*Original Research*

# A comparative study of garlic antibacterial activity

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## Abstract

This comparative study was conducted between local (Libyan) and imported (Chinese) garlic to evaluate their antibacterial activity against some isolated gram-positive and gram-negative bacteria.

The study was carried out by using the agar well diffusion method at different aqueous extract concentrations (25%, 50%, 75% and 100%).

The results showed that distinct antibacterial effects on both types of garlic with some differences between local and imported garlic. However, the zone of inhibition was more against *Staphylococcus aureus*, *Klebsiella pneumonia* and *Escherichia coli*, respectively. Furthermore, the antibacterial activity increased with the increase of concentration. So, this study recommends that garlic should be used against bacterial infection and more studies may be done against other bacterial species, especially multidrug-resistance strains.

***Keywords:*** Allicin, Allium sativum, antibacterial activity, China, Libya, garlic

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## Introduction

Garlic (*Allium sativum L.*) is an herbaceous plant that belongs to the Alliaceae family [1]. Long ago, garlic was used as an alternative medicine for the therapy of multiple diseases. It plays an important role in lowering mortality and morbidity rates [2]. The world started to use medicinal plants for many reasons such as small expenses and the fewest side effects compared to chemical and pharmaceutical products [3]. Garlic was discovered in Codex Ebres since ancient times in 1550 BC as an herbal medicine [4]. The pharaohs used it as a treatment for many diseases such as heart diseases, headaches, dangerous bites and many other kinds of tumors [5]. When garlic cloves are squished, the odorless compound alliin extracted from amino acids comprising a sulfur compound reacts with the enzyme alliinase producing compound allicin which, in turn, decomposes to diallyl disulfide which is responsible for the pungent odor of garlic [6]. The compound allicin has many distinctive activities such as hypoglycemic action, hypocholesterolemia, antioxidant and it plays a significant role against cancer cells in addition to antimicrobial activity [7]. In 1858, Louis Pasteur was the first to explore the antibacterial effectiveness of garlic from a scientific side (*Allium sativum L.*) and onion (*Allium cepa L.*) [8]. Many studies have recently shown that garlic has a broad spectrum bacteriological effects. These effects include multidrug-resistant enterotoxigenic *Escherichia coli* (ETEC) and antifungal inhibitory action, particularly against *Candida albicans*. It also involves antiviral activity and anti-parasitic activity, especially some significant human intestinal protozoan parasites as *Entamoeba histolytica* and *Giardia lamblia* [9]. This research shades light on a comparison between the two types of local and imported garlic as an antibacterial against some pathogenic isolated bacterial species including one gram-positive bacteria *Staphylococcus aureus* and two gram-negative bacteria *Escherichia coli* and *Klebsiella pneumonia*.

## Materials and methods

*Plant material:* About half a kilogram of local Libyan garlic and imported Chinese garlic was bought from the weekly local market in Al'assabiea, Libya during summer

2020. Subsequently transferred to the microbiology laboratory at the Higher Institution for Sciences and Technology Al'assabiea, Libya for further identifications and preparations.

*Garlic aqueous extract preparation:* The method used was that of Praba and Kumaresan with a slight modification to suit the present experimental conditions [10]. The 500 mg garlic clove were washed with tap water to remove dust. A 100 mg of the garlic cloves weighed, while the rest quantity was excluded. The included weight was cut into small pieces with a sterile surgical blade number 22 and put in a rotatory blender for 15 minutes. The extract filtered using Whatman number 1 filter paper and the collected extract was 23 ml considered as 100% concentration. Another three different concentrations were prepared after dilution with sterile water, i.e., the total concentrations were prepared 25%, 50%, 75% and 100% and kept in a refrigerator until the experimental work was carried out.

*Bacterial isolates:* The test microorganisms were isolated from out-patients Yefren hospital. It includes one gram-positive bacteria (*S. aureus*) and two gram-negative bacteria (*E. coli* and *K. pneumonia*). They were kindly provided in broth medium from the microbiology laboratory at the Higher Institution for Sciences and Technology Yefren, Libya. The aforementioned bacterial isolates were subjected to gram staining, growth on selective media and some biochemical tests, using Bergy´s manual of determinative bacteriology charts to verify the bacterial isolates [11]. The pure cultures were sub-cultured on nutrient agar slants and kept at 4 °C until studying the antibacterial activity comparison of garlic against the tested bacterial isolates.

*Agar well diffusion essay:* Using aseptic technique, bacterial suspension was prepared from overnight cultures on nutrient broth using the rotary instrument to enhance bacterial growth by which the turbidity of initial suspension was adjusted to 0.5 McFarland standard (0.5 ml, 1.17%w/v, $BaCl_2$ x $2H_2O^+$ 99.5 ML 1% w/v, $H_2SO_4$) [12]. A suspension of three tested bacteria contains about $10^8$ colony forming units (CFU) per ml spread by streak method on Muller-Hinton agar media [13]. Subsequently, four wells in each plate were made using a sterile cork borer. Using sterile pipette 25µl from different prepared aqueous garlic extract concentrations injected in each well i.e. 25%, 50%, 75% and 100%. All plates autoclaved overnight and the average zones of inhibition measured using a ruler. The experiment was done in triplicate.

