Serratia plymuthica: Process optimization, scale-up and freeze-drying for postharvest biocontrol on carrots

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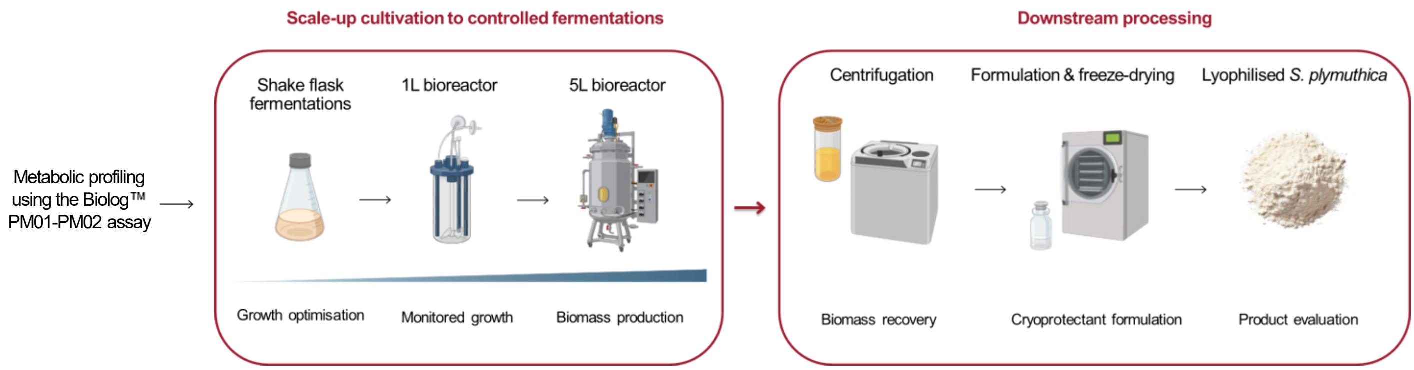
Introduction & Objective

Serratia plymuthica, a Gram-negative, facultatively anaerobic bacterium previously isolated from the carrot surface, has shown strong antagonistic activity against carrot pathogens, making it a promising candidate for biological control. This study aimed to optimise cultivation conditions of *S. plymuthica*, in order to maximise biomass yield, enabling scale-up and the development of a freeze-dried formulation for postharvest application on carrots.

Experimental



Results

Shake flask experiments

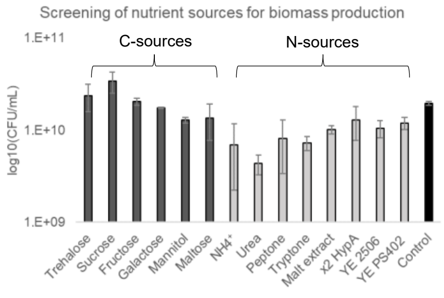


Figure 1. Screening of carbon and nitrogen sources for biomass production (log(CFU/mL)) in LB medium. Control consists of 1% glucose. Error bars show standard deviation (n=2).

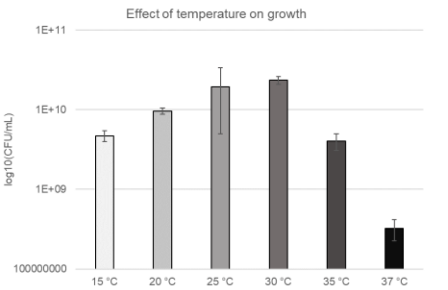


Figure 2. Effect of temperature on microbial growth (log(CFU/mL)) in LB with 1% glucose. Error bars: SD (n=2).

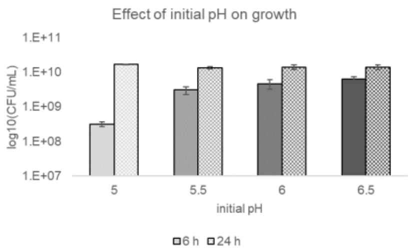
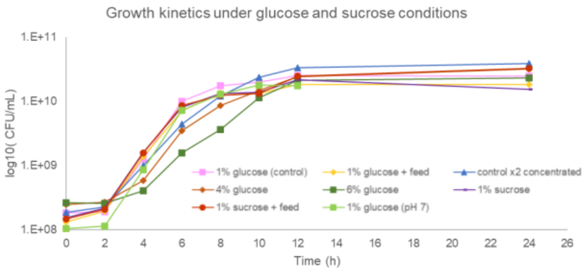


Figure 3. Effect of initial pH on microbial growth (log(CFU/mL)) at 6 and 24 h in LB with 1% glucose. Error bars: SD (n=2).

Scale-up and downstream

Figure 4. 24 h growth curves under different glucose and sucrose conditions. "Feed" (-◆-) refers to bolus feeding at 8 h using 3-times concentrated media.



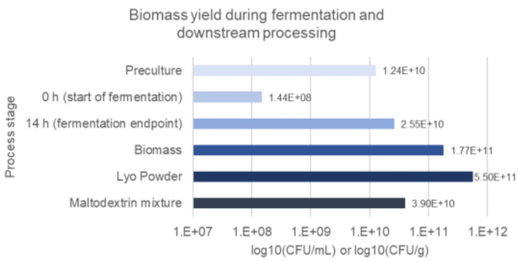


Figure 5. Biomass yield throughout the process, from preculture to formulation with carrier after lyophilization (log10(CFU/mL) or log10(CFU/g)).

Conclusions & Outlook

- Optimal growth of *S. plymuthica* was observed at 30 °C. Initial pH (5-6.5) affected growth rate but not final biomass, while controlled pH at 7 had no significant effect. Highest biomass yields were obtained with 1% glucose or sucrose, with best performance in 2x concentrated LB.
- Scale-up enabled high biomass production (>10^{11} CFU/mL) which remained high after downstream processing and freeze-drying, with a dry matter of 95.25% and cell survival rate ≈ 28%. Incorporation of maltodextrin helped stabilise the final product and preserve cell viability. The downstream process, particularly biomass recovery, still requires further optimisation.
- The lyophilised powder is intended for postharvest application on carrots as a sprayable formulation, requiring high biological and physicochemical stability.

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