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Pharmacotherapeutic Activity of *Allium sativum* (Garlic) Bulb against Gram-positive and Gram-negative Bacteria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AIA conceptualized and designed the study and also wrote the manuscript. Author ACN managed the analyses of the study. Author KON managed the literature searches. Author JAE wrote the protocol while author AUM performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Background: Emergence of methicillin drug resistance is evident and has become a global challenge. Seeking for alternative antibiotics that are new, natural, plant based, cost e□ective and less toxic is the recent task for global health.
Aim: This study is aimed at assessing the pharmacotherapeutic activity of *Allium sativum* (Garlic) bulb against gram-positive and gram-negative bacteria.
Materials and Methods: Fresh *A. sativum* bulbs were purchased from a local market in Ibadan, Nigeria and were identified by a botanist. They were cut into small pieces and mashed in a laboratory with a mortar and pestle and the fluid squeezed out of the resultant slurry. The

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antibacterial activity of the juice was determined by diffusion method. Nutrient agar medium was prepared using standard method. Pure cultures of *Coliform bacillus*, *Staphylococcus epidermidis*, *Streptococcus viridians*, *Salmonella typhi* and *Escherichia coli* were obtained from the Department of Veterinary Microbiology and Parasitology, Federal University of Agriculture, Abeokuta, Nigeria. The juices were serially diluted to obtain 1.0%, 0.5%, 0.25% and 0.125% solutions in sterile test tubes. Sterilized 9 mm filter paper disc soaked in the diluted juice were placed on the plate and incubated for 24 hours at room temperature. The plates were examined for clear zones of inhibition. Presence of zones of inhibition indicated activity.

Results: The results showed that *A. sativum* bulb has antibacterial potential against all the bacteria used in this study and also exhibited inhibitory activity against them.

Conclusion: The result of this present study showed that *A. sativum* juice has high range of antibacterial potential against both gram positive (*S. epidemidis* and *S. viridans*) and gram negative bacteria (*C. bacillus, E. coli* and *S. typhi*). However, the extract has a greater inhibitory activity against gram positive bacteria than gram negative bacteria.

Keywords: Allium sativum; C. bacillus; E. coli; S. epidemidis; S. typhi; S. viridians.

1. INTRODUCTION

Emergence of resistant strains of pathogenic microorganism has continued to pose a major health concern about the potency and efficacy of several drugs, most importantly antibiotics currently in use [1]. Thus, attention has been shifted to medicinal plants. Sofowora [2] and Balandrin et al. [3] defined medicinal plants as plants in which one or more organs contain substances that can be used for therapeutic purposes or which it precursors for the manufacturing of drugs are useful for disease therapy. Since medicinal plants do not nearly save people from feeling pain but permit them to emerge unscathed, they deserve investigation. The local use of natural plants as primary health remedies, due to their pharmacological properties, is quite common in Asia, Latin America, and Africa [4].

Allium sativum (garlic) has traditional dietetic and medicinal uses as an anti-infective agent [5]. *In vitro* confirmation of the antimicrobial action of fresh and freeze-dried garlic juices against human pathogenic bacteria [6], fungi [7] and viruses [8] supports these applications. Garlic is a hardy perennial member of onion family. Studies explain that it may be originally native to Asia, but has long been naturalized to Europe northern Africa, Mexico and all over the world [9]. This medicinal plant is mainly used as condiments and for stopping in di erent cooking [10]. The use of higher plants and their juices to treat infections is an ancient practice in herbal medicine. The herbal medicine may be in the form of powders, liquid or mixtures which may be row or boiled, ointments linings and incision [11].

Traditional medicine is the sum total of knowledge skills and practices based on the theories, beliefs and experiences indigenous to di erent cultural that are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illness. In many developing countries, a large proportion of the population relies on traditional practitioners and their armamentarium of medicinal plants in order to meet health care needs. *A. sativum* is one of those plants that were seriously investigated over several years and used for century to treat infectious diseases [12]. Because, it is commercial, nutritional and medicinal values garlic is produced world widely.

