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Antibacterial activity of herbal spices (Garlic and Turmeric) on *Staphylococcus aureus* and *Escherichia coli*

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Abstract:
Background*: Garlic and turmeric are vital and beneficial spices used in the treatment of various illnesses. Pathogens' increasing multi-drug resistance drives researchers to look for new ways to treat infectious diseases. Therefore, garlic (Allium sativum) and turmeric (Curcuma longa) were tested for antibacterial properties.*
Materials and Methods*: The agar well diffusion method was used to determine the Minimum Inhibitory Concentration (MIC) of garlic and turmeric extracts on S. aureus and E. coli.*
Results*: Results showed that both spices had inhibition on the organisms; however, garlic had a higher effect than turmeric. Both test organisms were inhibited by 100, 200, 300mg/ml of garlic and turmeric extracts. The control used was tetracycline which had the highest zone of inhibition. This showed that tetracycline is a strong antibiotic against the tested organisms Escherichia coli and Staphylococcus aureus.*
Conclusion: *The study revealed that different extracts of Garlic (Allium sativum) and Turmeric (Curcuma longa) have a significant amount of antibacterial activities. However, depending on which solvent used for the extraction, the antibacterial activities were found to vary. Therefore, garlic and turmeric have been proven from the study to possess properties that can be coined into the pharmaceutical industry.*
Keywords*: Antibacterial; Garlic; Turmeric; Staphylococcus aureus; Escherichia coli.*

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I. Introduction

There has been a lot of interest in investigating natural materials as sources of new antibacterial agents. The use of higher plants and their extracts to treat infections is an old age practice in traditional African medicine. Different extracts from traditional medicinal plants' roots, barks, and leaves have been tested, and some natural products have been approved as new antibacterial drugs [1, 2, 3, 4, 5, 6]. It is an established practice that plant extracts are given singly or as a concoction and herbal decoction to treat some diseases [7]. Garlic, belonging to the family Liliaceae, is well known for having antibacterial effects. Garlic is a perennial bulb-forming plant that belongs to the genus *Allium.* Garlic *(Allium sativum)* has been known to possess dietary and medicinal properties [8]. They exhibit different antibacterial, antifungal, antiseptic, antiviral, expectorant, anti-histamine properties[7]. *Allium sativum is* characterized by a special flavor used for cooking [9, 10]. However, turmeric *(Curcuma longa)* is a medicinal plant that belongs to the Zingiberaceae family. It is a perennial plant with underground rhizomes. *Curcuma longa* is widely consumed as a flavoring, preservatives, and coloring agent in South Asia, India, China, and Nigeria. It is well known for its unique medicinal properties [11, 12]. Garlic has been used in ancient times in India and China for a beneficial effect on the heart and circulation cardiovascular disease [13, 14, 15]. Regular use of garlic may help prevent cancer, treat malaria, and raise immunity. Ginger, hidden-lily, Alpinia are members of the Zingiberaceae family, of which turmeric is one of the plants well studied. Historically, turmeric has been used throughout India, China, Indonesia, and Nigeria as a spice and medical agent. Traditionally, turmeric has been used to heal the wound and reduce bleeding to heal the wound and reduce bleeding with bruises, sprains, leech bites, and as an anti-inflammatory agent [12].

Staphylococcus aureus is a Gram-positive, facultative anaerobic cocci-shaped bacteria of the genus *Staphylococci.* It is a normal flora of the body, frequently found in the nose, respiratory tract, and skin [16]. Pathogenic strains of *Staphylococcus aureus* can cause many illnesses, from minor skin infections such as pimples, boils, and abscesses to life-threatening diseases such as pneumonia and meningitis [17]. *Escherichia coli* are Gram-negative, facultatively anaerobic, rod-shaped bacteria of the *Escherichia* genus. They are commonly found in the lower intestine of warm-blooded organisms [18]. Most *Escherichia coli* are harmless, but some serotypes can cause a series of food poisoning in their host. Information on the importance of herbal spices for their medicinal purposes is limited. People suffer from illness due to pathogenic microorganisms such as *Escherichia coli* and *Staphylococcus aureus,* resulting from access to contaminated water and dirty [19]. Such

pathogenic bacteria have been capable of infecting many people over a short period. However, a major problem with pharmaceutical antibiotics is that they can promote the development of resistant strains of bacteria [20]. Initially, the antibiotics kill most bacteria being attacked with repeated exposure.

On the contrary, these few bacteria that by chance are genetically resistant to antibiotics begin to multiply. Unlike pharmaceutical drugs (antibiotics), garlic and turmeric do not seem to produce any strain and may be effective against strains that have become resistant to pharmaceutical antibiotics [19, 21]. Information on the antibacterial effect of *Allium sativum* and *Curcuma longa* will be used by the public for immediate treatment of any bacterial infection-resistant strains of bacteria developed from pharmaceutical antibiotics. Thus, the present study investigated the antibacterial effect of herbal spices turmeric and garlic respectively on some common pathogenic microorganisms such as *Escherichia coli* and *Staphylococcus aureus.*

II. Materials And Methods

Collection of Plant Material

Garlic and turmeric were purchased from the local Bori market in Khana L.G.A, Rivers State, and identified *Allium sativum* and *Curcuma longa*, respectively.

