OPEN ACCESS Freely available online

Mycobacterial Diseases

ISSN: 2161-1068

Commentary

Natural Products as Emerging Anti-Mycobacterial Agents

Sooki Dulcie*

Deapartment of Drug Resistance, Griffith University, Brisbane, Australia

DESCRIPTION

The increasing incidence of Multidrug-Resistant (MDR) and Extensively Dug-Resistant (XDR) strains of *Mycobacterium tuberculosis (M. tb)* has intensified the need for novel therapeutic strategies. Natural products, derived from plants, fungi, bacteria, and marine organisms, have long been a rich source of anti-mycobacterial agents, offering diverse chemical scaffolds and unique mechanisms of action that can be leveraged to combat TB. This article explores some of the promising natural anti-mycobacterial compounds and their mechanisms of action. Several natural compounds, including alkaloids, terpenoids, flavonoids, and peptides, have shown potential in inhibiting *M. tb*. These compounds often target crucial bacterial processes such as cell wall synthesis, protein synthesis, and energy metabolism. Continued research into these natural products may lead to the development of new drugs that can effectively combat MDR and XDR TB.

Plant-derived anti-mycobacterial compounds

Plants have been a treasure trove of biologically active compounds with anti-mycobacterial properties. Many traditional medicines for TB are plant-based, with various phytochemicals exhibiting potential as modern anti-mycobacterial agents.

Terpenoids: These are a class of natural products found abundantly in plants and have shown promising anti-TB activity. Examples include ursolic acid, oleanolic acid, and lupeol. Terpenoids typically disrupt the mycobacterial cell wall, a important structure for bacterial survival. Their lipophilic nature allows them to interact with and permeabilize the waxy lipid-rich outer layer of the mycobacterial cell wall, leading to cell lysis and death.

Alkaloids: Alkaloids like berberine, found in *Berberis* species, exhibit potent activity against mycobacteria. Berberine targets DNA and RNA synthesis, leading to growth inhibition of *M. tb*. Its ability to disrupt nucleic acid metabolism makes it a valuable candidate for TB treatment, especially in cases of drug resistance.

Flavonoids: Found in various plants, flavonoids such as quercetin and catechins possess anti-mycobacterial activity. These compounds are known to inhibit key enzymes involved in the survival of mycobacteria, such as enoyl-ACP reductase (InhA), which is important for the biosynthesis of mycolic acid, a major component of the mycobacterial cell wall.

Bacterial and fungal natural products

Soil-dwelling bacteria and fungi are prolific producers of secondary metabolites with potent anti-mycobacterial activity.

Rifamycins: One of the most well-known examples of bacterial-derived anti-mycobacterial compounds is rifampicin, which belongs to the rifamycin class. Derived from the bacterium *Amycolatopsis rifamycinica*, rifampicin inhibits DNA-dependent RNA polymerase in *M. tb*, preventing transcription and bacterial replication. The success of rifampicin has inspired the search for other bacterial metabolites that may overcome resistance.

Lantibiotics: These are a class of peptide antibiotics produced by various strains of *Lactococcus* and *Bacillus*. Lantibiotics exhibit a unique mechanism of action by binding to bacterial cell membrane lipids, forming pores that lead to cell leakage and death. Some lantibiotics have been shown to inhibit Mycobacterium species, making them candidates for further exploration.

Macrolides: Another class of bacterial natural products with anti-mycobacterial activity is the macrolides, which include clarithromycin. These compounds inhibit protein synthesis by binding to the 50S subunit of the bacterial ribosome, effectively halting mycobacterial growth.

Marine natural products

The ocean is a largely untapped source of bioactive compounds with anti-mycobacterial potential. Marine sponges, algae, and bacteria have yielded a variety of natural products with unique mechanisms of action.

Manzamines: These are marine alkaloids isolated from sponges that have demonstrated significant activity against *Mycobacterium tuberculosis*. Manzamines disrupt the mitochondrial function of the bacterium, leading to the generation of Reactive Oxygen Species (ROS) and subsequent bacterial cell death.

Correspondence to: Sooki Dulcie, Deapartment of Drug Resistance, Griffith University, Brisbane, Australia, Email: sookduc@gmail.com

Received: 03-Jul-2024, Manuscript No. MDTL-24-33706; **Editor assigned:** 05-Jul-2024, PreQC No. MDTL-24-33706 (PQ); **Reviewed:** 19-Jul-2024, QC No. MDTL-24-33706; **Revised:** 26-Jul-2024, Manuscript No. MDTL-24-33706 (R); **Published:** 02-Aug-2024, DOI: 10.35248/2161-1068.24.14.493.

Citation: Dulcie S (2024). Natural Products as Emerging Anti-Mycobacterial Agents. Mycobact Dis.14:493.

Latrunculins: Another marine-derived compound class, latrunculins, has shown activity against mycobacteria by disrupting the bacterial actin cytoskeleton, a structure essential for cell division and maintenance.

Mechanisms of action

Understanding the mechanisms of action of natural anti-mycobacterial products is essential for the development of new TB therapies. Common mechanisms include, many natural compounds, particularly those derived from plants, target the unique mycobacterial cell wall, which is composed of mycolic acids, arabinogalactan, and peptidoglycan. By inhibiting enzymes involved in cell wall biosynthesis or directly damaging the membrane, these compounds compromise the integrity of the mycobacterial cell, leading to cell death. Several bacterial natural products, such as macrolides, inhibit ribosomal function, preventing protein synthesis. This halts bacterial growth and ultimately leads to cell death. DNA/RNA synthesis inhibition compounds like berberine interfere with nucleic acid synthesis, a important process for bacterial replication.

CONCLUSION

Natural products continue to offer potential leads in the development of new anti-mycobacterial drugs. These compounds, with their diverse chemical structures and novel mechanisms of action, provide hope for overcoming the challenges posed by drug-resistant strains of *Mycobacterium tuberculosis*. Continued exploration of plant, microbial, and marine sources may yield the next generation of therapies that can complement existing treatments and help reduce the global burden of tuberculosis. This mechanism is particularly useful against rapidly dividing mycobacteria. Certain marine-derived compounds, like manzamines, induce oxidative stress in mycobacteria by disrupting mitochondrial function, leading to the accumulation of toxic ROS that damage cellular components.