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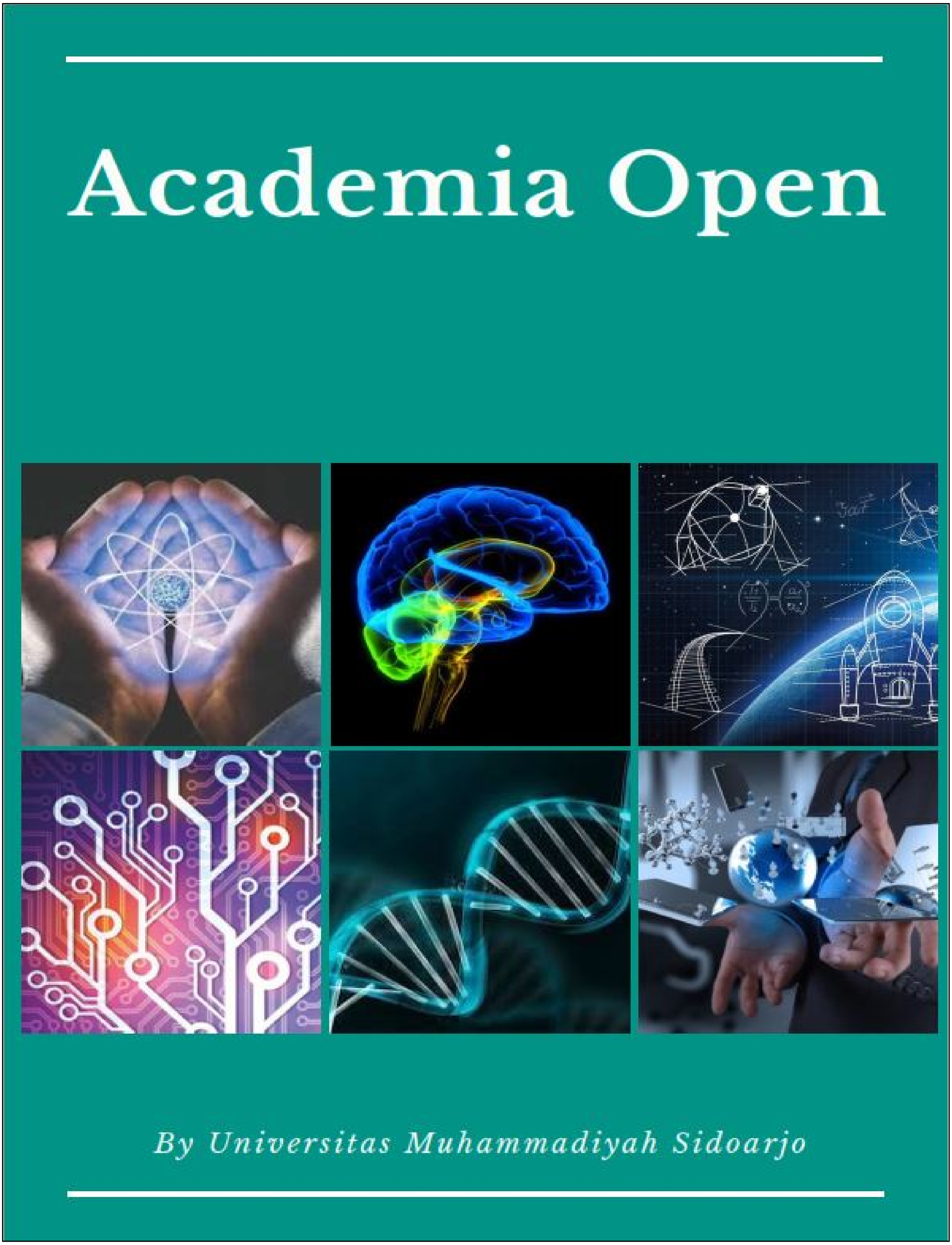

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Activity of Ethanoic Extract of Ginger (Zingiber officinale) Against Pathogenic E. coli and P. aeruginosa

Aktivitas Ekstrak Etanoat Jahe (Zingiber officinale) Terhadap E. coli dan P. aeruginosa Patogen

