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Phytochemical Screening and Antimicrobial Activity of Ginger (Zingiber Offinales) Extract on Organism Isolated from Infant Diarrhoea

Joy Chinyere Ogbu[1*], I.O. Bashiru[1], Egbunu Victor Mudi[1], S. Abubakar[2] and Udeh S.M.C[3]

[1]*Department of microbiology, University of Abuja, Nigeria*

[2]*Sheda Science and Technology Complex Abuja Nigeria*

[3]*National Primary Health Care Development Agency, FCT Office, Abuja- Nigeria*

[*]Corresponding Author
Joy Chinyere Ogbu, Department of Microbiology, University of Abuja, Nigeria.

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Abstract
This study was conducted to determine the Antimicrobial Activity of Ginger (Zingiber Officinale) against organisms isolated from infant diarrhoea. Staphylococcus aureus and Escherichia coli isolates obtained from the University of Abuja Teaching Hospital. The results for ginger extracts were recorded at 62.5mg/ml and 250mg for Escherichia coli and Staphylococcus aureus. MIC values for garlic extract reported for Staphylococcus aureus (250mg/ml) was observed to be higher than that of E.coli (62.5mg/ml) and for ginger extract, value for Staphylococcus aureus (125mg/ml) was also higher than that of Escherichia coli (31.25mg/ml). The MBC values also showed that the cells of Escherichia coli and Staphylococcus aureus were completely killed at 6.25mg/ml and 3.125mg/ml respectively. The study further revealed that inhibition was dose dependent and that ginger has a potential for great use in medicine.

Keywords: Ginger, Antimicrobial, Infant Diarrhoea

1. Introduction

Traditional medicine has been an essential part of healthcare in many developing countries, relying on knowledge passed down through generations about medicinal and toxic plants. Across Africa, Asia, and Latin America, populations commonly use traditional medicine for primary healthcare. The preference for medicinal plants is largely due to their lower side effects, affordability, accessibility, and broad therapeutic applications [1,2]. In developed nations, around 70–80% of the population use complementary or alternative medicine alongside conventional treatments, particularly for chronic illnesses [3]. According to WHO (2008), approximately 80% of Africans utilize herbal medicine, while in Ghana, about 70% of the population relies solely on traditional medicine. Several native forest species, including Allium sativum (garlic) and Zingiber officinale (ginger), are commonly used in herbal medicine. Garlic, which originated in Central Asia over 6,000 years ago, has long been a staple in Mediterranean, Asian, African, and European cuisines. It is a bulbous perennial herb closely related to onions, featuring a tall flowering stem that reaches 2–3 feet in height and produces pink or purple flowers in mid-to-late summer. The medicinal part of garlic is its bulb. Initially classified under the Liliaceae family, garlic is now categorized under Alliaceae and consists of two primary types: hard neck and soft neck varieties. Hard neck garlic has a woody central stalk, whereas soft neck varieties develop a pseudo-stem made of overlapping leaf sheaths and rarely produce flowers unless exposed to stressful environmental conditions. Garlic's therapeutic properties are attributed to its oil- and water-soluble sulfur compounds, particularly thiosulfinates, which are responsible for its antimicrobial activity. Extracts that lack thiosulfinates lose their antibacterial properties. Additionally, garlic is known for its potential in preventing heart diseases such as atherosclerosis, high cholesterol, and hypertension, as well as reducing the risk of stomach and colon cancers. Similarly, ginger is widely used as a spice, medicine, and delicacy. It belongs to the Zingiberaceae family, which consists of over 45 genera and 800 species.

2. Materials and Methods

2.1. Study Area

This research utilized fresh ginger (Zingiber officinale) sourced from the Gwagwalada market, located within the Gwagwalada Area Council of Nigeria's Federal Capital Territory (FCT). Gwagwalada, one of the FCT's six area councils, covers 1,043 km² and had a population of 157,770 in 2006. The town of Gwagwalada is situated at an elevation of 210 meters.