Naturally occurring plants have played an important role in the discovery of new therapeutic agents. The therapeutic uses include beneficial e ects on the cardiovascular system, antibiotics, antidiabetic, anticancer, anti-inflammatory, antimalarial and hypoglycemic and hormone-like e ects [13]. But improper perception and use of herbal remedies result in adverse condition on our health. The understanding of consumer and physician on the toxicities, contradiction and drug interaction as well as side e ects of herbal remedies is poor. Due to this, several cardiovascular conditions, CNS bleeding, mouth ulcer, dermatitis is observable [14]. Adverse reactions attend because of improper use of garlic, including gastro intestinal upset, platelet dysfunction that produces post-operative bleeding and spontaneous epidural hematoma. And garlic allergy manifest as rhinitis, asthma, anaphylaxis contact dermatitis and pemphigus. Garlic ingredient diallyldisulfde, allicin, and allylpropyldisulfed are causative of allergies with diallyldisulfde being strongest sensitizer [15]. The

chemical burns reported are as result of prolonged placement of garlic. Generally training of practitioners who provide herbal medicine and forming national pharmacovigilance centers (or equivalent institutions) that analyses the causes and advert events of improper uses of herbal is crucial in preventing side e□ect [16]. This study therefore sought to assess the pharmacotherapeutic activity of *A. sativum* (garlic) bulb against gram-positive and gram-negative bacteria.

2. MATERIALS AND METHODS

2.1 Collection and Extraction of Plant Materials

Fresh garlic bulbs were purchased from a local market in Ibadan, Oyo State, Nigeria and were identified by a botanist. They were cut into small pieces and mashed in a laboratory with a mortar and pestle, and the fluid squeezed out of the resultant slurry.

2.2 Determination of Antibacterial Activity

The antibacterial activity of *A. sativum*was determined by the diffusion method of Kirby Bauer described by Duguid et al. [17].

2.3 Preparation of the Nutrient Medium

Nutrient agar medium was prepared according to the method described by Taiwo [18]. 2.8 g of nutrient agar was dissolved in 100 mL distilled water. The solution was sterilized in an autoclave at 121°C at 1.1N pressure for 15 minutes. The suspension was cooled and poured into sterile Petri-dishes to solidify. The agar depth of the medium was 4.0 mm.

2.4 Preparation Cultures and Inoculation

Pure cultures of *Coliform bacillus*, *Staphylococcus epidermidis*, *Streptococcus viridians*, *Salmonella typhi* and *Escherichia coli* obtained from the Department of Veterinary Microbiology and Parasitology, Federal University of Agriculture, Abeokuta, Nigeria were separately used to inoculate the Petri-dishes. This was done by streaking the surface of the plates in a zigzag manner until the entire surface was then covered. The inoculated plates were then incubated at room temperature for 24 hours [18].

2.5 Assay of Bacterial Inhibition Activity

The *A. sativum* juice was serially diluted to obtain 1.0%, 0.5%, 0.25% and 0.125% solutions in sterile test tubes according to Taiwo [18]. Sterilized 9 mm filter paper disc soaked in the diluted juice was placed on the plate and incubated for 24 hours at room temperature. The plates were examined for clear zones of inhibition. Presence of zones of inhibition indicated activity. The zones were measured.

3. RESULTS

The results of antibacterial activity and inhibition of bacterial growth by the *A. sativum* bulb are presented in Tables 1 and 2 respectively.

