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Mini Review

Microbial Lipopeptides' Ecological Applications

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Abstract

Secondary metabolites known as Lipopeptides (LPs) are produced by a wide variety of bacteria and fungi. Their interesting compound construction includes both a peptide and a lipid moiety. LPs are of major biotechnological interest attributable to their emulsification, antitumor, immune modulatory and antimicrobial exercises. Until this point in time, these adaptable mixtures have been applied across numerous businesses, from drugs through to food handling, beauty care products, horticulture, weighty metal, and hydrocarbon bioremediation. Both the variety of environments from which LP producing microorganisms have been isolated and the variety of LP structures suggest that these microorganisms play important roles in their natural environment. However, we have a limited understanding of LPs' ecological function. The mode of action and the role of LPs in motility, antimicrobial activity, the removal of heavy metals, and biofilm formation are discussed in this review. The need to distinguish LPs from a variety of microorganisms is discussed, with a focus on taxa that live in "extreme" environments. In order to learn more about how LPs and cell membranes interact, we show how powerful computational target fishing and molecular dynamics simulations can be. Together, these advancements will give us a better understanding of how novel LPs work and what their roles are in the natural environment.

Keywords: Lipopeptides, Immune modulatory, Antimicrobial, Hydrocarbon, Bioremediation, Biofilm

INTRODUCTION

Amphiphilic molecules like microbial Lipopeptides (LPs) have both polar and apolar moiety structures. The apolar moiety is a linear or branched fatty acid with various lengths and degrees of oxidation, while the polar moiety is a cyclic peptide. Several gram positive (Bacillus or Streptomyces), gram negative (Pseudomonas), and gram variable (Paenibacillus) bacteria as well as a variety of fungal (Phoma and Emericella) genera have yielded LPs. The biosynthetic pathways of LPs are secondary metabolite pathways. Biosynthetic Gene Clusters (BGCs) encode the enzymes that make them; two or more genes in an organized arrangement, including regulatory elements. Non Ribosomal Peptide Synthetases (NRPS) and hybrid NRPS Polypeptide Synthetase (PKS), both large multi modular, multi domain proteins, are primarily responsible for LP synthesis. There are at least three catalytic domains in each NRPS module an adenylation (A) domain, condensation (C) domain, and Peptides Carrier Protein (PCP) domain. The bacterial phyla Proteobacteria, Actinobacteria, Firmicutes, and Cyanobacteria have dominated the discovery of a wide variety of NRPSs. However, the genetic machinery necessary to synthesize NRPs has been discovered in a number of lineages, including *Deinococcus thermus*, Chlorobi, Verrucomicrobia, and Gemmatimonadetes. Pharmaceutics, food processing, cosmetics, agriculture, and heavy metal and hydrocarbon bioremediation are just a few of the numerous industries in which LPs are utilized. Characterized LPs have been shown to have a wide range of bioactivities, including antimicrobial, immune modulator, tumor suppressant, and surfactant properties. Over chemically synthesized surfactants, microbial synthesized LP bio surfactants have several advantages: They are biodegradable, have minimal toxicity, have effective bioactivities at low concentrations, and reduce the risk of allergies and irritation when used in cosmetics. Additionally, LP bio surfactants maintain their bioactivity over a broad pH, salinity, and temperature range (Okada BK, 2017) (Yu W, 2018).

DISCUSSION

The functions of lipopeptides in bacterial motility

During active motility, which is also referred to as flagellum dependent motility, LPs play the role of a wetting agent, lowering surface tension and facilitating the expansion of bacterial colonies. In both liquid and semiliquid media, flagellated bacteria swim and swarm using this intrinsic motor driven movement. Using the LPs serrawetting, putisolvin, and surfactin, respectively, this phenomenon has been observed in *Serratia marcescens, Pseudomonas putida*, and *Bacillus subtilis* species. Extracellular or cell attached LPs reduce hydrophilic interactions between bacteria and biotic or abiotic surfaces in passive motility. A type of bacterial surface translocation called passive motility uses external forces to move away from surfaces and reduce their adherence. The bacterial colony is able to spread out from the point of origin and spread out over surfaces thanks to sliding, a form of passive motility that is aided by cell division. Bio surfactants secreted by bacteria, mostly LPs, are produced during sliding to lessen the friction caused by hydrophilic forces between cells and the substrate. This allows bacteria that lack nutrients to colonize surfaces (Zhu YG et al., 2019) (Lopatkin AJ, 2016).

Liposomal antimicrobial properties

The unique mode of action of antibiotic LPs is determined by their chemical structure. Although the LPs' mechanism of action is not fully understood, there is evidence that they act as a detergent or in pore formation to destabilize the bacterial membrane. Through their lipid tails, all LPs studied thus far interact with membranes. Because of this mode of action, LPs are able to function as broad-spectrum antibiotics with a lower risk of resistance. For instance, peptide sequence variation reduces protease cleavage, so mutations that alter the composition and organization of membrane lipids would require a high energy cost from the defending microorganism. Crystal lomycin, aspartocin, laspartomycin, friulimicin, daptomycin, and surfactin are examples of characterized LPs with antimicrobial activity. However, the specific mechanisms underlying these bioactivities of antimicrobials remain a mystery (Orman MA, 2013).

