueous extract of both the garlic varieties, while S. typhi was susceptible to both the extracts of garlic varieties.

Syzygium aromaticum
Pharmacognosy and use of Syzygium aromaticum
The above plant part is used world wide as an important spice of kitchen. Cloves (Syzygium aromaticum) are the aromatic dried flower buds of a tree in the family Myrtaceae. The clove tree is an evergreen that grows to a height ranging from 8–12 m, having large leaves and sanguine flowers in numerous groups of terminal clusters. The flower buds are at first of a pale color and gradually become green, after which they develop into a bright red, when they are ready for collecting. Cloves are harvested when 1.5–2 cm long, and consist of a long calyx, terminating in four spreading sepals, and four unopened petals which form a small ball in the center. In Ayurvedic medicine it is considered to have the effect of increasing heat in system, hence the difference of usage by region and season. Cloves are used in Indian Ayurvedic medicine, Chinese medicine, and western herbalism and dentistry where the essential oil is used as an anodyne (painkiller) for dental emergencies. Cloves are used as a carminative, to increase hydrochloric acid in the stomach and to improve peristalsis. Cloves are also said to be a natural anthelmintic. The essential oil is used in aromatherapy when stimulation and warming are needed, especially for digestive problems. Topical application over the stomach or abdomen are said to warm the digestive tract. Clove oil, applied to a cavity in a decayed tooth, also relieves toothache. It also helps to decrease infection in the teeth due to its antiseptic properties. Studies have resulted that its effectiveness for fever reduction, as a mosquito repellent and to prevent premature ejaculation has been inconclusive. Clove may reduce blood sugar levels. The buds have antioxidant properties.

Figure 3: Clove
In the above study the antifungal effect of clove have been studied aginst some gram negative bacteria namely S. aureus, P. aeruginosa, E. coli. Agar diffusion susceptibility test revealed inhibition zone of clove sample. Compare to ethanolic extract, methanolic extract was showing best result against gram positive culture Staphylococcus aureus (MTCC 2940) and two gram negative cultures Pseudomonas aeruginosa (MTCC 2453) and E. coli (MTCC 739). The MIC value was determined by using broth dilution methods. Methanolic extract of clove was subjected to get the MIC against test organisms and it was found to be 2.31 mg/ml for E. coli, 0.385 mg/ml for Staphylococcus aureus and 0.01 mg/ml for Pseudomonas aeruginosa. In the above study little change was done by addition of metal ions (Zn++, Cu++, Pb++, Ca++, Mg++, Fe++) along with methanolic extract of clove samples gave positive results against test organisms.

Activity agnist some gram negative bacteria
In the above study the essential oil and the extract of clove have been studied agnist some gram negative bacteria namely Escherchia coli, Proteus mirabilis, Pseudomonas aeruginosa, Enterobacter aerogenes, Klebsiella ozaenae, Klebsiella pneumoniae, Serratia marcescens, Salmonella typhi, Shigella dysentriae and Vibrio cholerae. The screening was performed by using standard disc diffusion method. The aqueous infusion and decoction of clove exhibited maximum activity against P. aeruginosa with 10.43 mm mean diameter of zone of inhibition ± 1.76 standard deviation and 10.86 mm mean diameter of zone of inhibition ± 1.46 standard deviation respectively. Essential oil of clove exhibited maximum activity against V. cholerae with 23.75 mm mean diameter of zone of inhibition ± 3.03 standard deviation. K. ozaenae, K. pneumoniae, S. marcescens, S. typhi, S. dysentriae and V. cholerae were found resistant to aqueous infusion and decoction while essential oil showed strong antibacterial activity against all bacterial isolates tested.

Antifungal properties
In the above study the antifungal effect of clove have been studied agnist time, concentration and organism namely Candida albicans, Penicillium citrinum, Aspergillus niger and Trichophyton mentagrophytes. The fungicidal effect of CO-sugar was compared with disinfectants commonly used in hospitals, such as povidone-iodine and chloroxylenol. The fungicidal effect of clove oleoresin caused important lethal effect, P. citrinum and A. niger were more resistant. After 60 minutes, clove oleoresin dispersed (0.4% v/v) in concentrated sugar solution caused a 99.6% reduction of the initial population (106 c.f.u./ml) of Trichophyton mentagrophytes.

Pharmacognosy and uses
It’s an evergreen tree native to southern China, Bangladesh, Uganda, India, and Vietnam. Like its close relative Cinnamomum verum, also known as "Ceylon cinnamon", it is used primarily for its aromatic bark, which is used as a spice. In the United States of America, cassia is often sold under the culinary name of "cinnamon". The buds are also used as a spice, especially in India, and were once used by the ancient Romans. The tree grows to 10–15 m tall, with greyish bark and hard elongated leaves that are 10–15 cm long and have a decidedly reddish colour when young. Cinnamomum aromaticum is a close relative to Ceylon cinnamon (C. verum), Saigon cinnamon (C. loureiroi), also known as "Vietnamese cinnamon"), camphor laurel (C. camphora), malabathrum (C. tamala), and Indonesian cinnamon (C. burmannii). As with these species, the dried bark of cassia is used as a spice. Some cinnamon oil-entrained compounds could prove toxic in high concentrations. Cassia’s effects on enhancing insulin sensitivity appear to be mediated by type-A polymeric phenolics. Despite these findings, cassia should not be used in place of anti-diabetic drugs, unless blood glucose levels are closely monitored, and its use is combined with a strictly controlled diet and exercise program. Due to a toxic component called coumarin, European health agencies have warned against consuming high amounts of cassia. Other possible toxins founds in the bark/powder are cinnamaldehyde and styrene. A systematic review of research indicates that cinnamon may reduce fasting blood sugar, but does not have an effect on hemoglobin A1C, a biological marker of long-term diabetes.

