



Antibacterial effect of *Allium sativum* against organisms isolated from clinical Samples from Cutaneous and Urinary Tract Infections

Aiwa Mary Paulose¹, Shinu Krishnan²

¹ Second year Msc student, School of Medical Education, Kottayam, Kerala

² Guide, Associate Professor, Department of Medical Microbiology, School of Medical Education, Kottayam, Kerala.

Abstract

In this study the antibacterial effect of *Allium sativum* against *Staphylococcus aureus*, *Citrobacterspp*, *Escherichia coli* and *Pseudomonasspp* were determined by agar well diffusion method. The variations in antibacterial effect of fresh garlic, dried garlic and autoclaved garlic were studied. Garlic extracts were prepared with isopropyl alcohol and chloroform. It has been observed that organisms were highly sensitive to dried garlic extract and fresh garlic extract (except *Pseudomonas spp* with zone range of 16mm, 14mm in dry and 14mm, 12mm in fresh chloroform and isopropyl alcohol extract respectively) but autoclaved garlic extract showed no trace of antibacterial effect on any of the organisms. The antibacterial effect of garlic is mainly due to the sulphur compound allicin, yielded from its precursor alliin; present in intact garlic cloves, by allinase enzyme during mechanical grinding or cutting of garlic. Action of allicin is proved to be heat sensitive which justifies the lack of antibacterial effect of autoclaved garlic extract. Currently the bacterial resistance to antibiotics have made it difficult to treat even simple infectious diseases. In this scenario natural substance with considerable antibacterial effect that too with different mode of action is of great medical relevance. The results of this study justify the centuries old traditional medicinal practices with garlic and support and emphasise the use of garlic as therapeutic and health product along with the need and reason to focus more on it.

1. Introduction

Garlic (*Allium sativum*) is an erect herb of the *Alliaceae* family, 30 to 60cm tall¹. It is a perennial herb with a characteristic pungent smell. The garlic plants bulb is the most commonly used part of the plant. Bulb is on a

disc like stem, consisting of several segments (cloves), enclosed in a common membrane that is at the base of foliage leaves. The cloves are used for consumption (raw or cooked) or for medical

pipettes of 100- 40 µl).

2.2 Sample collection

The garlic cloves were obtained from Kottayam Town of Kerala state for the research procedure. The cloves were separated and the transparent coverings were peeled manually to obtain the edible portion. A portion of which is sundried another is autoclaved and the rest is left fresh. Mortar and pestle was used to pound the garlic cloves into powder or paste, then sieved and stored in a covered plastic container for further use.

2.3 Isolation of clinical sample

Ten pus and ten urine samples were taken for study and inoculated into blood agar and MacConkey agar and incubated at 37⁰ C overnight. Organisms were isolated. Identification and biochemical characterization done manually by Gram's staining, hanging drop method for motility testing, coagulase test, catalase test, OF test, nitrate reduction test, indole test, MR test, VP test, citrate test, sugar fermentation tests, citrate test, urease test. Cultural characters also noted in various culture media's.

2.4 Preparation of extracts

- Fresh garlic of good quality was purchased from Kottayam market.
- Garlic cloves were separated and peeled off to obtain the edible portion.
- 50g of garlic was weighed out six times for testing in three different conditions, i.e.; dried, autoclaved and fresh.

- For which two portions were chopped and kept under sunlight for few days for dried extract preparation.
- Another two portions were autoclaved and the left two portions were used freshly.
- So as a total we have three categories comprising two portion of garlic each.
- All the six portions were crushed and grinded individually using a mortar and pestle at required time
- One portion from each category was filtered using isopropyl alcohol; individually and so was the other portion with chloroform.
- For that a 250ml sterile conical flask was taken and a funnel was placed on top of the conical flask with folded filter paper on top.
- The grinded garlic with the solvent was added on to the filter paper.
- The setup was left undisturbed for hours.
- The extract was filtered out into the conical flask.
- It was then sealed and kept in the refrigerator for further use and not in the freezer.

