Volume: 4 **Issue: 1**
Year: 2023
DOI: 10.53811/ijtcmr.1249215

International Journal of Traditional and Complementary Medicine Research

Publisher
Duzce University

ORIGINAL RESEARCH

Investigating the Astonishing Antimicrobial Potential of Papaya seeds against *Salmonella* spp and *Candida albicans*

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Received: 08.02.2023 Accepted: 27.03.2023

Abstract
Objective: This study focused on the in vitro antibacterial efficacy of papaya seed ethanolic and aqueous extracts against *Salmonella* spp. and *Candida albicans*.
Material-Method: Dry seeds of *Carica papaya* were extracted with ethanol and hot water and tested for antimicrobial activity against *Salmonella* spp and *Candida albicans* using agar well diffusion method on Muller Hilton agar.
Results: The study found that the extracts worked better against *Salmonella* spp than *Candida albicans*, however, ethanol extract was stronger against the isolates with inhibition zone diameter (IZD) ranging from 10 mm to 32 mm, compared to the aqueous extract which only had 4 mm to 9 mm zones at certain concentrations.
Conclusion: The activity of *Carica papaya* seed extracts demonstrates that the seeds are as significant as other parts of the plant and provides a scientific basis for the seeds' use in the treatment of many ailments in the local community. The extracts were more effective against *Salmonella* spp., with the ethanol extract having the highest antibacterial activity, indicating that the components of papaya seeds are more soluble in organic solvents and had stronger bactericidal characteristics. As a result, extensive analyses of the bioactive chemicals in *Carica papaya* seeds and their modes of action are required to present a full picture.
Keywords: Antimicrobial Effects, Power of Papaya Seeds, Plant Medicine, Plant Waste

INTRODUCTION

Medicinal plants are abundant sources of diverse secondary metabolites, such as tannins, terpenoids, alkaloids, and flavonoids, which have been shown to possess antimicrobial properties in vitro. In light of the increasing side effects associated with synthetic drugs, experts have refocused their attention on the potential benefits of medicinal plants[1]. With the emergence of new and drug-resistant diseases affecting both humans and animals, the limited effectiveness of antibiotics and other conventional drugs has highlighted the urgent need for alternative therapies. The antibacterial effects of certain plant extracts can be profound and effective against resistant infectious pathogens when used in combination. Several studies have demonstrated the potential of herbal medicines as safe, effective, and cost-efficient alternatives to conventional drugs for treating certain bacterial infections.[2]

The *Carica papaya* plant is a tropical plant that has many pharmacological activities and is rich in nutrients such as vitamins C, A, and E, minerals magnesium and potassium, pantothenic acid, folate, and fiber.[3-4] It has been extensively studied and its various parts, including the flesh, pulp, root, leaves, and stems, have been shown to have medicinal properties.[5-6] The leaves and flowers of *Carica papaya* have antioxidant and antibacterial properties against *Salmonella typhi*, *Klebsiella pneumonia*, and *Bacillus subtilis*.[7-9] The plant has also been found to have additional medicinal uses, including anticancer, reducing hepatotoxicity, anti-amoebic, hypoglycemic, anti-fertility, and anti malarial activities.[5-12]

Although the seeds of the *Carica papaya* plant are

typically discarded, they have been found to have bacteriostatic activity against gram-positive and negative organisms and could be useful in treating chronic skin ulcers.[13] However, there are only a few reports on antibacterial activities from *Carica papaya* seeds.[14-16] Therefore, it is important to study the in vitro antibiotic activity of ethanolic and aqueous extracts of papaya seeds against *Salmonella* spp and *Candida albicans* to provide more scientifically proven information on the antibacterial activity of this plant. This will help pharmacies and the general public understand the importance of consuming papaya seeds instead of treating them as waste.

MATERIALS AND METHODS

Collection and identification of plant materials

The seeds of *Carica papaya* were obtained from fresh pulp of Papaya fruit obtained from Modern Market Lafia, Nasarawa State, Nigeria. *Carica papaya* seeds were oven-dried at 65^{o}C for 1 hour and crushed with a sterile mortar and pestle to form a coarse powder. The powder was collected in an air tight container and stored in a cool, dry place, away from sunlight[17]. The ethanol and aqueous extract of the seed was carried out. A measure of, 10 grams, 7.5 grams, 5 grams, and 2grams respectively of the extract concentrate was reconstituted in 10 ml of sterile distilled water to obtain solution of different concentrations (100% , 75%, 50% and 20%) used for the antimicrobial screening.[18]

Preparation of media

The media used include Nutrient agar (Oxoid^{TM}) and Potato Dextrose Agar (Oxoid^{TM}) for the maintenance of the test isolates, Nutrient broth (Oxoid^{TM}) for broth culture and Muller Hilton agar (Oxoid^{TM}) for the antimicrobial assay. The media were prepared according to manufacturer's specifications.

