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Antifungal Activity of Plantain Peel (*Musa paradisiaca* L.) on *Aspergillus tamarii* and *Monascus ruber*: An *in vitro* Study

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ABSTRACT

Background and Objective: Plantains are frequently used due to their nutritional and therapeutic properties. Using the percentage inhibition test, the effects of plantain (*Musa paradisiaca* L.) peel extract on *Aspergillus tamarii* and *Monascus ruber* strains were examined. **Materials and Methods:** *Aspergillus tamarii* and *Monascus ruber* strains were obtained from Shoe Leather samples kept in the open air (under cold conditions) for 2 months to be exposed to microorganisms and a loaf of bread purchased from a roadside vendor in Port Harcourt, Rivers State in September, 2023. After making the plantain peel extract, the well agar diffusion method was used to measure its antibacterial activity and the serial broth dilution method was used to determine its minimum inhibitory concentration. **Results:** When 60 mg/mL of stalk extract was used, *Aspergillus tamarii* and *Monascus ruber* strains showed complete (100%) growth suppression. Growth inhibition decreases with concentration up to the minimal inhibitory concentration. The work's findings support the notion that plantain extracts can stop and even eradicate the growth of rotting fungi, suggesting that the extract, when taken in the right amounts, can be used to both treat and preserve food. **Conclusion:** The findings provide more evidence to support the hypothesis that plantain peel extract, which was employed as the solvent to extract the active components, had antifungal activity. From the results of the study, it is suggested that the extract of plantain peel has antimicrobial activity against *Aspergillus tamarii* and *Monascus ruber* strains and that the extract may be used to control plant diseases.

KEYWORDS

Musa paradisiaca, *Aspergillus tamari*, *Monascus ruber*, plantain, peel, extract, antifungal

INTRODUCTION

Plantain (*Musa paradisiaca*) is an important staple food for rural and urban consumers in Nigeria and[1], it is consumed as an energy-giving food. There have been reports of medicinal uses for the plant's leaves, roots, and flowers, among other parts. For instance, cuts, insect bites, and newly opened wounds are all treated with leaf juice[2]. The plant's sap has been used as a cure for Hysteria, Epilepsy, Dysentery, and Diarrhea; the leaves, on the other hand, have been utilized as anthelmintic, astringent, and mild laxatives[3,4]. Anaemia and sexually transmitted infections have been treated with a cold infusion of the roots.

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According to reports, plantains are abundant in fiber, which helps to prevent colon cancer by decreasing cholesterol and relieving constipation. Traditional healers in Nigeria treat Typhoid fever, Malaria, Diarrhea, Ulcers, and Stomach aches with a plantain decoction[5,6]. Okorondu *et al.*[7] have documented the antifungal characteristics of *M. Paradisiaca's* peel and stalk extracts. The leaf extract's effectiveness against *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

In ancient times, plants have been used for medicinal purposes in the treatment of various diseases worldwide[8]. Many traditional plants and plant-based products have demonstrated pathogen-fighting antimicrobial properties. Given all of the above, the purpose of this study was to examine the antifungal qualities of unripe *Musa paradisiaca* peels.

MATERIALS AND METHODS

Collection of samples and preparation: This research was carried out from 17th January, 2020 to 17th September, 2021. Fresh fingers of plantain fruits were collected from a garden located University of Port Harcourt, Choba Port Harcourt, Nigeria at the lecturers' residential quarters. The fungi that were utilized as test organisms *Aspergillus tamarii* and *Monascus ruber*, were regularly isolated from Shoe Leather and stale loaves of bread, and it is believed that they are mostly to blame for the spoiling of leather and bread that have been stored. They were subcultured onto Sabouraud dextrose agar and verified as pure isolates before being utilized. The peels were properly chopped and dried in an aluminum tray using a moisture extraction oven at 60°C for 72 hrs and packed into a sterile Ziploc bag to avoid contamination. The dry peels were ground separately in a laboratory locally manufactured mill and passed through a 1 mm sieve, packed into a sterile glass jar, and tightly screwed.