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Abstract

Ginger (Zingiber officinale) extracts were tested for their antibacterial effectiveness in Thi-Qar province against harmful microorganisms including Escherichia coli and Pseudomonas aeruginosa. To prepare the plant materials for extraction with 95% ethanol, they were collected, cleaned, dried, and ground. The bactericidal activity of ginger extracts was tested using the agar well diffusion technique at concentrations of 25%, 50%, 70%, and 100% w/v. Independent sample t-tests and one-way analysis of variance were part of the statistical analysis. Strong antibacterial activity was shown at all concentrations ($p < 0.05$) in the data, with the highest effectiveness shown against both bacterial strains at 100% concentration. When it came to P. aeruginosa, ginger was more effective than E. coli. These results support the use of ginger in alternative treatments for bacterial diseases by highlighting its potential as a natural antibacterial agent

Highlights:

1. Ginger extracts show antibacterial effectiveness against E. coli and P. aeruginosa.
2. Highest activity observed at 100% concentration using agar well diffusion technique.
3. Highlights ginger's potential as a natural antibacterial alternative for bacterial diseases.

Keywords: Walnut husks, iron removal, biosorption, Langmuir isotherm, thermodynamic study

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Introduction

Commercially accessible antimicrobial medications have been used to address microbial pathogenicity and other infectious illnesses for several decades. Multidrug resistance (MDR) has emerged in several bacterial infections as a result of the extensive use of antibiotics. The most significant obstacle to effectively treating infectious diseases and managing microbial pathogenicity is the rise of drug-resistant microorganisms [1, 2]. Research into novel antimicrobial compounds is necessary due to the rising medication resistance in infections and the growing demand from customers for safe food. A result of this is that medicinal herbs and spices are now being prescribed more often than antibiotics [3]. There are an estimated 250,000 to 500,000 different types of plants on Earth, yet only a small fraction of them are actually edible. As natural products, these plants provide a wealth of potential new natural medicines [4]. A growing number of people have turned to them in recent decades as an alternate kind of treatment for a wide range of illnesses [5].

The side effects of herbs and spices are less severe than those of synthetic medications. Affordable, easily available, and well-tolerated by patients, these therapies are a great option for low-income communities [6]. Because of their many health benefits, spices and herbs have seen a dramatic uptick in popularity in both developing and industrialized nations in recent years. Some phytochemicals or essential oils in spices and plants have antibacterial properties. The kind and composition of the spices, the amount utilized, the type of microbes, the content of the food, and the surrounding temperature and pH level are the primary elements that affect this activity [7, 8]. A number of studies have shown that many spices and herbs have antimicrobial and antifungal effects. Nevertheless, the exact mechanism of their antibacterial effect remains a mystery [9].

A long-standing part of African heritage is the use of medicinal spices and herbs to heal various ailments. Although they have been used for a long time, there aren't many bioactive plant chemicals that have been produced for antibiotic usage in clinical settings. Notable examples of alkaloids that have been effectively transformed into chemotherapeutic medicines are quinine and emetine. One type of antibacterial food that is gaining popularity in the Western diet is ginger. Combating resistant diseases is made easier using novel antibiotics and antimicrobial compounds produced from plants [10, 11]. The antibacterial qualities of ginger, scientifically known as Zingiber officinale, are well-documented, and it is a popular ingredient in many tea recipes. The antibacterial qualities of ginger have been highly esteemed by Asian cultures for eons. The South Indian sweet known as Injimurappa (translated as "ginger candy" in Tamil) is made with ginger [12]. The Zingiberaceae family includes the perennial plant ginger. The tropical areas of Southeast Asia are its original home, although it has since been farmed all throughout China [13]. Because of its distinct pungent scent and flavor, ginger is used as a spice in cooking. It also serves as a great source of bioactive phenols such gingerols, shogaols, and zingerones, among other bioactive chemicals [14]. The volatile oil of ginger is derived from the plant's rhizome and is known as ginger essential oil. Its distinctive scent and biological efficacy provide it great room for growth in the culinary, cosmetics, and pharmaceutical sectors [15].

GEO has the ability to treat respiratory and gastrointestinal issues, and it is known to be a safe natural substance [16]. A specific kind of diarrhea is a major cause of infant death in underdeveloped nations, and ginger chemicals have shown promise in treating this condition [17]. Multiple studies have demonstrated that ginger can alleviate nausea associated with chemotherapy, pregnancy, and motion sickness. Ancient Indian and Chinese cultures recognized garlic's beneficial benefits on cardiovascular health, circulation, and illness prevention. Consistent intake has the potential to aid in the fight against cancer, malaria, and immune system deficiencies [18]. In addition to its antibacterial properties, ginger has been used to treat diabetes, candidiasis, colds, and asthma. It also shows promise against foodborne pathogens such as E. coli, P. aeruginosa, Salmonella, Shigella, and Staphylococcus aureus [19]. For ages, people have known that garlic contains medicinal properties that might help fight against several kinds of germs. This study evaluates ginger's antibacterial efficacy in regard to specific clinical illnesses.