2.5 Antimicrobial Susceptibility Testing

These are tests devised to determine the susceptibility of the isolated pathogen to the antimicrobial agent. Media used is Muller Hinton Agar (MHA), having translucent, light amber in colour appearance. Well diffusion

method was adopted here. MHA plates were prepared beforehand using Himedia. Organisms were inoculated as lawn culture on to the plate using a sterile swab and wells were punched. 100µl of the extract was added to the wells using a micropipette and sterile distilled water was used as control. Plates were then carefully placed in an incubator overnight; afterwards clear zones of inhibition were seen and the measurements were recorded.

3. Results

Staphylococcus aureus, *Citrobacterspp*, *Pseudomonas spp*, *Escherichia coli* were the organisms with higher percentage of aetiology and so were taken for study from the 10 pus and urine samples.

Garlic (*A. sativum*) has antimicrobial properties against *Staphylococcus aureus*, *Citrobacterspp*,

Pseudomonas spp, *Escherichia coli*. Dry garlic extract show more antibacterial effect against all the organisms tested followed by fresh extract. Autoclaved extract shows no significant antibacterial effect. Isopropyl alcohol extract of garlic show slightly higher effect than chloroform extract. Allicin is said to be the major component responsible for the antibacterial effect..

Allium sativum has been used traditionally for ages to treat a wide array of diseases. So the results of this study justify the centuries old traditional medicinal practices with garlic and support and emphasize the use of garlic as therapeutic and health product along with the need and reason to focus more on it.

Sensitivity pattern observed for *Citrobacterspp*

Sl no	Sensitivity test using antibiotics		Sensitivity test using extracts					
	Antibiotics used	Zone size	Isopropyl alcohol extract			Chloroform extract		
			Dried	Fresh	Autoclaved	Dried	Fresh	Autoclaved
1	Ciprofloxacin	20	31	26	0	30	22	0
2	Meropenem	20						
3	Amikacin	17						
4	Cefoperazone/Sulbactam	16						
5	Piperacilin/Tasobactam	16						
6	Cefixime	10						
7	Cefuroxime	8						

Sensitivity pattern observed for *Pseudomonas spp*

Sl no	Sensitivity test using antibiotics		Sensitivity test using extracts					
	Antibiotics used	Zone size	Isopropyl alcohol extract			Chloroform extract		
			Dried	Fresh	Autoclaved	Dried	Fresh	Autoclaved
1	Piperacilin/Tazobactam	23	16	14	0	14	12	0
2	Ciprofloxacin	21						
3	Amikacin	18						
4	Cefixime	10						
5	Aztreonam	10						
6	Cefuroxime	0						
7	Meropenem	0						