2.2. Collection and Identification of the Plant Materials

Fresh ginger rhizomes were purchased from the Gwagwalada market in Abuja. These samples were then transported to the Biology Laboratory at the University of Abuja for identification and authentication. After washing with distilled water and peeling, the samples were dried in a hot air oven at 30°C for 48-72 hours.

2.3. Materials Used

The following materials were used in this study: (3.3.1) Chemicals and Reagents: 70% ethanol, Muller Hinton Agar, distilled water, Nutrient Agar, and methylated spirit. (3.3.2) Equipment and Glassware: Electronic incubator, electronic digital weighing balance, Bunsen burner, Petri dishes, wire loop, matches, marker, Whatman filter paper, black nylon, hand gloves, measuring beakers, measuring cylinders, and conical flasks.

2.4. Ethanol Extraction of the Plant Materials

Dried ginger was ground into a fine powder using a mortar and pestle. 100g of each powder was then placed into separate volumetric flasks, and 500ml of 70% ethanol was added to each flask using a measuring cylinder. The flasks were covered with black nylon and left to soak at room temperature for 3 days. After soaking, the mixtures were filtered using Whatman filter paper. The resulting filtrates were then heated in a water bath at 78°C for 24 hours to evaporate the ethanol, yielding the crude extracts used for antimicrobial analysis.

2.5. Media Preparation

2.5.1. Muller Hinton Agar

To prepare the Muller Hinton Agar, 7.80g of the agar was weighed into a 250ml conical flask. 200ml of distilled water was added, and the mixture was autoclaved at 121°C for 15 minutes. After cooling to 35-40°C, 20ml of the agar was aseptically dispensed into each Petri dish [4].

2.6. Test Organism used for the analysis

The study utilized clinical isolates of two bacterial species: Gram-positive Staphylococcus aureus and Gram-negative Escherichia coli. These isolates were obtained from the Microbiology laboratory of the University of Abuja Teaching Hospital Gwagwalada and transported to the Biology laboratory of the University of Abuja. The isolates were then preserved on Nutrient Agar slants in bijoux bottles and stored at 4°C.

2.7. Determination of the Antibacterial Activity of the Extracts

The antibacterial activity of the crude extracts was determined using the agar well diffusion methods. Crude extracts at concentrations of 500mg/ml, 250mg/ml, 125mg/ml, and 62.5mg/ml were tested. Mueller Hinton Agar was prepared according to the manufacturer's instructions and autoclaved at 121°C for 15 minutes. The crude extracts were liquefied by adding 5g of the ethanolic ginger extract into 9ml of sterile distilled water in a test tube and doubling dilution was carried out on each tube to reduce the concentration of the crude extracts by half. The test organisms were inoculated onto the surface of the Muller Hinton Agar by streaking with a wire loop. Wells (6mm diameter) were created on each Petri plate using a flamed cork borer and labeled with numbers and horizontal lines.

2.8. Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC)

The MIC and MBC of the extracts were assessed following the protocols outlined in Cheesbrough's "Medical Laboratory Manual for Tropical Countries" (2011). Five concentrations of ethanolic ginger extracts (50.0 mg/ml, 30.0 mg/ml, 20.0 mg/ml, 10.0 mg/ml, and 5.0 mg/ml) were prepared and tested for their ability to inhibit bacterial growth. The plates were incubated at 37°C for 24 hours. The lowest extract concentration at which no bacterial growth was observed was recorded as the MIC. The MBC was determined by plating the lowest concentrations on Nutrient Agar and examining the plates for growth after 24 hours of incubation. The lowest concentration that prevented any visible growth of the test organism was recorded as the MBC.

3. Results

The results of this study indicated that ginger extracts exhibited antimicrobial activity against the tested bacterial isolates.

