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Synthetic rhamnolipids an alternative for crop protection. Synthesis and biological evaluation against different pathosystems

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PURPOSE OF THE ABSTRACT

In agriculture production, various pesticides have been used for plant protection against diseases and insect pests and persist for long period in fruits and vegetables, causing harm to human beings. Substitution of these pesticides by compounds with low toxicities may contribute to reduce environmental and social impacts.

BioScreen is a part of SmartBioControl (Interreg V) project that aims to search and identify new molecules able to control the pathogens of cross-border crops thanks in particular to the development of a high-throughput screening platform.

Rhamnolipids (RLs) are glycolipidic biosurfactants produced by bacterial species (Pseudomonas aeruginosa) and have the potential to be part of these alternative strategies. They have already been used for classic industrial applications (bioremediation, fine chemistry, surface coating, additives for food, cosmetics, etc..) but RLs have

also been shown to display antibacterial and antifungal activities. Moreover they could be involved in the activation of plant defense mechanisms.

However, high production cost of large-scale fermentation and potential pathogenicity of Pseudomonas aeruginosa, commonly used for rhamnolipid synthesis, have led to extensive research for safer and cost-effective production methods. In addition, the fermentation is not selective and provides a mixture of different rhamnolipids (mono- and disaccharides, with different fatty acid length) that can be a problem for the registration of phytosanitary products.

In this context, we decided to develop a reaction pathway to obtain rhamnolipids from biosourced raw materials (Figure 1). Several compounds have been synthesized with different linker functions (ether, ester, succinate ester, carbamate) and variable chain lengths (from 4 to 18 carbon atoms).

The antifungal activity and the ability to stimulate the plant defense mechanisms of these rhamnolipids have been evaluated by the Catholic University of Louvain and the University of Reims Champagne Ardennes.

Direct antagonism tests evaluated the inhibition potential of rhamnolipids, at three molar concentrations (0.1, 0.2 and 0.3 mM), on spore / sporangium germination and mycelial development of various pathogens under controlled conditions

A strong inhibition of the development of Phytophthora infestans MUCL 54981 (pathogen causing potato mildew) was measured and a retarding effect on growth of Botrytis cinerea BC630 (pathogen causing grey mould of vine) was observed with the C10 and C12 rhamnose ethers. The difference in activity observed between P. infestans and B. cinerea could probably be related to the hemibiotropic and necrotropic nature of both pathogens.

In order to evaluate the ability of the different RLs to induce early defense mechanisms in the plant, the production of reactive oxygen species (ROS) was studied. The first tests were carried out on model plant, Arabidopsis thaliana. Different concentrations (0.025, 0.05 and 0.1 mM) of our rhamnolipids were tested on leaf discs to monitor the production of ROS for 12 hours. We have observed that the C10 and C12 ether derivatives, as well as the C12 ester derivative, induce a significant production of ROS at 0.05 and 0.1 mM. More, the protection capacity of these molecules is currently tested on whole plants of Arabidopsis against the two pathogens, Phytophthora infestans and Botrytis cinerea.

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FIGURES

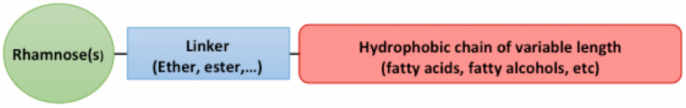

FIGURE 1

Structure of synthesized rhamnolipids

Linkers are mainly ether, esters or carbamate functions. Hydrophobic moieties of rhamnolipids are fatty alcohols or acids, or alkylsuccinate compounds.

FIGURE 2

KEYWORDS

Rhamnolipids | Direct antagonism | Reactive oxygen species (ROS) | antifungal activity

BIBLIOGRAPHY

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