Sensitivity pattern observed for *Escherichia coli*

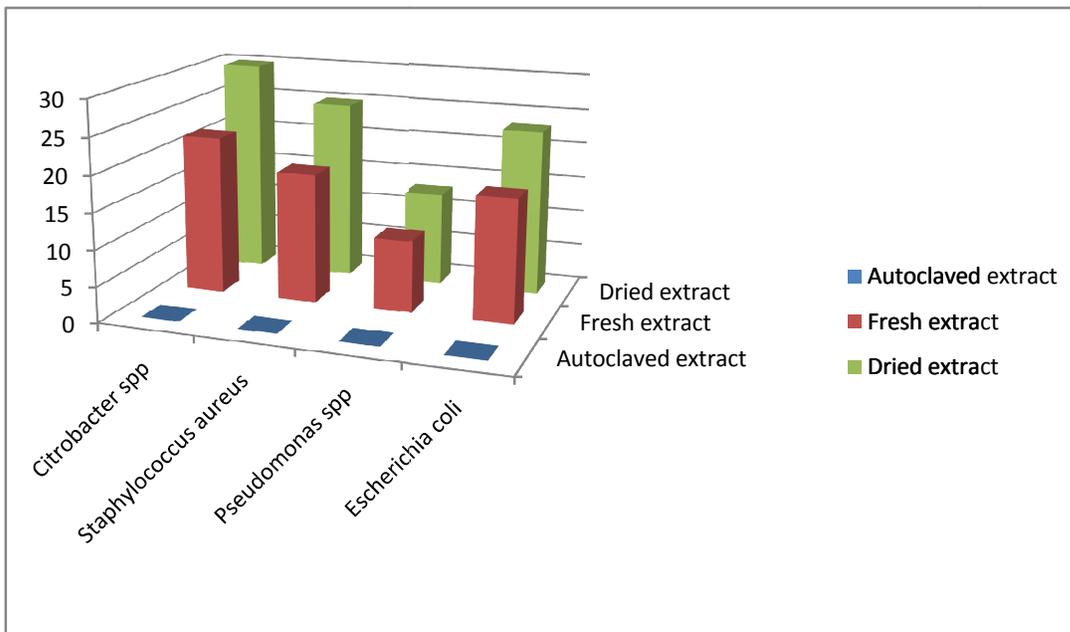
Sl no	Sensitivity test using antibiotics		Sensitivity test using extracts					
	Antibiotics used	Zone size	Isopropyl alcohol extract			Chloroform extract		
			Dried	Fresh	Autoclaved	Dried	Fresh	Autoclaved
1	Chloramphenicol	22	25	22	0	23	19	0
2	Amikacin	18						
3	Cefepime/Sulbactam	14						
4	Ciprofloxacin	10						
5	Levofloxacin	0						
6	Cefuroxime	0						
7	Cefixime	0						

Sensitivity pattern observed for *Staphylococcus aureus*

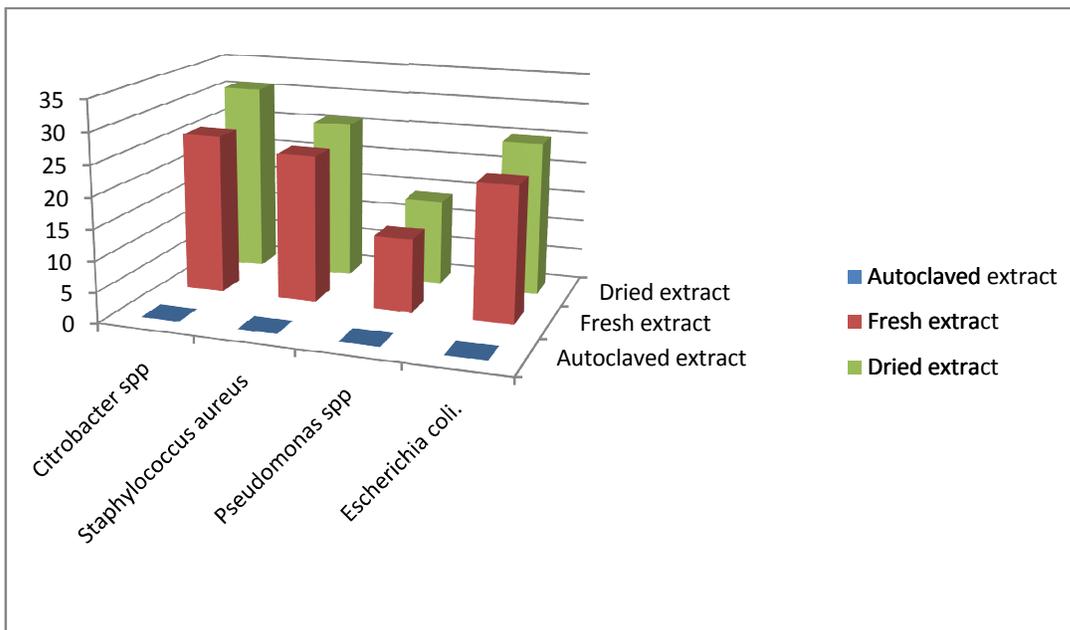
Sl no	Sensitivity test using antibiotics		Sensitivity test using extracts					
	Antibiotics used	Zone size	Isopropyl alcohol extract			Chloroform extract		
			Dried	Fresh	Autoclaved	Dried	Fresh	Autoclaved
1	Cloxacilin	25	27	24	0	25	22	0
2	Cefoperazone/ Sulbactam	24						
3	Clindamycin	20						
4	Ampicillin/Sulbactam	20						
5	Methicillin	16						
6	Levofloxacin	0						
7	Cefurexime	0						
8	Cefixime	0						