The LP's ability to interact with membrane sterols is thought to be influenced by its hydrophobicity. For some LPs to have antimicrobial activity, hydrophobicity is necessary. However, too much of this property could harm the host cell and affect its target's specificity (Greber KE et al., 2018) (Buchoux S et al., 2008).

Lipopeptides and their job in biofilm arrangement

Biofilms are intricate communities of microorganisms that are attached to biotic or abiotic surfaces by one or more species .The promotion of cell division, proliferation, and resistance to environmental and chemical stressors are among the ecological functions of biofilm formation. Active organic matter decomposition processes that increase the availability of nutrients and metabolic cooperation take place within the biofilm. The ability of biofilm forming bacteria to acquire new genetic traits through horizontal gene transfer is yet another advantage .Depending on the structure of the LP and the polarity of the cells and substrate, LPs can either encourage or discourage the formation of biofilms. *Mycobacterium avium*, a pathogenic bacterium with a lipopeptides anchored to the cell wall, has been shown to play a role in promoting biofilm formation. *Pseudomonas fluorescens* SBW25 has also been shown to benefit from the biofilm forming effects of cyclic LPs. Our understanding of how LPs work to encourage biofilm formation is incomplete. Despite the fact that it has been suggested that orientation plays a role in adhesion, LPs the molecule that makes it easier for the cell surface interactions of hydrophobic or hydrophilic hydrophilic (Straus SK, 2006) (Tyurin AP et al., 2018).

CONCLUSION

LPs are a group of compounds that play a variety of ecological and bioactive roles thanks to their extensive structural diversity. Motility, antimicrobial activity, biofilm formation, and association with heavy metals are regarded as LPs' primary functions. NRPSs and hybrid NRPS PKSs synthesize LPs; these enzymes play a role in the synthesis of secondary metabolites that are linked to adaptation and protection mechanisms that microorganisms use to survive in harsh environments. There is a wide variety of NRPS producing bacteria found in challenging ecosystems, including marine, microbial mats, and Antarctic desert soils. As a result, "extreme" microorganisms are appealing sources for the extraction of novel LP structures in the future. The discovery of diverse LPs will undoubtedly lead to new insights into the ecological roles of LPs, particularly those produced under a myriad of environmental stressors, as new technologies such as meta genomics, genomics, bioinformatics tools, and MD simulations are combined with rapid bioactivity screening methods and analytical chemistry techniques (Siegel MM, 2010) (Borders DB, 2007).

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CONFLICT OF INTEREST

None

REFERENCES

1. Okada BK, Seyedsayamdost MR (2017). Antibiotic dialogues: Induction of silent biosynthetic gene clusters by exogenous small molecules. FEMS Microbiol Rev. 41: 19-33.
2. Yu W, Hallinen KM, Wood KB (2018). Interplay between antibiotic efficacy and drug induced lysis underlies enhanced biofilm formation at subinhibitory drug concentrations. Antimicrob Agents Chemother. 62.

3. Zhu YG, Zhao Y, Zhu D, Gillings M, Penuelas J, et al (2019). Soil biota, antimicrobial resistance and planetary health. Environ Int. 131.

4. Lopatkin AJ, Sysoeva TA, You L (2016). Dissecting the effects of antibiotics on horizontal gene transfer: Analysis suggests a critical role of selection dynamics. BioEssays. 38: 1283-1292.

5. Orman MA, Brynildsen MP (2013). Dormancy is not necessary or sufficient for bacterial persistence. Antimicrob Agents Chemother. 57: 3230-3239.

6. Greber KE, Ciura K, Belka M, Kawczak P, et al (2018). Characterization of antimicrobial and hemolytic properties of short synthetic cationic lipopeptides based on QSAR/QSTR approach. Amino Acids. 50: 479-485.

7. Buchoux S, Lai Kee Him J, Garnier M, Tsan P, Besson F, et al (2008). Urfactin triggered small vesicle formation of negatively charged membranes:A novel membrane-lysis mechanism. Biophys J. 95: 3840-3849.

8. Straus SK, Hancock REW (2006). Mode of action of the new antibiotic for Grampositive pathogens daptomycin: Comparison with cationic antimicrobial peptides and lipopeptides. Biochim Biophys Acta Biomembr. 1758: 1215-1223.

9. Tyurin AP, Alferova VA, Paramonov AS, Shuvalov MV, Malanicheva IA, et al (2018). Crystallomycin revisited after 60 years: Aspartocins B and C. Medchemcomm.9: 667-675.

10. Siegel MM, Kong F, Carter GT (2010). Aspartocin cyclic lipopeptide antibiotics: massspectral structural confirmations and the diagnostic role played by the, b diaminobutyric acid residue. J Mass Spectrom. 45: 820-823.

11. Borders DB, Leese RA, Jarolmen H, Francis ND, Fantini AA, et al (2007). Laspartomycin, an acidic lipopeptide antibiotic with a unique peptide core. J Nat Prod. 70: 443-446.