International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018
ISSN 2229-5518

Research Article

Study of Antibacterial Activity of Household Spices

Shailesh Budhathoki[1*], Anup Basnet[2]

[1]Department of Microbiology, St. Xavier's College, Kathmandu, Nepal [2]Lecturer, Department of Microbiology, St. Xavier's College, Kathmandu, Nepal

Abstract

Spices are plants with intensive and distinctive flavors, aromas which has been used in both fresh and dry form. Many of the spices used daily has been reported to have antimicrobial as well as medicinal value. E.g. Garlic and Cinnamon have been used in their raw form for the treatment of wounds, injuries and joint pains etc.

Aims: The aim of the study is to explore the antimicrobial activity of garlic, cinnamon, clove and ginger.

Methods and Results: Different concentrations of extracts were prepared by using solvent ethanol. The antimicrobial activity was tested against *Bacillus spp., E. coli, Staphylococcus aureus and Salmonella* Typhi at different concentrations of spice extracts using Agar well diffusion method. The spices were found to have antibacterial effect with clove being most effective spice inhibiting all bacterial species tested.

Conclusions: Further study needs to be done as cinnamon and ginger as they were found to have absence of inhibitory effect even after being effective as remedies in number of illness and having number of organic compounds within them.

Significance and Impact of study: Spices are mostly used in foods for flavoring agents however, their use can also help in preventing the number of diseases by the inhibition of causative bacterial species.

Key words: Spices, Antimicrobial activity, Extract, Inhibition, Organic Compounds

Introduction

From historical periods, spices have been used for different purpose as trade, medicinal and food uses. They were used as exchange currencies in oldest trade among other commodities including ivory, salt etc. Nutmeg and mace are used for treatment of range of ailments including digestive disorder, flatulence, cholera, rheumatism etc. On other hand, spices are also used as perfumes, cosmetics, ointments as well as antidotes against poisons [4], [10], [12].

On top their flavor boosting, spices are noted for their preservative and medicinal value [11]. Although, used as

Correspondence: Shailesh Budhathoki, Department of Microbiology, St. Xavier's College, Maitighar, Kathmandu, Nepal.
Email: zubeen.salman24@gamil.com, shailesh.budhathkoi@sxc.edu.np

International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018
ISSN 2229-5518

flavoring and seasoning agents in foods, many spices also have significant microbial activity which is due to specific chemical or essential oils [5]. They act as preservatives in many food; they also have antioxidants [13].

The therapeutical effectiveness of garlic is because of oil and water soluble organosulfur compounds, thiosulfinates which is mainly responsible for its antibiotic activity. As Hughes and Lawson reported if extract from garlic is free from thiosulfinates, antimicrobial capacity will be lost [1]. Garlic possess sulfur and numerous phenolic compounds which aids in antibacterial as well as antifungal activity [9].

Ginger is truly a world domestic remedy. Fresh ginger has been found to be effective against cold-induced disease, dyspepsia, cough, nausea,, colic, rheumatism, heart palpitation, asthma etc. [13]. Gingerols are major antimicrobial components of ginger. 10-gingerol and 12-gingerol which are highly alkylated gingerols, effectively inhibits growth of oral pathogens [8].

Eugenol and Cinnamic aldehyde are reported to be the major antimicrobial components in cloves, cinnamon and cassia [2]. Cinnamon contains 0.5-1.0% volatile oil, out of which 75 % is cinnamic aldehyde and 8% eugenol while cloves has 14-21% volatile oil, which is 95% eugonol [6], [7].

Inhibition of growth of bacteria, yeasts, fungi and microbial toxins synthesis by spices and its derivatives has been well reported, so they could be used in food conservation on their own or as adjuvant antimicrobial compounds for assuring the production of microbiologically stable foods [3]. The present study was conducted with an objective to investigate the antibacterial activity of garlic, cinnamon, clove and ginger.

Materials and Methods

A. Spice Extract preparation

Fresh spices were purchased from the local market. They were cleaned, washed with sterile distilled water and then surface sterilized by alcohol. 100 gm of each spice was homogenized [Antimicrobial component extracted using 95% ethanol (48 hrs)] using a sterile blender and the extract was filtered using sterile muslin cloth. The extract was considered 100 % concentration of the spice extract. Various dilutions (10^{-1}, 10^{-2}, and 10^{-3}) of the extracts were prepared by mixing with required volumes of sterile distilled water.