Zone of inhibition of the extracts were standardized by comparing with commonly used antibiotics pattern from the Standard chart.

Chloroform extract graph:



Isopropyl alcohol extract graph:



4. Discussion

Garlic has been known for ages to have anti-infective properties against a wide range of microorganisms⁹. This study shows that there is

significant antibacterial effect against *Staphylococcus aureus*, *Pseudomonas spp*, *Citrobacterspp*, and *Escherichia coli*. This indicates that garlic has a broad spectrum of

antimicrobial activity and a wide therapeutic window. The sensitivity of these isolates to garlic extract also implies that the intrinsic bio substances in this extract are naive to the various drug resistance factors of the isolates, which include beta-lactamase expression, increased pyrolidonylarylamidase activity, aminoglycoside-modifying enzymes, and altered ribosomal binding¹⁰. Meanwhile, the antimicrobial potency of garlic has been attributed to its ability to inhibit toxin production and expression of enzymes for pathogenesis¹¹. Several studies including those of Rees et al and Kumar and Sharma had previously demonstrated the antibacterial potency of aqueous garlic extracts against enteropathogens such as *Vibrio parahaemolyticus*, *E. coli*, *Klebsiella* spp., *Proteus* spp., and *S. aureus* and anticandidal effects against *Candida* spp¹².

In conclusion, the results of this study have provided scientific justification for the use of garlic extract in health products and herbal remedies against bacterial infections. Therefore, complementary and alternative medicine practices with plant extracts including garlic as a means of decreasing the burden of drug resistance and reducing the cost of management of diseases would be of clinical and public health importance in this country. There is extensive literature on the antibacterial effects of fresh garlic juice, aqueous and alcoholic extracts, lyophilized powders, steam distilled oil and other commercial preparations of garlic. Fenwick and Hanely (1985) undertook a

thorough review of the antibacterial effects of garlic and other allium vegetables up to mid 1984¹³. The antibacterial effects of garlic have been studied by Reuter et al. (1996)¹⁴. The study of Deresse D. A recent study on antibacterial effect of garlic (*Allium sativum*) on *Staphylococcus aureus*: An in vitro study. *Asian J Med Sci.* 2010¹⁵ revealed that antibacterial activity of the garlic extract was heat sensitive, all clinical isolates of *S. aureus* were tested on garlic extract which was autoclaved at 121°C for 15 min. There was no antibacterial effect of garlic in contrast to the work of Shokradeh and Ebadi 2006¹⁶. Tsao S M et al (2001) successfully found sensitivity in *Pseudomonas aeruginosa* garlic oil and four diallyl sulphides¹⁷. This antimicrobial potency disparity of garlic has been attributed to the different concentrations of individually and synergistically active biosubstances in garlic preparations coupled with their interactions with sulfhydryl agents in culture media. This phenomenon has been used to explain the stronger antimicrobial effect of allicin than garlic oil disulfides¹⁸.

5. Acknowledgment

I express my sincere gratitude to Mr Shinu Krishnan (Guide, Associate Professor, Department of Medical Microbiology, School of Medical Education, Kottayam, Kerala) and Ms. Sangeetha, and Ms. Libina Joy Department of medical microbiology, SH hospital for guiding and facilitating the work.