Extract preparation from plantain peels: The 50 g each of the ground samples of *M. paradisiaca* peel was weighed into separate sterile bottles. The solvent used for extraction was ethanol. The ethanol extract of the weighed-out samples was prepared by soaking in 250 mL each of ethanol for 48 hrs, during which the mixtures were intermittently shaken. They were later filtered using sterile filter paper.

Incubation of fungi: A total of 12 slants (sample bottles containing SDA media) were prepared, 2 for each fungi growth. They were sealed with cling film, labeled, and incubated at room temperature (27±2°C) and left for about 7 days to allow colony growth, and any contaminated slant was removed.

Fungal susceptibility testing: A modified agar well diffusion technique[9] was employed to conduct this experiment. The chilled nutritional agar media was aseptically put into each Petri plate and gently stirred to combine. The plates were allowed to be set before creating wells using a sterilized cork. Different quantities of the extract diluted with water were placed into various wells and marked accordingly. Portions of the fungus growing on SDA were gathered using a sterile inoculation loop and equally distributed among the wells drilled in the Petri plates with various extract concentrations. Controls were Petri plates with SDA but no extracts. Each treatment was replicated for the other fungus. Radial growth was assessed using a metric rule in both extract-treated and control groups. Radial growth was analyzed for both extract-treated and control samples to investigate the influence of *Musa paradisiaca* peel and stalk extract on the growth of fungi. Radial fungal growth reduction was represented as a percentage when compared to the control.

Minimum inhibitory concentration (MIC): A modified method[7] was used to perform MIC. A portion of the extract (0.2 g) was diluted in 10 mL of sterile distilled water, yielding a concentration of 60.0 mg/mL. This 60 mg/mL concentration was double-diluted in sterile distilled water to provide 30, 15, 7.5, and 3.75 mg/mL. The 1 mL of each concentration of the extract was added to the wells, and the process was performed again for the other fungus. This was let sit there for four days and inspected for the growth of fungi. The minimal inhibitory concentration was calculated by taking the most minimal concentration of the extract that prevented fungus growth. Plates without extracts from experiments were used as controls.

RESULTS

Effects of *Musa paradisiaca* peel extract on the isolates on *Monascus ruber* strain: The growth inhibition (percentage) of *Monascus ruber* strain treated with different concentrations of plantain peel ethanol extract is shown in Table 1. Results show that the radial growth of *Monascus ruber* strain in culture was suppressed as compared to the control experiment. It was also observed that as the concentration of the extract reduces, the percentage inhibition reduces also up to a minimum inhibitory concentration. The minimum inhibitory concentration is presented in Table 1. The ethanol extract of *Musa paradisiaca* peel showed significant growth inhibition of the *Monascus ruber* strain in a dose-dependent manner. At the highest concentration (60 mg/mL), complete inhibition (100%) was observed, while at lower concentrations, the inhibition decreased. At 30 mg/mL, 85.33% inhibition was recorded, 69% at 15 mg/mL, and 43.35% at 7.5 mg/mL. No inhibition was observed at 3.75 mg/mL, indicating the lower concentrations were ineffective in inhibiting growth.

Effects of *Musa paradisiaca* peel extract on the isolates of *Aspergillus tamarii*: The growth inhibition (percentage) of *Aspergillus tamarii* treated with different concentrations of plantain peel ethanol extract is shown in Table 2. The result shows that the radial growth of *Aspergillus tamarii* in culture was suppressed as compared to the control experiment.

Additionally, it was noted that, up to a certain inhibitory dose, the percentage inhibition decreases as the extract concentration does. Table 2 displays the minimal inhibitory concentration.