Test organisms

The test organisms were collected from the stock cultures of the Medical Microbiology and Parasitology Department, Dalhatru Alhraf Specialist Hospital. The isolates include *Salmonella* spp and *Candida albicans*. Broth culture of the test organisms were prepared by plating the organism in test tube containing 10 mL of nutrient broth and this was incubated at 37^{o}C for three (3) hours prior to the time for antimicrobial test.[19]

Antibacterial screening

The agar well diffusion method established by[20] was used to conduct the antibacterial susceptibility test. A 3-hour-old broth culture of each isolate was swabbed onto the surface of solidified Muller-Hinton agar with even coverage over the entire agar. After drying for five minutes, extract solutions were introduced into wells created in each appropriately labeled petri-dish using a sterile micropipette. To determine the sensitivity of the isolates, commercial antimicrobials (gentamicin and fluconazole) were used as controls. The plates were then incubated at 37°C for 24 hours. The zone of inhibition diameter (IZD) observed was measured using a metric ruler, reported in millimeters (mm), and compared to the gold standard. The results were reported as either resistant or sensitive.

Statistical data

Data obtained was analyzed using Microsoft Excel programme and presented in charts to visualize the impact of the extracts on the different pathogenic microorganism.

RESULTS AND DISCUSSION

In this study, the dried seeds of the *Carica papaya* seeds were tested for their antimicrobial properties against *Salmonella* spp and *Candida albicans*. The seeds were extracted using ethanol and hot water and the results showed that the ethanol extract had weak antimicrobial effects against *C. albicans* with an inhibition zone diameter of 10 mm and 6 mm (Figure 1) compared to the control that had IZD as high as 43 mm. The aqueous extract had no antibacterial effect. These findings are similar to previous studies that also found low antifungal activity against *C. albicans* in papaya seed extract, bacang mango leaf extract, and the combination of red betel leaf and avocado seed extract.[21-23] The antimicrobial properties of papaya seeds may stem from the presence of chemical compounds such as benzyl isothiocyanate which has been found to exhibit antibacterial activity against different strains of bacteria like *Salmonella typhi* and *Staphylococcus aureus*.[24] Other compounds present in papaya seeds, such as carpaine and pseudocarpaine, have also demonstrated antimicrobial activity against various strains of bacteria and fungi.[25-27]

On the other hand, the ethanol extract showed stronger antibacterial activity against *Salmonella* spp than the aqueous extract but lower than gentamycin (control) (Figure 2). The inhibition zone diameter of the ethanol extract increased from 10 mm to 32 mm with an increase in concentration, while the aqueous extract only had IZD of 4 mm and 9 mm at 75% and 100% concentration. This suggests that the components of *Carica papaya* seeds are more readily soluble in ethanol than in water, which aligns with previous findings that ethanol extracts of papaya leaves and stem were found to be more effective against bacteria than aqueous extracts.[9]

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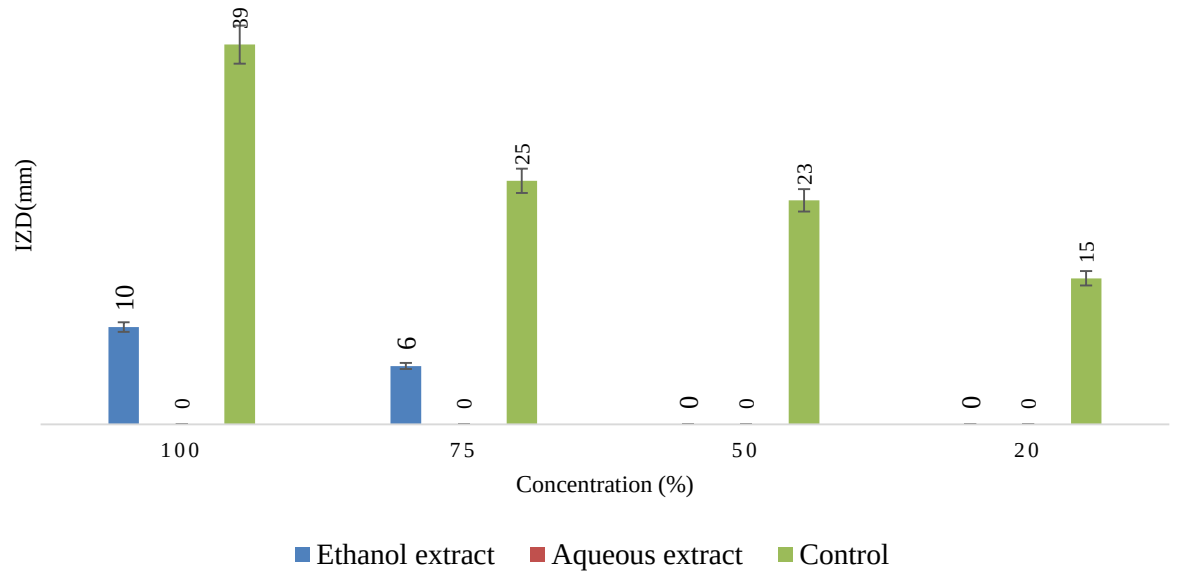