## Results

The experiments were finished at the microbiology laboratory of the Higher Institution for Sciences and Technology Al'assabiea, Libya and conducted in sterile conditions. Some important biochemical tests were performed in addition to the gram staining methods before starting to know the inhibitory effect of garlic on the target bacteria. The findings indicate that a distinctly antibacterial effect of both local and imported garlic (*Allium sativum L.*) against one positive bacteria (*S. aureus*) and two gram-negative bacteria (*E. coli* and *K. pneumonia*). There were more inhibitory effects on gram-positive bacteria (*S. aureus*) than gram-negative bacteria (*E. coli* and *K. pneumonia*), respectively, as shown in **Figures 1-3**. In the present study, the antibacterial inhibitory effect increased with increasing garlic concentration as described in **Table 1**.

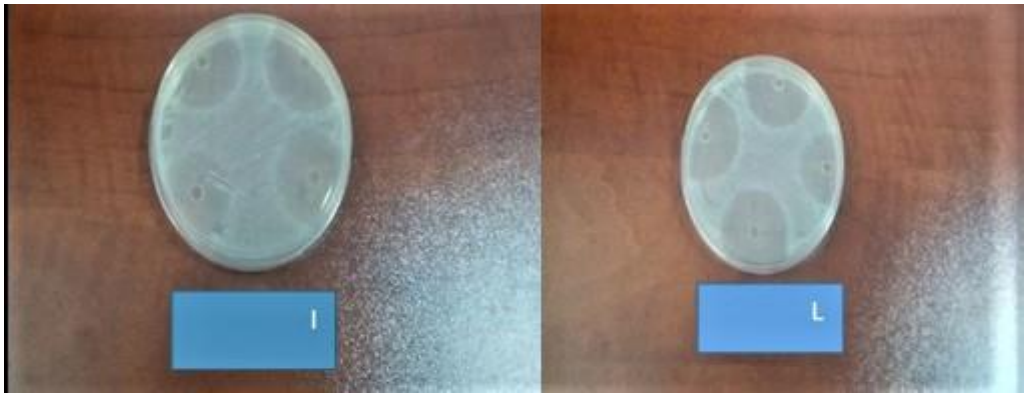


**Figure 1:** A comparison between imported and local garlic against *S. aureus*


**Figure 2:** A comparison between imported and local garlic against *K. pneumonia*


**Figure 3:** Comparison between imported and local garlic against *E. coli*

**Table 1**: Comparison the inhibitory effect of garlic against target bacteria

| Bacteria / Concentrations | *S. aureus* | | *E. coli* | | *K. pneumonia* | |
|---|---|---|---|---|---|---|
| | Zone of Inhibition in mm | | Zone of Inhibition in mm | | Zone of Inhibition in mm | |
| | Local garlic | Imported garlic | Local garlic | Imported garlic | Local garlic | Imported garlic |
| 100% | 36 | 39 | 36 | 23 | 21 | 21 |
| 75% | 35 | 33 | 35 | 20 | 19 | 19 |
| 50% | 33 | 31 | 33 | 19 | 16 | 16 |
| 25% | 30 | 29 | 30 | 18 | 14 | 14 |

## Discussion

The results of this study were consistent with the research of previously published [14]. Furthermore, the antibacterial inhibitory effect increased with increasing garlic concentration as described in **Table 1** which is also compatible with some other published studies [15, 16]. The increasing resistance of microorganisms including bacteria to major antibiotics stresses the necessity to experiment with the natural compounds for exploring their antibacterial activity and their potential as an alternative medicine [17]. Otherwise, a synergistic effect between herbal medicine and antibiotics will prevent resistance to multiple drug resistance [18]. Since a long time ago, garlic was used as an antimicrobial, and the inhibitory effect of garlic related to the sulpha

compounds in it, mainly allicin [19]. Although the exact interaction between allicin and bacterial lipid membrane has not yet been elucidated [20]. It is suggested that the generally accepted mechanism involved in the bactericidal action of allicin is due to its interaction with cysteine-containing enzymes involved in the major biosynthesis pathways. Thus, exposure to allicin leads to oxidation and inhibition of many bacterial sulfhydryl enzymes [21]. According to this research, the bactericidal effect on gram-positive bacteria was more than gram-negative bacteria because of more lipid membrane percentage (20% in *E. coli*) compared with only (2% in *S. aureus*). While the inhibition zone of local and imported garlic against gram-negative bacteria *K. pneumonia* was the same, the study did not find a justification for that and therefore the reason is still unknown. However, it should not exclude that this study has a major limitation concerned with no comparison with control antibiotics as standard.

## Conclusion

This study appointed that there were some differences between local and imported garlic against the bacterial isolates *S. aureus* and *E. coli* but was not found differences in bactericidal activity against *K. pneumonia*. This study supports that local garlic has antibacterial activity but more studies should be done against other bacterial species, mainly multidrug-resistance strains.

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## Conflict of Interest

The author declares no conflict of interest.

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