**Botanical classification**

**Kingdom:** Plantae  
**Phylum:** Angiosperms  
**Order:** Myrtales  
**Family:** Myrtaceae  
**Genus:** Syzygium  
**Species:** S. aromaticum  
**Synonyms**
- Caryophyllus aromaticus L.  
- Eugenia aromatica (L.) Baill.  
- Eugenia caryophyllata Thunb.  
- Eugenia caryophylyb (Spreng.)

**Antibacterial activity on food born pathogens**
The antibacterial efficacy of clove was determined on food born pathogens namely S. aureus, P. aeruginosa, E. coli. In the above study the essential oil and the extract of clove have been studied on food born pathogens caused a 99.6% reduction of the initial population (106 c.f.u./ml) of C. albicans, after 2 min contact, was similar to that presented by disinfectants commonly used in hospitals, such as povidone-iodine and chloroxylenol.

**Antibacterial activity agnist food born pathogen and spoilage bacteria**
The activity was studied agnist food born pathogens namely Listeria monocytogenes (5 strains), Staphylococcus aureus (4 strains), Escherichia coli O157: H7 (6 strains), Salmonella Enteritidis (4 strains), Vibrio parahaemolyticus and Bacillus cereus and 5 food spoilage bacteria: Pseudomonas aeroginosa, P. putida, Alcaligenes faecalis, and Aeromonas hydrophila. The above study confirmed the activity of clove agnist the organisms. The MIC values for ethanol, aqueous extracts, and essential oil from clove ranged from 0.5 to 5.5 mg/ml, 0.8 to 5.5 mg/ml, and 1.25 to 5 %, respectively. The result showed that essential oil of clove reduced all Listeria monocytogenes cells to an undetectable level in ground chicken meat within 1 day of exposure. The above study also stated the use of clove as a preservative, clove could be useful to control L. monocytogenes.

**Cinnamomum aromaticum**

![Figure 4: Cinnamomum aromaticum](image)
Activity against some food born microbes

The study have been evaluated agnist some food born bacteria and fungus namely Gram-positive bacteria Bacillus cereus, Bacillus subtilis, Bacillus sp., Staphylococcus aureus, Staphylococcus epidermidis, Listeria monocytogenes and Micrococcus luteus, while the Gram-negative bacteria comprised Escherichia coli, Klebsiella sp. and Pseudomonas aeruginosa. The fungal isolates used in this study were Alternaria sp., Aspergillus fumigatus, Aspergillus niger, Aspergillus sp., Penicillium sp., Rhizopus sp. And Rhizomucor sp. The antimicrobial activities of cinnamon extract and oil were determined by the agar well diffusion method. Cinnamon extract was found to be effective against almost all of the food-borne microbes. B. cereus was found to be the most sensitive to cinnamon extract with an inhibition zone diameter (IZD) of 17 mm, followed by S. aureus (16 mm). Bacillus sp., B. subtilis and S. aureus were found to be partially sensitive to the test extract with an IZD of 14, 14 and 13 mm, respectively. The organism P. aeruginosa was found to be resistant. cinnamon oil inhibited the growth of all the test bacteria, it produced the widest IZD against B. cereus (29 mm), followed by S. aureus (20 mm). It also inhibited the growth of P. aeruginosa and produced an IZD of 16 mm. 21

Activity against microorganisms isolated from patients of oral infection

The Strept mutans, Staph. aureus, Cand.albicans and Cand. Glabrata are the most common cause of oral infection. The organisms are prone to drug resistance so in the above study the cinnamon and Eucalyptus oil have been evaluated for the effect. The oils were prepared by steam distillation and their inhibitory activity at different concentrations and the minimum inhibitory concentrations (MIC) were determined. All of the bacterial and fungal isolates were sensitive to Cinnamon and Eucalyptus. Cinnamon oil showed strong promising inhibitory activity on all the 5 mutans isolates at a concentration as low as 3.12%. Eucalyptus oil showed less inhibitory activity, as the least effective concentration of this oil was 25%. The MIC of Cinnamon and Eucalyptus oil ranged 12.8- 51.2 and 64-256mg/ml 31.

CONCLUSION

Infection and related disease are been problematic to human because of the health complication but also due to the difficulty in there management. The infection creates many complication and the for most issue is the drug resistance. After all taking precaution the issues of drug resistance have been more and more reported. Another problem is the side effect of the synthetic antimicrobial drug. The herbal drugs have been always the alternative and the answers for all the above issues. In the above article the spices and the use as antimicrobial have been discussed. These are the food supplement and the additives which have been used by the humans daily. The main concern of the article have been to bring out the use of spices in health rather than provide taste to the food.

REFERENCES