Collection of Test Organisms

The two different strains were used for testing antibacterial activity were *Escherichia coli* and *Staphylococcus aureus*. The test organisms used in this study were obtained from the Department of Science Laboratory, Ken Saro-Wiwa Polytechnic, Rivers State, Nigeria. The bacteria were cultured on nutrient agar slants. The cultures were maintained by subculturing periodically and preserved at 4° C before use.

Preparation of Water and Ethanol Extracts of Garlic (*Allium sativum*) and Turmeric (*Curcuma longa*)

Rhizomes of turmeric and garlic bulbs were washed and cut into small pieces and dried in an oven at 100°C for five hours, after which it was blended using a blender one after the other. Two hundred grams (200g) of the blended garlic and turmeric were weighed on an electronic weighing balance, transferred into two sterilized conical flasks containing 150ml of ethanol and water separately, and kept aseptically for 72 hours. The solutions were passed through a funnel lined with filter paper to obtain the extracts for garlic and turmeric, respectively. The filtrate was dried in an oven at 80°C and blended again to obtain the final extracts which were stored in sample collection bottles and labelled.

Preparation of Concentrations of Extracts

Three different concentrations of 100, 200, and 300mg/ml were prepared for each extract. For l00mg/ml, 1g of the extract was weighed and transferred into a sample collection bottle, and 5ml of distilled water was added to it. For 200mg/ml, 2g of the extract was weighed and transferred into a sample collection bottle, and 5ml of distilled water was also added to it. Finally, for 300 mg/ml, 3g of the extract was weighed and blended again to obtain the final extracts which were stored in sample collection bottles.

Preparation of Media

Muller Hinton agar was selected for the sensitivity test. 7.6g of Muller Hinton agar was weighed and transferred into a conical flask, and dissolved in 200ml of water. It was autoclaved at 1210c for 15 minutes.

Preparation of Macfarland Standard

This was prepared by dissolving 1g of BaCl (Barium Chloride) in 100ml of distilled water, giving 1% BaCl. 1ml of sulphuric acid was collected and added to 99.4ml of distilled water. The pipette was used to transfer 0.5ml of BaCl into 9.95ml of sulphuric acid. The MacFarland standard was used to prepare the bacterial suspension based on turbidity.

Preparation of Microbial Suspension

The microbial suspension was prepared according to MacFarland standard. 1.7g of Sodium chloride was weighed and dissolved in 200ml of distilled water to give normal saline (0.85%). 10ml of normal saline was transferred into two different test tubes. The organisms were transferred from the stock culture using a sterile wire loop into the test tubes of the normal saline until it matched the' turbidity of 0.5% MacFarland standard.

Sensitivity For Antibacterial Activity

Antibacterial activity was tested by the agar well diffusion method. Two drops of the microbial suspension were inoculated per 100ml of the medium and poured twelve petri-dishes arid allowed to solidify. Each plate was duplicated for each of the concentrations. A 6.0mm diameter sterile cork borer was used to bore three (3) holes on each solidified agar plate. A sterile pipette was used to transfer concentrations from the sample bottle into the

three (3) different holes bored on the agar plate. Masking tape was used to label each hole according to its concentration. The plates were left for about an hour for the extract to diffuse properly into the medium; the plates were arranged in the incubator and incubated at 37°C for twenty-four (24) hours.

Measurement of Zone of Inhibition

After 24 hours of incubation at 37°C, the plates were observed for clear zones around wells. The zone of inhibition was measured using a meter rule in millimeters.

III. Results

The results of this study are presented in Tables 1 and 2. The garlic (*Allium sativum*) extracts of both water and ethanol possessed antibacterial activity against the two tested organisms at the minimum inhibitory concentration (MICs) of 300, 200, and l00mg/ml. Results showed the antibacterial activity of garlic against *Staphylococcus aureus* and *Escherichia coli.* The minimum inhibitory concentration (MIC) of the plant was also determined. Turmeric *(Curcuma longa)* extracts of both water and ethanol also possessed antibacterial activity against the two tested organisms at the minimum inhibitory concentration of 300, 200, and l00mg/ml. Results showed the antibacterial activity of *Curcuma longa* against *Staphylococcus aureus* and *Escherichia coli.* The minimum inhibitory concentration was also measured. Tables 1 and 2 show the *Curcuma longa* and *Allium sativum* zone of inhibition on the selected test organisms.