B.Assessment of Antibacterial activity

The selected bacterial strains were inoculated into sterile nutrient broth and incubated at 37 °C for 16-18 hrs. The nutrients broth cultures were swabbed on the surface of sterile Muller Hinton agar plates. Agar wells of 6 mm diameter were bored with the help of sterilized agar borer. 10 µL solution of spice extracts were added to different wells in the plates. The plates were incubated at 37 °C for 24 h. Diameter of inhibition zone were measured (in mm).

Results

During the study four household spices (Cinnamon, Ginger, Garlic and Clove) were used for the extraction of antimicrobial fraction and were tested against four bacterial (*Bacillus* spp, *Escherichia coli*, *Staphylococcus aureus* and *Salmonell*a Typhi). Among the four bacterial species tested *Bacillus* spp, *E coli* and *Salmonella* Typhi was found to be resistant to cinnamon as indicated by the inhibitory effect observed in Agar well diffusion as zone of inhibition (Table 1 &2).

Table 1: Antimicrobial activity of spices against *Bacillus* spp and *Staphylococcus aureus* (zone of inhibition in mm)

S.N.	Spices	*Bacillus* spp			*Staphylococcus aureus*		
		Dilution			Dilution		
		10^{-1}	10^{-2}	10^{-3}	10^{-1}	10^{-2}	10^{-3}
1.	Cinnamon	-	-	-	10	-	-
2.	Ginger	-	-	-	31	20	-
3.	Garlic	40	22	11	-	-	-
4.	Clove	25	10	-	20	8	-

Salmonella Typhi was resistant to all the spices except clove (Table 2). *Staphylococcus aureus* was sensitive to all spices except garlic (Table 1) whereas *Bacillus* spp and *E coli* were resistant to cinnamon and ginger (Table 1&2).

Correspondence: Shailesh Budhathoki, Department of Microbiology, St. Xavier's College, Maitighar, Kathmandu, Nepal.
Email: zubeen.salman24@gamil.com, shailesh.budhathkoi@sxc.edu.np

International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018
ISSN 2229-5518

Table 2: Antimicrobial activity of spices against *Escherichia coli* and *Salmonella* Typhi (zone of inhibition in mm).

S.N.	Spices	*Escherichia coli*			*Salmonella Typhi*		
		Dilution			Dilution		
		10^{-1}	10^{-2}	10^{-3}	10^{-1}	10^{-2}	10^{-3}
1.	Cinnamon	-	-	-	-	-	-
2.	Ginger	-	-	-	-	-	-
3.	Garlic	29	14	-	-	-	-
4.	Clove	22	10	-	19	8	-

The bar diagrams showed the inhibition of organisms by spices extract. Cinnamon and Ginger didn't showed inhibitory effect against *Bacillus* (Figure1).

Fig. 1: Bar diagram of inhibition of *Bacillus* Spp by Spices.

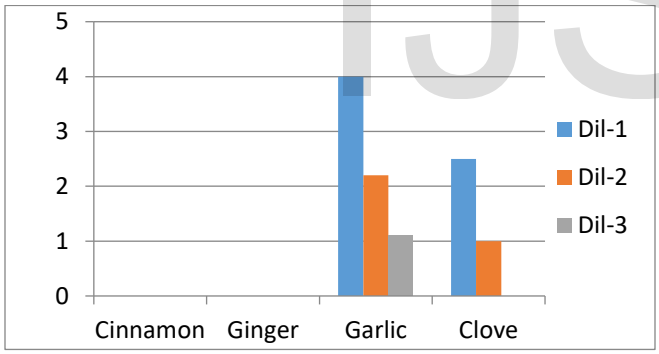
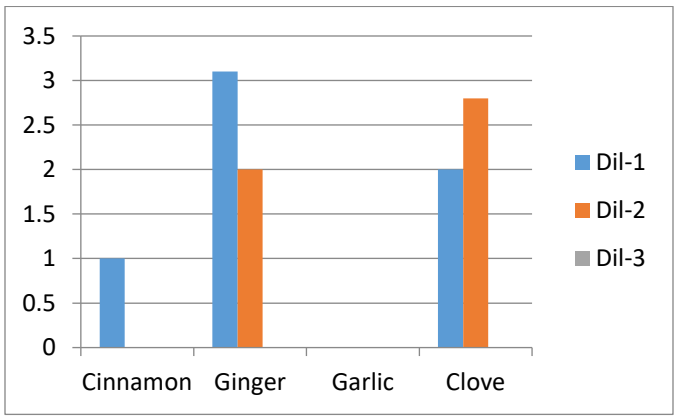
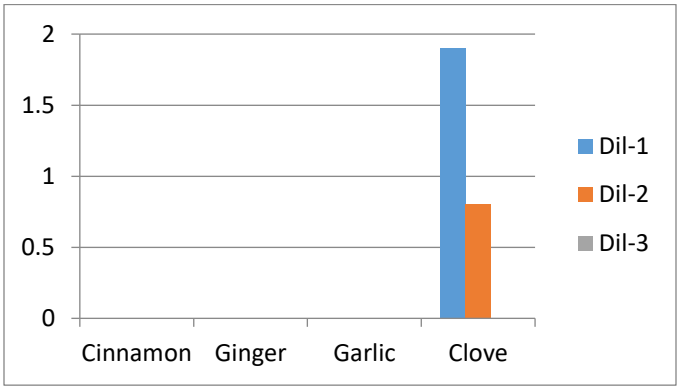