6. References

1. Lewson et al., 1998; Moyers 1996E. Block. Garlics and other alliums: The lore and the science. Royal society of Chemistry. Pp. 190-9, 2010.
2. Bolton, S., et al, 1982
3. Pelage et al, 1986
4. Cavallito et al 1944
5. Wills, E. D. et al 1956
6. Fernandez Guerrero ML, Ramos JM, Marrero J, Cuenca M, FernandezRoblas R, de Gorgolas M: Bacteremic pneumococcal infections in immunocompromised patients without AIDS: the impact of beta-lactam resistance on mortality. *Int J Infect Dis* 2003;7:46–52.
7. Ako-Nai AK, Ikem IC, Aziba A, Ajayi AA, Onipede OA: Bacteriological examination of chronic osteomyelitis cases in Ile-Ife, SouthWestern Nigeria. *Afr J ClinExpMicrobiol* 2003;4:41–51.
8. Oliver B: Medicinal plants in Nigeria. *Nigerian Coll Arts SciTechnol* 1960;1:1–137
9. Cercenado E, Vicente MF, Diaz MD, Sanchez-Carrillo C, Sanchez-Rubiales M: Characterization of clinical isolates of betalactamase-negative, highly ampicillin-resistant *Enterococcus faecialis*. *Antimicrob Agents Chemother* 1996;40:2420–2422. 29. Paparaskevas J, Vatopoulos A, Tassios PT, Avliami A, Legakis NJ, Kalapothaki V: Diversity among high-level aminoglycosideresistant enterococci. *J AntimicrobChemother* 2000;45:277–283.
10. Willis ED: Enzyme inhibition by allicin, the active principle of garlic. *J Biochem (Tokyo)* 1956;63:514–520. 32. Rees LP, Minney SF, Plumer NT, Slater JH, SkymeDA: A quantitative assessment of antimicrobial activity of garlic (*Allium sativum*). *World J MicrobiolBiotechnol* 1993;9:303–307
11. Dewitt JC, Notermanns S, Gorin N, Kampelmacher EH: Effect of garlic oil or onion oil on toxin production by *Clostridium botulinum* in meat slurry. *J Food Protect* 1979;42:222–224. Willis ED: Enzyme inhibition by allicin, the active principle of garlic. *J Biochem (Tokyo)* 1956;63:514–520
12. Rees LP, Minney SF, Plumer NT, Slater JH, Skyme DA: A quantitative assessment of antimicrobial activity of garlic (*Allium sativum*). *World J MicrobiolBiotechnol* 1993;9:303–307. 33. Kumar A, Sharma VD: Inhibitory effect of garlic (*Allium sativum* Linn) on enterotoxigenic *Escherichia coli*. *Indian J Med* 1982;76:66–70.
13. Fenwick GR, Hanley AB (1985). The genus *Allium*-Part 3. Medicinal effects. *CRC Crit. Rev. Food Sci. Nutr.* 1: 71-74)
14. Reuter HD, Koch HP, Lawson DL (1996). Therapeutic effects and Applications of garlic and its

Preparation. In: Garlic: the science and Therapeutic Applications of *Allium sativum* L. and related Species, 2nd Edn., Koch HP and Lawson DL (Eds), pp: 135-212).

15. Antibacterial effect of garlic (*Allium sativum*) on *Staphylococcus aureus*: An in vitro study. *Asian J Med Sci.* 2010
16. Shokradeh M, Ebadi AG (2006). Antibacterial effect of Garlic (*Allium sativum*) on *staphylococcus*. *Pak. J. Biol. Sci.* 9(8): 1577-1579)
17. . Tsao SM, Yin MC: In vitro activity of garlic oil and four sulphides against antibiotic-resistant *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. *J Antimicrob Chemother* 2001;47: 665–670
18. O’Gara EA, Hill DJ, Maslin DJ: Activities of garlic oil, garlic powder and their diallyl constituents against *Helicobacter pylori*. *Appl Environ Microbiol* 2000;66:2269–2273.