

Significance of Rhamnolipids as a Biological Control Agent in the Management of Crops/Plant Pathogens



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Abstract

Rhamnolipids has been recognised as a safe biosurfactant with diverse and unique properties and could be a permanent replacement to the synthetic chemicals used in the management of plant pathogens. With regard to this, the review intends to report the recent applications of rhamnolipids in the management of plants pathogens.

What are Rhamnolipids

Rhamnolipids are bio surfactants, which are glycolipidic in nature containing carbohydrates and hydroxyl aliphatic acids. They are produced by *P. aeruginosa* strains and are one of the most studied glycolipid biosurfactants. They have a hydrophobic tail that contains one or two fatty acids joined to the carboxyl end of one or two rhamnose molecules referred to as monorhamnolipid and dirhamnolipid respectively [1].

Reported Attributes of Rhamnolipids

Various scientists have described the significance of rhamnolipids in industries, pharmacy and agriculture. Their special attributes that make them unique include low toxicity, selectivity, rapid biodegradation, easy mass production on cheap substrates, stability under different environmental conditions and environment friendly. These diverse properties are making rhamnolipids the ecological alternative for the synthetic biosurfactants [2-5].

Modes of Action of Rhamnolipids

The biological control activities of rhamnolipids produced by *Pseudomonas aeruginosa* strains could be linked to their ability to liberate the intracellular contents of targeted pathogens by causing disruption and lyses of the cells [6,7]. They act on the target cells by disrupting the lipid content and proteins of cell membranes thereby changing the configuration of the cell wall and osmolarity of the cell. This subsequently leads to increase in their toxicity on pathogenic microorganisms [8].

Recent Advances in the Utilization of Rhamnolipids for the Management of Bacterial and Fungal Crop Pathogens

Rhamnolipid biosurfactants isolated from various *P. aeruginosa* strains have potential applications in agriculture because of their antimicrobial properties in addition to being a biosurfactant and their ability to induce non specific-immunity in plants [9]. *In-vitro* studies reported the efficacy of rhamnolipids against gram-negative bacteria like *Ralstonia solanacearum* responsible for causing bacterial wilt in tobacco, tomato, pepper and potato plants and *Xanthomonas campestris* responsible for black rot in cruciferous vegetables [10]. Antifungal properties of rhamnolipids have also been established in vitro against zoosporic phytopathogens like *Botrytis sp.*, *Rhizoctonia sp.*, *Pythium sp.*, *Phytophthora sp.* [11,12] *Mucor miehei* and *Neurospora crassa* [13]. The zoospores do not possess cell walls. They are surrounded only by plasma membrane. Rhamnolipids target them by interacting with the plasma membrane resulting in disintegration of the membrane and finally lyses of the cells [11]. *In vitro* growth inhibition assay also showed that rhamnolipids affected the mycelial growth of fungi [10].

Studies of antifungal properties of rhamnolipids have also been extended *in vivo* in plant systems, particularly crop plants. Application of rhamnolipids protected the pepper plants from *Pytophthora* blight disease. Similarly, treatment of cucumber plants with rhamnolipids prevented the development of *Colletotrichum orbiculare* on the leaves [10]. Studies further

conducted by Yoo et al. [14] showed the potential application of rhamnolipids in preventing water borne damping off disease in plants caused by phytopathogenic oomycetes *Phytophthora sp.* and *Pythium sp.* Sharma et al. [15] further corroborated the results in chilli pepper and tomato plants. In another study conducted by Millioli et al. [16] application of rhamnolipids together with *R. glutinis* showed bioactivity against *A. alternate*, a serious pathogen causing post harvest black rot in certain cultivars of plants.

Conclusion and Recommendation

Though chemical pesticides and fungicides have helped in controlling the outbreaks of plant diseases, their long-term use is not feasible because of their adverse effects on environment. Thus, the search for eco-friendly alternatives has driven interdisciplinary research leading to the discovery of many potential molecules of biological origin. Rhamnolipids is one of them [16,17]. Because of their diverse properties as stated earlier, they are in the pipeline for large-scale use in controlling crop pathogens. This review has highlighted the use of rhamnolipids in the biological control of plant bacterial and fungal pathogens. The further application of functional meta genomics will assist in the discovery of more strains with high yield, stability, and better attributes. Also, more focus is required on identifying the non-target effects of rhamnolipids in their use as biological control agents against plant pathogens.

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