The ethanol extract of *Musa paradisiaca* peel demonstrated a significant inhibitory effect on *Aspergillus tamarii* growth. At the highest concentration (60 mg/mL), complete growth inhibition (100%) was observed. At lower concentrations, the inhibition decreased, with 58.41% at 30 mg/mL, 33.33% at 15 mg/mL, and no inhibition at concentrations below 15 mg/mL. These findings suggest that the extract's efficacy in inhibiting fungal growth is dose-dependent.

The ethanol extract of *Musa paradisiaca* peel demonstrated varying levels of antimicrobial activity against the tested fungal strains. The minimum inhibitory concentration (MIC) for *Aspergillus tamarii* was 7.5 mg/ml, while for *Monascus ruber* strain, it was 3.75 mg/mL. These results indicate that *Monascus ruber* strain is more susceptible to the ethanol extract than *Aspergillus tamarii* shown in Table 3.

Table 1: Growth inhibition of *Monascus ruber* strain by the ethanol extract of *Musa paradisiaca* peel in percentage

Isolates	Concentration of extract (mg/mL)				
	60	30	15	7.5	3.75
Control	0	0	0	0	0
Monascus ruber strain	100	85.33	69.00	43.35	0.00

Table 2: Growth inhibition of *Aspergillus tamarii* by the ethanol extract of *Musa paradisiaca* peel in percentage

Isolates	Concentration of extract (mg/mL)				
	60	30	15	7.5	3.75
Control	0	0	0	0	0
Aspergillus tamarii	100	58.41	33.33	0.00	

Table 3: Minimum inhibitory concentrations of the ethanol extract of *Musa paradisiaca* peel on *Aspergillus tamarii* and *Monascus ruber* strain

Isolates	Solvent extract (mg/mL) ethanol
Aspergillus tamarii	7.5
Monascus ruber strain	3.75

DISCUSSION

Ethanol extract from the peel of *Musa paradisiaca* prevented the *Monascus ruber* strain and *Aspergillus tamarii* from growing. As the plant extract concentration drops below the minimum inhibitory concentration (MIC), the percentage of test fungal growth inhibition decreases. According to this study, the ethanol extract from the peel of *Musa paradisiaca* inhibited the development of the strains of *Aspergillus tamarii* and *Monascus ruber*, indicating the existence of an antifungal component in the plant tissue.

Aspergillus tamarii which was isolated from decaying leather shows that this organism is a major cause of decay in leathers. *Musa paradisiaca* peel ethanol extract was used in this study to inhibit the growth of this fungus. This further proves that *M. paradisiaca* peel ethanol extract can be used to protect the leather from decay. This is also true for the other organism (*Monascus ruber* strain) used in this study which was isolated from bread. *Musa paradisiaca* peel ethanol extract can be added to loaves of bread to increase their shelf life.

Plant-derived antimicrobials have been shown to have minimal side effects and substantial therapeutic promise for the treatment of a wide range of infectious diseases[10].

Therefore, the addition of this plant extract to drugs can also help in treating fungal diseases. The use of chemicals to protect leathers and increase the shelf life of drugs may have adverse effects on the environment and not safe for consumption by man or animals.

The benefits of using plant extract to control plant diseases are its pathogenic specificity, biodegradability, affordability, accessibility, and environmental friendliness. Chemical analysis of regional medicinal plants offer important hints for the discovery and creation of novel medications[6]. Alkaloids and flavonoids have been linked to the antimicrobial qualities of plant extract[11]. It has been discovered that bitter-tasting phytochemicals including flavonoids and alkaloids have antibacterial qualities. These plant extracts' antifungal qualities were facilitated by the presence of beneficial phytochemicals such as flavonoids, alkaloids, tannins, and saponin[12,13].

The study by Okorondu *et al*.[7] on *Musa paradisiaca* peel and even stalk extracts using methanol as a solvent also prove that *Musa paradisiaca* has great antifungal properties. These studies showed that *Musa paradisiaca* peel and stalk extracts inhibited the growths of *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella typhi*.

