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EXPLORING THE ANTIMICROBIAL POTENTIAL OF ACTINOMYCES: A STUDY ON ANTIBACTERIAL AND ANTIFUNGAL PROPERTIES

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ABSTRACT

The increasing prevalence of antibiotic-resistant pathogens has intensified the search for novel antimicrobial agents. Actinomyces, a genus of filamentous, Gram-positive bacteria, has been recognized for its potential in producing bioactive compounds. This study investigates the antibacterial and antifungal activities of Actinomyces isolates, aiming to identify promising candidates for therapeutic applications.

Keywords: Actinomyces, antimicrobial activity, antibacterial, antifungal, bioactive compounds

1. INTRODUCTION

The growing threat of antimicrobial resistance (AMR) has necessitated the exploration of novel bioactive compounds with potent antibacterial and antifungal properties. Among the diverse microbial taxa known for their secondary metabolite production, the genus Actinomyces has garnered significant attention due to its prolific ability to synthesize bioactive compounds. Actinomyces, a genus of Gram-positive, filamentous bacteria, primarily inhabits soil and mucosal membranes of humans and animals. These microorganisms play an essential role in natural ecosystems by contributing to the decomposition of organic matter and promoting soil health. However, their significance extends beyond ecological functions, as they have emerged as promising sources of antimicrobial agents.

Historically, actinomycetes, particularly the genus Streptomyces, have been the cornerstone of antibiotic discovery, yielding clinically important compounds such as streptomycin, tetracycline, and erythromycin. While Streptomyces has been extensively studied, the genus Actinomyces remains relatively underexplored in the context of antimicrobial compound production. Recent studies suggest that Actinomyces species possess unique biosynthetic pathways that may lead to the discovery of novel antibiotics and antifungal agents. This potential is especially critical in the current landscape of rising multidrug-resistant (MDR) bacterial and fungal pathogens.

The antibacterial properties of Actinomyces are attributed to its production of diverse secondary metabolites, including polyketides, nonribosomal peptides, and other bioactive compounds. These metabolites exhibit a broad spectrum of activity against both Gram-positive and Gram-negative bacteria, often targeting essential cellular processes such as protein synthesis, cell wall biosynthesis, and DNA replication. In addition to antibacterial agents,

Actinomyces has demonstrated antifungal potential, producing compounds that inhibit fungal growth by disrupting cell membrane integrity or interfering with ergosterol biosynthesis.

The search for new antimicrobial agents from Actinomyces is driven not only by the need to combat AMR but also by the expanding understanding of microbial ecology and the role of symbiotic interactions. Certain Actinomyces strains have been found in symbiotic relationships with plants, insects, and marine organisms, where they provide protective antimicrobial compounds against pathogenic invaders. Such ecological insights open new avenues for isolating and characterizing bioactive metabolites with potential therapeutic applications.

Despite the promising antimicrobial potential of Actinomyces, several challenges hinder its full exploration. The complex and often slow-growing nature of these bacteria, coupled with difficulties in culturing specific strains, poses significant barriers to research. Advances in metagenomics, genome mining, and synthetic biology offer new tools to overcome these challenges, enabling the identification and production of novel antimicrobial compounds from Actinomyces.

This study aims to explore the antibacterial and antifungal properties of Actinomyces species, focusing on the isolation, characterization, and bioactivity assessment of their secondary metabolites. By expanding our knowledge of Actinomyces and its antimicrobial potential, this research contributes to the ongoing efforts to discover new and effective agents to address the global AMR crisis.

The global rise in antimicrobial resistance poses a significant challenge to public health. Natural products, particularly those derived from actinomycetes, have historically been a rich source of antibiotics. Actinomyces, a lesser-explored genus within the actinomycetes group, has shown potential for producing diverse bioactive compounds. This research focuses on exploring the antimicrobial properties of Actinomyces against selected bacterial and fungal pathogens.

2. MATERIALS AND METHODS

2.1. Isolation of Actinomyces

Soil samples were collected from diverse environments and subjected to serial dilution and plating on selective media to isolate Actinomyces strains. Morphological and biochemical tests were performed for preliminary identification.

2.2. Cultivation and Extraction of Bioactive Compounds Isolated strains were cultured in ISP-2 broth for 7–10 days under controlled conditions. Post-incubation, cultures were centrifuged, and bioactive compounds were extracted using ethyl acetate.

2.3. Antibacterial Activity Assay

The antibacterial potential was assessed using the agar well diffusion method against Gram-positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) bacteria. Zones of inhibition were measured to evaluate efficacy.

2.4. Antifungal Activity Assay Antifungal activity was tested against Candida albicans and Aspergillus niger using the disc diffusion method. Inhibition zones were recorded post 48-hour incubation.

2.5. Minimum Inhibitory Concentration (MIC)MIC values were determined using the broth microdilution method for both antibacterial and antifungal assays to quantify the potency of the extracts.

3. Results

3.1. Isolation and Identification

A total of 15 Actinomyces strains were isolated. Morphological and biochemical analyses confirmed the identity of the isolates.

3.2. Antibacterial Activity

Out of 15 isolates, 9 exhibited significant antibacterial activity, with inhibition zones ranging from 12 mm to 20 mm. The most potent isolate demonstrated activity against both S. aureus and E. coli.

3.3. Antifungal Activity

Seven isolates showed antifungal activity. Inhibition zones against C. albicans ranged from 10 mm to 18 mm, while those against A. niger ranged from 8 mm to 16 mm.

3.4. MIC Determination

The MIC values for the most active extracts ranged between 8 µg/mL and 32 µg/mL for bacterial strains and 16 µg/mL to 64 µg/mL for fungal strains.

4. DISCUSSION

The study highlights the antimicrobial potential of Actinomyces isolates, emphasizing their ability to produce bioactive compounds effective against both bacterial and fungal pathogens. The broad-spectrum activity observed suggests the presence of novel antimicrobial agents that warrant further chemical characterization and pharmacological evaluation.

5. CONCLUSION

Actinomyces strains demonstrate significant antibacterial and antifungal activities, positioning them as promising candidates for the development of new antimicrobial agents. Future studies focusing on compound purification and mechanism of action will be crucial in harnessing their full therapeutic potential.

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