Integrated approaches for the study of *Rhodococcus* biodegradation of plastics and its degradative functions

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Abstract:

Plastic consumption is ever increasing with a consequent global plastic production growing year by year. Thus, plastic polymer waste management is a prevalent issue due to the high persistence of many plastic wastes that have been accumulating in the environment. A promising approach is the development of green technologies comprising effective microbial biodegradative strategies for bioremediation to mitigate environmental plastic contamination and biotechnological applications.

Rhodococcus is one of the most extraordinary genera for its catabolic versatility, with an extensive asset of genes encoding enzymes for the biotransformation and/or biodegradation of a wide array of organic compounds, contaminants, and waste. However, *Rhodococcus* has received relatively little attention for plastic biodegrading capabilities of diverse biodegradable and non-biodegradable polymers and the corresponding genetic determinants.

Among plastics, polyethylene (PE) is the most utilized synthetic plastic worldwide and it accounts for around 60% of the total accumulated plastic waste. On the other hand, among biodegradable polymers, polycaprolactone (PCL) is often utilized as a model for studying polyester biodegradability and the phenotypical and molecular features of microorganisms that catabolize biodegradable aliphatic polyesters. *Rhodococcus opacus* R7 can grow on untreated PE or PCL as the sole carbon and energy source. Thus, this capacity has been under evaluation. Growth kinetic analyses showed that R7 can grow on both PE or PCL powder, R7 cells either produce biofilm on PE film or increase their density of a magnitude order on PCL. Gas chromatographic analyses coupled with mass spectrometry on dichloromethane extract of *R. opacus* R7 cultures grown on PE or PCL showed their intermediates of growth. Enzymatic activity screening revealed that exposure to PE or PCL causes overexpression of secreted laccases or esterases/lipases in the culture medium. Moreover, omic approaches (genomic and transcriptomic) unveil potential genetic determinants for the diverse metabolisms: two laccases-like enzymes and hydroxylases for PE and lipases/hypothetical proteins for PCL biodegradation.

These promising results represent a valid platform for further biotechnological applications in biodegradative processes and catalytic reactions.