Methods

Collecting specimens of fresh Zingiber officinale plant parts from a market in Thi-Qar province, the College of Science laboratory tested them for antibacterial activity against two harmful bacteria. The germs were isolated and identified in the lab.

Phytochemical extraction drying

Prior to extraction, the Zingiber officinale plant parts were washed in running water and then in sterile distilled water. Following the method outlined by Ameen and Okab [2], the material was subjected to a 48-hour drying period in an oven set at 50° C before being milled into a powder.

Preparation of bacterial suspension

The College of Science laboratory isolated and recognized Pseudomonas aeruginosa and Escherichia coli as bacteria. The two bacterial colonies' concentration was adjusted by adding sterile distilled water until it reached

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the 0.5 McFarland standard, which is 1.5 × 10^8 CFU/ml. To keep the total number of microorganisms within an acceptable range, the turbidity of a microbiological suspension can be adjusted to meet McFarland requirements. The 0.5 McFarland standard was prepared by vigorously mixing 9.95 ml of 0.18M H_2SO_4 (1.0% w/v) with 0.05 ml of barium chloride ($BaCl_2$) (1.17% w/v $BaCl_2 \cdot 2H_2O$). To minimize loss due to evaporation, the McFarland standard tube can be securely sealed for a maximum of six months. A white backdrop with a black line between the test and standard was used to make comparisons easier [2].

Preparation ethanolic extracts

A variety of phytochemicals are produced when certain plant components are extracted (Kazlauskaite et al. [20]). A solvent, more precisely 95% ethanol, was used to extract phytochemicals from the plants. A 100 ml ethanol extract was prepared by dissolving 25 g, 50 g, 70 g, and 100 g of powdered plant material in an appropriate volume of sterile ethanol at 25%, 50%, 70%, and 100% w/v, respectively. A sterile flask was used to keep the mixture undisturbed for 24 hours to prevent evaporation. After that, sterilized Whatman no.1 filter paper was used to filter it. The agar well diffusion technique was quickly used to evaluate the antibacterial activity of the ethanoic extracts that were generated in this way.

Statistical analysis

The statistical tests used in the analysis were SPSS version 26, with a significance level of $p < 0.05$, and they included One-way ANOVA for comparing means, LSD for evaluating mean differences, and independent sample t-tests

Result and Discussion

Result

Activity of Ginger (Zingiber officinale) Against Pathogenic Bacteria

The present study revealed a noteworthy difference with a p-value <0.05 in the efficacy of ginger against pathogenic bacteria. The ginger extract demonstrated activity at all concentrations, showing enhanced efficacy against P. aeruginosa in comparison to E. coli. The maximum activity was recorded at a 100% concentration, whereas the minimum activity against E. coli was noted at a 50% concentration, and against P. aeruginosa at a 25% concentration, as shown in Table 1.

Concentration	E. coli	P. aeruginosa	p. value
	Mean ± S. D		
25	16.6 ± 0.72bc	20.4 ± 2.10c	0.001
50	15.4 ± 1.15c	22.7 ± 1.56b	<0.001
70	18.5 ± 2.01a	22.3 ± 0.98b	<0.001
100	17.6 ± 1.54ab	26.7 ± 2.76a	<0.001
p. value	0.021	<0.001	
LSD	1.46	1.84	