Figure 1. Antibacterial activity of *Carica papaya* seeds on *Candida albicans* showing its inhibition zone diameter, IZD (mm).

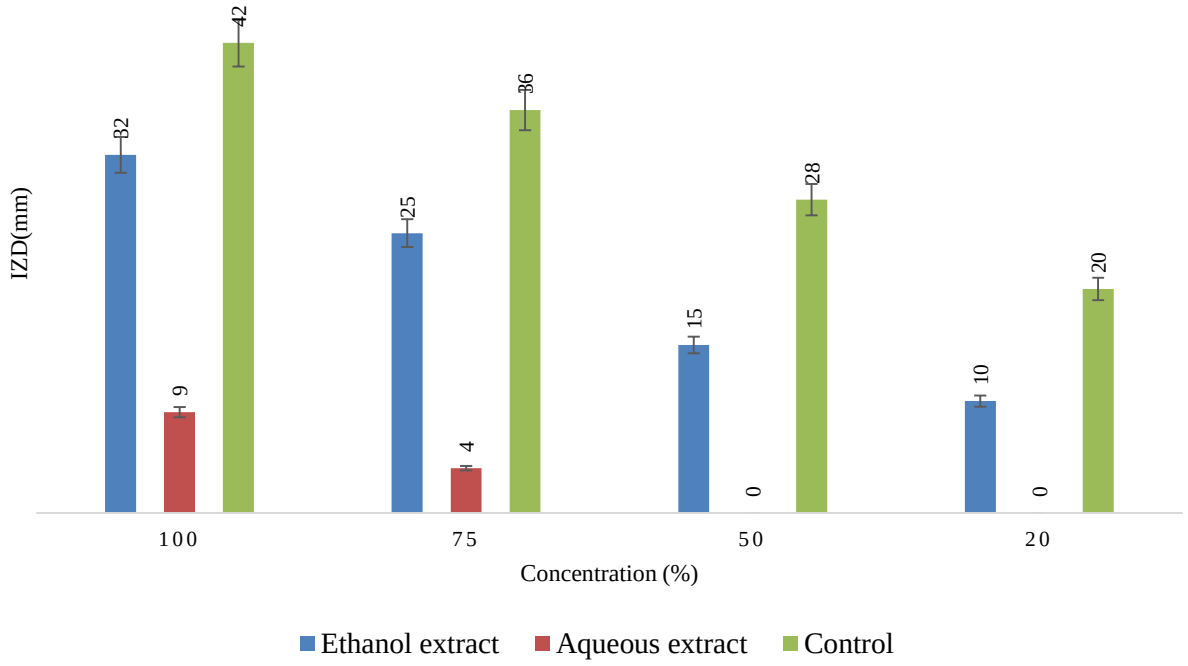

Figure 2: Antibacterial activity of *Carica papaya* seeds on *Salmonella* spp showing its inhibition zone diameter, IZD (mm).

The results of this study indicate the potential antimicrobial efficacy of *Carica papaya* seeds against *Salmonella* spp and *Candida albicans*, however, the small sample size may limit the generalizability of the findings to other microorganisms. The underlying mechanism of the antibacterial activity is not elucidated in this study, and additional research is necessary to shed light on this matter.

CONCLUSION

Carica papaya seed extract activity reveals that the seeds are as important as other parts of the plant and

provides a scientific foundation for the seeds' use in the treatment of many ailments in the local community. The extracts were more efficient against *Salmonella* spp., with the ethanol extract having the higher antimicrobial activity, showing that papaya seed components are more soluble in organic solvents and had better bactericidal properties. As a result, in order to offer a complete picture, thorough investigations of the bioactive compounds in *Carica papaya* seeds and their modes of action are required.

Disclosure Statement: The authors have no conflicts of interest to declare.
Author contributions: Conceptualization: Emmanuel, O., Daniel, A and Peace, O. Design: Writing and Investigation/Data collection: Emmanuel, O.
Conflict of Interest: There is no potential conflict of interest relevant to this article.
Funding: No financial support.

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