Fig. 2: Bar diagram of inhibition of *Staphylococcus aureus* by Spices.



Garlic was not found to be inhibitory against *Staphylococcus aureus* (Figure 2) while *Salmonella* Typhi was found to be inhibited only by clove (Figure 3).

Fig. 3: Bar diagram of Inhibition of *Salmonella* Typhi by Spices.



Cinnamon and ginger were unable to inhibit Escherichia coli as well (figure 4).

Fig. 4: Bar diagram of inhibition of *Escherichia coli* by Spices.

Discussions

Household spices are widely being used as antimicrobial agents these days. Number of bacteria are sensitive to the extracts of cinnamon, clove, garlic, ginger etc. The inhibition of the growth of microorganisms is due to presence of the antimicrobial compounds in the spices.

Cinnamaldehyde, Eugenol, Eugenol Acetate, Sesquiterpenoids, Cinnamyl Acetate, and Trans-cinnamic

Correspondence: Shailesh Budhathoki, Department of Microbiology, St. Xavier's College, Maitighar, Kathmandu, Nepal.
Email: zubeen.salman24@gamil.com, shailesh.budhathkoi@sxc.edu.np

International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018
ISSN 2229-5518

Acid are some antimicrobial components in cinnamon. Cinnamaldehyde has electro- negative characteristic which is the reason for antimicrobial activity. Electro-negative compounds intervene biological processes involving electron transfer and react with nitrogen-containing components. Clove has antimicrobial constituents such as Eugenol, Eugenol acetate, β-caryophyllene and these constituents contribute to antimicrobial activities. Due to presence of eugenol, clove is antimicrobial in nature. Eugenol denature proteins in cells, reacts with the phosphate lipid of the cell membrane and mitochondria [14].

Garlic has antimicrobial constituents such as Aliin, Allicin, Ajoene DATS. Antimicrobial effect is due to organosulfur compounds. Allicin react with enzyme containing thiol, thus inhibits Acetyl co-A forming system and interfere in DNA synthesis as well as protein synthesis. 10-gingerol, 12-gingerol, 5-acetoxy-6-gingerol, 3, 5-diacetoxy-6-gingerdiol and galanolactone are antimicrobial constituents in ginger which exert their anti-emetic effect partly by acting on the 5-HT3 receptor ion-channel complex, probably by binding to a modulatory site distinct from the serotonin binding site. These constituents contribute to antimicrobial activities of these spices towards microorganisms [14].

Our findings were found to be in accordance with Zaika (1988) who reported the antimicrobial activity of spices against microorganisms, Karippuah P et al. (2012) who reported the antibacterial activity of cloves and ginger, Benkeblia (2004) who reported the antimicrobial activity of garlic, and Bullerman et al. (1977), who reported the antimicrobial activity of clove and cinnamon.

Also, the findings were in accordance with Maharjan D et al. (2011) who reported that the essential oils of cinnamon and cloves possess excellent bacterial properties. Also, the findings of study were in accordance with the findings of Chawla T et al. (2014) who reported clove have better antimicrobial activity on *Bacillus* species.

Present study was an attempt to study the antibacterial activity of common household spices used in daily life (Kitchen). The investigation carried out concludes the presence of antibacterial activity of the spices. The inhibitory action varies with the bacterial species which can be due to differences of antimicrobial compound found among the spices and the susceptibility of bacterial strains towards these compounds. Further study needs to be carried out to assess the potential antimicrobial activity of spices.

Conclusions

The spices commonly used in food preparation has been antibacterial activity against the bacterial species tested. Among the spices, clove was found to be most effective in the inhibition of the bacterial growth, which indicates its rich antimicrobial activity.However, other spices were found to have lower inhibitory activity against tested bacterial species with cinnamon being the spice with lowest inhibitory potential.

The study suggests the use of spices in the food preparation has health benefits as they inhibit the bacterial growth thus, lowering the chances of contamination of food as well as chances of food borne infection.