4. DISCUSSION

The search for newer sources of antibiotics is a global challenge pre-occupying research institutions, pharmaceutical companies, and academia, since many infectious agents are becoming resistant to synthetic drugs. In recent years, the growing demand for herbal products has led to a quantum increase in volume of plant materials traded across the countries. However, the use and history of herbs dates back to the time of early man, who had the crudest tools as his implements and use stones to start his fire. They used herbs in their raw and cooked forms to keep fit. Since that time, the use of herbs has been known and accepted by all nations and has been known also as the first line of treatment available to man [19]. The importance of herbs in the management of human ailments cannot be over emphasized. It is clear that the plant kingdom harbours an inexhaustible source of active ingredients invaluable in the management of many intractable diseases [20]. Furthermore, the active components of herbal remedies have the advantage of being combined with other substances that appear to be inactive. However, these complementary components give the plant as a whole a safety and efficiency much superior to that of its isolated and pure active components [20]. This study therefore sought to assess the pharmacotherapeutic activity of *A. sativum* (garlic) bulb against gram-positive and gram-negativebacteria.

In this present study, the juice of *A. sativum* bulb was observed to have high range of antibacterial potential against both gram positive (*C. bacillus, S. epidemidis* and *S. viridans*) and gram negative

bacteria (*E. coli* and *S. typhi*) (Table 1). The juice was also e□ective against antibiotic resistant bacteria and their toxic products. This e□ect might be due to the constituents of garlic, especially, the allicin has been reported to a□ect the growth of bacteria by inhibiting there DNA and proteins synthesis partially and also by inhibiting RNA synthesis as primary target [21]. This is in agreement with the findings of Ogunjobi and Elizabeth [22] but contradicts that of Airaodion et al. [23] who reported that both ethanolic and aqueous extracts of *Carica papaya* leaves shows no antibacterial activity against *S. typhi*. *S. typhi* is a gram-negative bacterium that is responsible for typhoid fever and has been a burden on developing nations for generations [24]. Therefore, *A. sativum* might be useful in the management of typhoid fever.

The results of the inhibition of bacterial growth by the juice of *A. sativum* showed that the juice exhibited highest antibacterial activity against gram positive organisms. The susceptibility of bacteria to antibiotic chemical is expressed in minimum inhibitory concentration (MIC) or high zone of inhibition [25]. MIC is the lowest concentration of a chemical, usually a drug, which prevents visible growth of a bacterium or bacteria. MIC depends on the microorganism, the affected organism (*in vivo* only) and the antibiotic itself [26]. The susceptibility of bacterial strains also depend on their structural composition, particularly gram-positive bacteria contain lower percentage of lipid than the gram-negative bacteria. Thus, the lipid content of the membranes will have an e□ect on the permeability of hydrophobic and volatile bioactive substances in garlic. Hence this phenomenon may favor the destruction of the cell wall and genetic material of gram-positive bacteria than that of gram-negative bacteria [21]. Therefore, the lower inhibitory action of garlic on gram-negative bacteria in this study might mean the outer membrane of gram-negative bacteria make it less susceptible to antimicrobials than gram positive bacteria [27]. This is agreement in with the findings of Wolde et al. [21] and Airaodion et al. [23].

Table 1. The antibacterial activity of *A. sativum* bulb

Test organisms	Antibacterial activity
Coliform bacillus	+
Staphylococcus epidemidis	+
Streptococcus viridans	+
Salmonella typhi	+
Escherichia coli	+

Table 2. Inhibition of bacterial growth by *A. sativum* bulb

Test organisms	Dilution (%)	Zone of inhibition (mm)
Coliform bacillus	1.00	4.00
	0.50	3.50
	0.25	2.50
	0.125	1.00
Staphylococcus epidermidis	1.00	4.50
	0.50	3.50
	0.25	2.50
	0.125	2.00
Streptococcus viridans	1.00	4.50
	0.50	3.00
	0.25	2.50
	0.125	1.00
Salmonella typhi	1.00	2.50
	0.50	1.00
	0.25	0.00
	0.125	0.00
Escherichia coli	1.00	3.00
	0.50	2.50
	0.25	1.50
	0.125	1.00

5. CONCLUSION

The result of this present study showed that *A. sativum* juice has high range of antibacterial potential against both gram positive (*C. bacillus, S. epidemidis* and *S. viridans*) and gram negative bacteria (*E. coli* and *S. typhi*). However, the extract has a greater inhibitory activity against gram positive bacteria than gram negative bacteria.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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