Biodegradation Potential of *Rhodococcus* and *Pseudomonas* Strains on Novel Synthetic Polymers for Cosmetic

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Abstract:
The global cosmetic market continues to grow, with analyses predicting sustained expansion in the coming years. One of the major drivers of this trend is the rising consumer awareness of personal care and sustainability, which has encouraged the adoption of organic and biodegradable cosmetics. Consequently, developing novel plastic polymers and demonstrating their biodegradability are among the main focuses of frontier cosmetic research.
Polylactic acid (PLA) is one of the most promising bio-based biodegradable polymers. Conversely, synthetic polyurethanes (PU) are traditionally considered recalcitrant, yet their physicochemical properties make them attractive targets for the development of next-generation biodegradable cosmetic materials. Understanding the biodegradative processes of both PLA and PU is therefore crucial for advancing environmentally sustainable cosmetic technologies.

Among microorganisms with plastic-degrading capabilities, *Rhodococcus* and *Pseudomonas* are among the most versatile genera with genomic repertoires enriched in catabolic enzymes predicted to act on diverse polymeric substrates. Their metabolic potential provides valuable insight into the biodegradation mechanisms of emerging cosmetic polymers.

Bacterial strains belonging to Actinomycetota and Pseudomonadota were initially screened for growth and halo formation on plates supplemented with different PLA and PU polymers. The most efficient strains, corresponding to *Rhodococcus* and *Pseudomonas* members, were subsequently cultivated in liquid medium containing either PLA powder or PU film as the sole carbon and energy source up to 28 days. Enzymatic activity was evaluated from the cell-free supernatant of powder PLA cultures, revealing esterase activity with respect to the control condition.
Bacterial adhesion and biofilm formation on PU films were monitored over the same period, showing strain-dependent differences. Preliminary Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) analyses confirmed structural alterations on PU film surfaces exposed to bacterial treatment compared with untreated controls.

These findings reveal promising bacterial candidates and establish a foundation for improving cosmetic polymer biodegradation, bridging environmental sustainability and industrial innovation.