CONCLUSION

It was concluded that the plant extract was able to inhibit and kill the growth of these spoilage fungi and this implies that the extract can be used to protect leathers against decay and increase the shelf life of drugs. The results obtained in this work further claim that *Musa paradisiaca* peel extract demonstrated antifungal action. The growth of *Aspergillus tamarii* and *Monascus ruber* strain in culture was suppressed by the ethanol peel extract tested when compared with the control experiment. It was also shown that inhibition reduced as the concentration of extract reduced.

SIGNIFICANCE STATEMENT

This groundbreaking study unequivocally demonstrates the potent antifungal properties of plantain peel extract, showcasing its remarkable ability to completely inhibit the growth of *Aspergillus tamarii* and *Monascus ruber* strains. These findings have far-reaching implications, positioning plantain peel extract as a highly promising, eco-friendly, and cost-effective solution for controlling fungal diseases, preserving food, and promoting sustainable agricultural practices.

REFERENCES

1. Ighodaro, O.M., 2012. Evaluation study on Nigerian species of *Musa paradisiaca* peels: Phytochemical screening, proximate analysis, mineral composition and antimicrobial activities. Researcher, 4: 17-20.
2. Onyenekwe, P.C., O.E. Okereke and S.O. Owolewa, 2013. Phytochemical screening and effect of *Musa paradisiaca* stem extrude on rat haematological parameters. Curr. Res. J. Biol. Sci., 5: 26-29.
3. Sofowora, A., E. Ogunbodede and A. Onayade, 2013. The role and place of medicinal plants in the strategies for disease prevention. Afr. J. Tradit. Complementary Altern. Med., 10: 210-229.
4. Okareh, O.T., A.T. Adeolu and O.T. Adepoju, 2015. Proximate and mineral composition of plantain (*Musa paradisiaca*) wastes flour; a potential nutrients source in the formulation of animal feeds. Afr. J. Food Sci. Technol., 6: 53-57.
5. Okigbo, R.N. and O.D. Omodamiro, 2007. Antimicrobial effect of leaf extracts of pigeon pea (*Cajanus cajan* (L.) Millsp.) on some human pathogens. J. Herbs Spices Med. Plants, 12: 117-127.
6. Pereira, R.S., F.C.P. Santos, P.R.V. Campana, V.V. Costa and R.M. de Pádua *et al*., 2023. Natural products and derivatives as potential *Zika virus* inhibitors: A comprehensive review. Viruses, Vol. 15. 10.3390/v15051211.
7. Okorondu, S.I., C.O. Akujobi and I.N. Nwachukwu, 2012. Antifungal properties of *Musa paradisiaca* (Plantain) peel and stalk extracts. Int. J. Biol. Chem. Sci., 6: 1527-1534.
8. Salmerón-Manzano, E., J.A. Garrido-Cardenas and F. Manzano-Agugliaro, 2020. Worldwide research trends on medicinal plants. Int. J. Environ. Res. Public Health, Vol. 17. 10.3390/ijerph17103376.
9. Balouiri, M., M. Sadiki and S.K. Ibnsouda, 2016. Methods for *in vitro* evaluating antimicrobial activity: A review. J. Pharm. Anal., 6: 71-79.
10. Angelini, P., 2024. Plant-derived antimicrobials and their crucial role in combating antimicrobial resistance. Antibiotics, Vol. 13. 10.3390/antibiotics13080746.
11. Cushnie, T.P.T. and A.J. Lamb, 2005. Antimicrobial activity of flavonoids. Int. J. Antimicrob. Agents, 26: 343-356.
12. Das, A. and R. Ruhal, 2025. Potential of plants-based alkaloids, terpenoids and flavonoids as antibacterial agents: An update. Process Biochem., 150: 94-120.
13. Karuppiah, P. and M. Mustaffa, 2013. Antibacterial and antioxidant activities of *Musa* sp. leaf extracts against multidrug resistant clinical pathogens causing nosocomial infection. Asian Pac. J. Trop. Biomed., 3: 737-742.