Table 1. *Activity of ginger (Zingiber officinale) against pathogenic bacteria*

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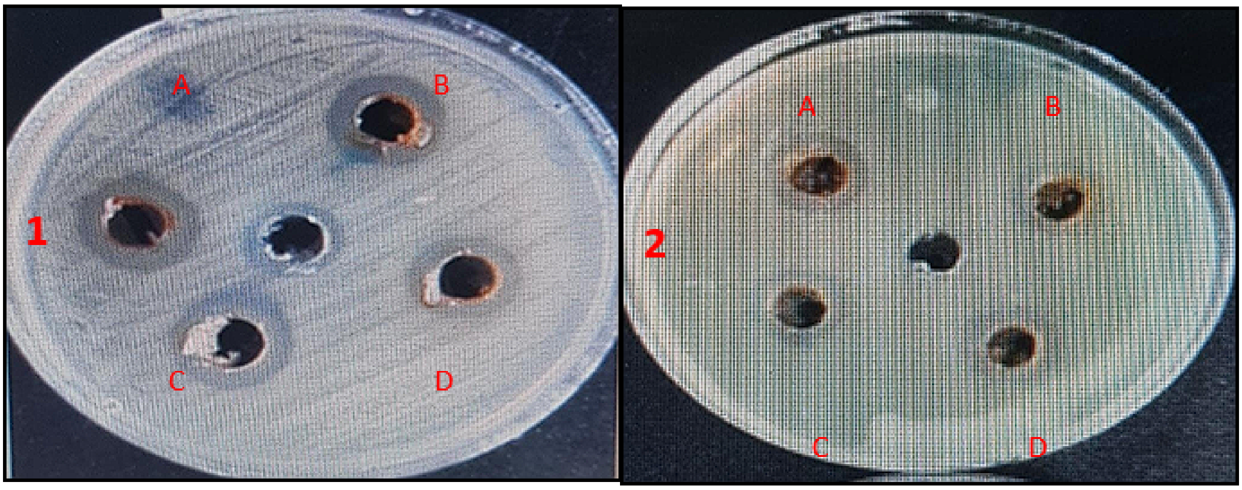

Figure 1. *Activity of ginger (Zingiber officinale) against pathogenic bacteria,*

•1: activity against E. coli bacteria, 2: activity against P. aeruginosa

•A: 100%, B: 70%, C: 50%, and D: 25% concentration respectively.

Discussion

This study demonstrates the notable antibacterial efficacy of ginger extracts against pathogenic bacteria, specifically Pseudomonas aeruginosa and Escherichia coli, with a p-value of less than 0.05. The results indicate that ginger demonstrates antimicrobial properties at all tested concentrations, with maximum efficacy noted at 100% concentration. Ginger exhibited higher efficacy against P. aeruginosa than E. coli, with diminished activity observed at lower concentrations. Multiple studies have demonstrated the antimicrobial properties of ginger against a range of pathogens. Lagha et al. [21] demonstrated that ginger extracts exhibit notable antibacterial activity, corroborating the current findings on their effectiveness against P. aeruginosa and E. coli. The concentration-dependent nature of ginger's antibacterial activity is consistent with findings from other studies. A study by Shaukat et al. [22] demonstrated that elevated concentrations of ginger extracts led to enhanced inhibition of bacterial growth, supporting the current study's finding of peak activity at 100% concentration. The differential activity of ginger against P. aeruginosa and E. coli aligns with prior research findings. A study by Meenu and Kaushal, [23] demonstrated that ginger extracts are particularly effective against Gram-negative bacteria, including P. aeruginosa, which is consistent with the findings of the current study. The mechanisms of action of ginger extract, attributed to bioactive compounds like gingerol and shogaol, are well-documented. These compounds disrupt bacterial cell membranes and inhibit metabolic processes, as indicated by Shukla and Singh [24], potentially explaining the observed efficacy against P. aeruginosa. The findings possess clinical significance, as the increasing resistance of pathogens like E. coli to standard antibiotics necessitates the exploration of alternative therapeutic options. Rahman et al. [25] highlight the potential of ginger as a natural antimicrobial agent, endorsing its application in therapeutic contexts.

Conversely, some studies have indicated variability in the antibacterial efficacy of ginger extracts. A study by Bashir et al. [26] demonstrated that ginger possesses antibacterial properties; however, its effectiveness varied considerably based on the extraction method and the bacterial strain examined, indicating that the findings may not be universally applicable. Koo and Gang [27] indicated that higher concentrations typically enhance antibacterial activity; however, there are instances where lower concentrations can be equally effective against specific pathogens, challenging the assumption that maximum efficacy is always observed at 100%. The study by Hlebová et al., [28] highlights the potential for bacteria to develop resistance to natural antimicrobial agents, such as ginger. It suggests that over-reliance on natural extracts may lead to resistance, raising concerns about the long-term viability of ginger as a primary antimicrobial agent

Conclusion

The present study offers significant evidence for the antibacterial properties of ginger against P. aeruginosa and E. coli. However, it is important to contextualize these findings within the existing literature, which includes both supportive and contradictory evidence concerning the effectiveness and use of ginger as an antimicrobial agent.

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