Concentration (mg/ml)	*S.aureus*	*E.coli*
500	8mm	13mm
250	13mm	9mm
125	3mm	17mm
62.5	5mm	25mm

Table 1: Antibacterial Activity of Ethanolic Ginger (*Zingiber officinale*) extract with zones of inhibition

Concentration (mg/ml)	*S.aureus*	*E.coli*
500	-	-
250	-	-
125	-	-
62.5	+	-
31.25	+	-
Keys: + = inhibition - = inhibition		

Table 2: Minimum Inhibitory Concentration of Ethanolic Ginger Extract

This result shows that the MIC value for *Staphylococcus aureus* (125mg/ml) is also higher than the MIC for *Escherichia coli* (31.25mg/ml).

Concentration (mg/ml)	*S.aureus*	*E.coli*
500	-	-
250	-	-
125	-	-
62.5	-	-
31.25	-	-
Key: - = inhibition (no growth)		

Table 3: Minimum Bactericidal Concentration of Ethanolic Ginger Extract

This results show that the MBC for the two test organisms (Staphylococcus aureus and Escherichia coli) are the same. Hence, at 31.25mg/ml, the ginger extract allowed no visible growth of the test organisms after 24 hours of incubation.

4. Discussion

Table 1 demonstrates that garlic extract had a greater inhibitory effect on Escherichia coli compared to Staphylococcus aureus, as reflected by the diameter of the zones of inhibition.

Table 2 shows that ginger extracts also displayed significant inhibitory effects against Escherichia coli compared to Staphylococcus aureus, as indicated by the zones of inhibition.

Tables 3 present the Minimum Inhibitory Concentrations (MIC) of the ethanolic extracts against the test organisms, revealing higher MIC values for Staphylococcus aureus than for Escherichia coli. The findings of this study confirm that garlic possesses antibacterial effects against both Gram-positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) bacteria. This aligns with Louis Pasteur's earlier observations that onion and garlic extracts exhibit antibacterial activity against a broad spectrum of bacteria [5]. The study also demonstrated that ginger has antibacterial properties against the test organisms, likely due to its acidic nature and the presence of bioactive phytochemicals. The greater zones of inhibition observed for ginger extract against Escherichia coli support the findings of Madu et al. (2018), who indicated that ginger is effective against foodborne pathogens such as Escherichia coli and Pseudomonas aeruginosa. Garlic juice has a history of use in Nepal and India for treating bacterial-related stomach disorders, a practice gaining increasing acceptance [6]. In certain regions of Kumasi, Ghana, diluted powdered garlic is incorporated into topical ointments to treat skin abrasions and prevent Staphylococcus aureus infections [7]. Among the Igbo people of Nigeria, ginger tea and drinks have long been used to treat both upper and lower respiratory tract infections, as well as for disinfecting wounds. Onyema and Amadi (2018) reported a decrease in wound site infections among patients at the National Orthopaedic Hospital in Enugu after cleaning wounds with diluted ethanolic ginger extract. The variations observed in the MIC and MBC values for the extracts are likely related to the interactions between the bioactive phytochemicals in each extract and the different bacterial structures. Gram-positive bacteria like Staphylococcus aureus have a thicker cell wall, potentially contributing to the higher MIC and MBC values. In contrast, Gram-negative bacteria like Escherichia coli possess a thinner cell wall, making them more susceptible to penetration and effects from even small amounts of bioactive compounds. This trend is evident in the MIC and MBC values presented in Tables 3-6. Both extracts demonstrated greater antibacterial activity against Escherichia coli, a finding consistent with the results of Akinyemi et al. (2016).

5. Conclusion

This study highlights the antibacterial properties of Ginger (Zingiber officinale). The results suggest the plant has significant potential for use in the pharmaceutical industry. The study indicates that ginger contains a wealth of bioactive compounds, making them potential sources of therapeutic agents [8,9].

Recommendations

Based on the findings of this study, it is recommended that further research be conducted to:

- Isolate and identify the specific active compounds present in garlic and ginger.
- Evaluate the antibacterial activity of ginger and garlic against a wider range of pathogenic bacteria.
- Investigate the relationship between the use of ginger and garlic and the effectiveness of commercial antibacterial drugs in treating infections caused by Staphylococcus aureus and Escherichia coli.

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