Table 1: Zone of inhibition (mm) of water and ethanol extracts of the *Curcuma longa*

Test organism	Sample extract	Zone of inhibition (mm) 100	200	300 (mg/ml)
E. coli	Water	6	10	13
	Ethanol	10	13	18
	Control	15	18	20
S. aureus	Water	15	20	25
	Ethanol	15	24	30
	Control	27	35	38

E. coli=Escherichia coli, S. aureus= Staphylococcus aureus, Control = Tetracycline

Table 2: Zone of inhibition (mm) of water and ethanol extract of the *Allium sativum*

Test organism	Sample extract	Zone of inhibition (mm) 100	200	300 (mg/ml)
E. coli	Water	10	13	15
	Ethanol	11	16	20
	Control	15	20	25
S. aureus	Water	20	27	30
	Ethanol	27	30	36
	Control	29	39	37

E. coli= Escherichia coli, S. aureus= Staphylococcus aureus, Control= Tetracycline

Staphylococcus aureus showed a high degree of sensitivity to *Allium sativum* extract in table 2. Both tables showed the inhibition zone of the control. The control used was tetracycline which had the highest zone of inhibition. This showed that tetracycline is a strong antibiotic against the tested organisms *Escherichia coli* and *Staphylococcus aureus.* Turmeric also showed antibacterial activity against *Staphylococcus aureus* and *Escherichia coli in* table 1. These showed that *Allium sativum* and the *Curcuma longa* extracts possess antibacterial compounds that could be used as substitutes for antibiotics.

IV. Discussion

Garlic and turmeric have good use as natural, effective antibacterial agents for preventing and treating bacterial infections. Mustafa [22], in their studies, reported that all garlic extracts concentration demonstrated varying degrees of antibacterial activities against both bacteria (*S. aureus* and *E. coli*). The zones of inhibition obtained using 100% garlic extract were more significant than those of lower garlic concentrations against *S. aureus* and *E. coli.* This report agrees with findings from the present study. Results indicated that extracts against the test organisms were 100, 200, and 300mg/ml. 300mg/ml had the highest zone of inhibition. Results showed that the highest antibacterial activity of garlic was against *Staphylococcus aureus. Staphylococcus*

aureus is extensively studied, and its sensitivity to plant extracts is reported widely [23]. Plant extracts with MICs between 100, 200, and 300mg/ml are relatively good antibacterial agents. Our finding is also in agreement with Shiv *et al.* [24] that supported that the antibacterial effect of aqueous extract of garlic extract was found to be stronger in comparison to turmeric.

In contrast to the study reported by Kuda et *al.* [25], this study's results supported the use of garlic in health products. For centuries, garlic has been known to possess medicinal and dietary effects [26]. Our study has further demonstrated the antibacterial potency of garlic against bacteria-resistant isolates *(S. aureus* and *E. coli*).

As spices have antibacterial properties, they can be used for better taste and preservation for other food items. According to Venugopal *et al.* [27], the addition of herbs and spices to the food preparations helps check the concentration of *Escherichia coli* in the body. It seems that this ability is due to having allicin in their bulbs. When garlic is cut, it is influenced by the allinase enzyme, the cysteine sulfoxide lyase, which turns into allicin (Deresse [28]). All these are responsible for garlic's antibacterial and antioxidant properties. Our finding is also comparable to what was reported by Abubakar [29] by the ability of garlic to inhibit the growth of Gram-positive ad Gram-negative bacteria. The results from the present study vary with the study reviewed by Md *et al.* [30], where water extract from garlic (*Allium sativum*) showed the highest antibacterial activity against *Staphylococcus aureus.* While our findings showed that ethanol extract from garlic showed the highest antibacterial activity against *Staphylococcus aureus,* both studies agree that garlic (*Allium sativum*) and Turmeric (*Curcuma longa*) have antibacterial properties. According to Tonin *et al.* [31], water and ethanol extracts (ethanol/water 70:30/80) prepared from rhizomes of turmeric showed great antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*

The essential oil of turmeric was reported to have antibacterial properties [32]. Our findings of turmeric are comparable to what was reported by Behura [33], and the results of the study support the use of turmeric against *Escherichia coli.* The highest concentration (300mg/ml) had the best activity and the more significant zones than other concentrations. This is due to more antibacterial active contents of the concentration, which leads to the accumulation of these components. Increasing the concentration may lead to elevating the amount of the active components, thus increasing the activity against bacteria. Pundor *et al.* [34] and Lawhavit *et al.* [35] reported that the turmeric extracts possess excellent antibacterial action against microbes such as *Bacillus cereus, Bacillus coagulans, B. subtilis, E. coli, P. aeruginosa, and S. aureus.* In a study by Praditya *et al.* [36], curcumin's antibacterial activity was investigated. It was shown to act against various important human pathogens such as strains of *Staphylococcus*, *Streptococcus*, and *Pseudomonas*. Our findings agree with Shoko *et al.* [37] that existing antibiotic drugs can be replaced with biomaterials from herbal medicine such as garlic, and turmeric, with high antibacterial, antiviral, and antioxidant activity. Therefore, the present study revealed garlic and turmeric's anti-*Staphylococcus aureus* and anti-*Escherichia coli* effects.

V. Conclusion

The results obtained from this study reveal that different extracts of Garlic (*Allium sativum*) and Turmeric (*Curcuma longa*) have a significant amount of antibacterial activity. However, depending on which solvent used for the extraction, the antibacterial activities vary. The extracts from these herbal spices (garlic and turmeric) could inhibit Gram-positive and Gram-negative (*Staphylococcus aureus* and *Escherichia coli*). Garlic and turmeric have good use as natural, effective antibacterial agents for preventing and treating bacterial infections.

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