Acknowledgment

I would like to express my sincere gratitude to my respected supervisors **Mr. Anup Basnet, Lecturer**, St. Xavier's College, Maitighar for his continuous guidance, motivation and support and enthusiasm.

We are grateful to Department of Microbiology of St. Xavier's College for providing the space, reagents, chemicals and materials required to carry out the research work as well as for their kind co-operation without which this work would have been impossible to carry out.

Last but not the least; I would like to thank my parents, for giving birth to me at the first place and my family members as well as friends for supporting me spiritually throughout this work.

Conflict of Interest

There is no conflict of interest that should be disclosed about this study.

Correspondence: Shailesh Budhathoki, Department of Microbiology, St. Xavier's College, Maitighar, Kathmandu, Nepal.
Email: zubeen.salman24@gamil.com, shailesh.budhathkoi@sxc.edu.np

International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018
ISSN 2229-5518

References

1. Bronwyn G Hughes and Larry D Lawson, "Antimicrobial effects of *Allium sativum* L. (garlic), *Allium ampeloprasum* L. (elephant garlic), and *Allium cepa* L. (onion), garlic compounds and commercial garlic supplement products", Phytother. Res, Vol 5 pp.154–158, 1991.
2. Chaudhry N.M.A. and P. Tariq, Bactericidal activity of black peeper, bay leaf, aniseed and coriander against oral isolates. Pak. J. Pharm. Sci., Vol 19 pp.214-218, 2006.
3. Davidson P.M., Branen A.L., Post S.L., "Naturally occurring and miscellaneous food antimicrobials", Antimicrobials in Food, Mercel Dekker Inc. pp. 371-419, 1983.
4. Dinesh Maharjan, Anjana Singh, Binod Lekhak, Shaila Basnyat, Lekhnath S. Gautam "Study on Antibacterial Activity of Common Spices", Nepal Journal of Science and Technology Vol 12 pp. 312-317, 2011.
5. Evandro Leite de Souza, Tânia Lúcia Montenegro Stamford, et al., "Antimicrobial effectiveness of spices: an approach for use in food conservation system", Braz. Arch. Biol. Technol, Vol 48 no.4 pp.1516-8913, 2005.
6. Frederic Rosengarten, Book of Spices, Livington Publishing Company, Wynnewood, Pennsylvania, 1969
7. James M Jay, Modern food Microbiology, Indian first edition, CBS Publishers and distributors, Delhi, India, 1987.
8. Lloyd Bullerman, "Inhibition of aflatoxin by Cinnamon" J. Food Science, Vol 39 no.1163, 1974.
9. Lloyd Bullerman, Lieu F Y and Sally A. Seier, "Inhibition of growth and aflatoxin production of Cinnamon and Clove oils: Cinnamic aldehyde and Eugenol", J. Food Science, Vol 42 no.1107, 1977.
10. Miri Park, Jungdon Bae and Dae-Sil Lee, "Antibacterial Activity of [10]-Gingerol and [12]-Gingerol isolated from Ginger Rhizome against Periodontal Bacteria", *Phytother. Res.* Vol 22 pp.1446–1449, 2008.
11. N. Benkeblia, "Antimicrobial activity of essential oil extracts of various onions (Allium cepa) and garlic (Allium sativum)", Swiss Society of Food Science and Technology, Lebensm.-Wiss. U.-Technol. Vol 37 pp. 263–268, 2004.
12. Oiye S.O., Muroki, N.M, ''Uses of Spices in Food" The Journal of food technology in Africa, Vol 7 no. 2 pp. 39-45, 2002.
13. Ponmurugan Karuppiah, Shyamkumar Rajaram, "Antibacterial effect of Allium sativum cloves and Zingiber officinale rhizomes against multiple-drug resistant clinical pathogens", Asian Pacific Journal of Tropical Biomedicine pp. 597-601, 2012.
14. Takayuki Shibamoto, Leonard Bjeldanes, Introduction to Food Toxicology, Academic press Inc, San Diego, California, USA, 1993.
15. Taneesha Chawla, Nida Itrat Abbasi, Aishwarya Tandon, Suneetha V , "Antimicrobial activity of spices like cloves cardamom and cinnamon on on *Bacillus* and *Pseudomonas*", International J. of Drug development and Research, 2014.
16. Zaika, L L "Spices and herbs: Their antimicrobial activity and its determination", J. Food Safety. Vol 9, pp. 97-118, 1988.

Correspondence: Shailesh Budhathoki, Department of Microbiology, St. Xavier's College, Maitighar, Kathmandu, Nepal.
Email: zubeen.salman24@gamil.com, shailesh.budhathkoi@sxc.edu.np