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Pilot scale production of lipopeptide biosurfactant and its application for drilling waste decontamination process

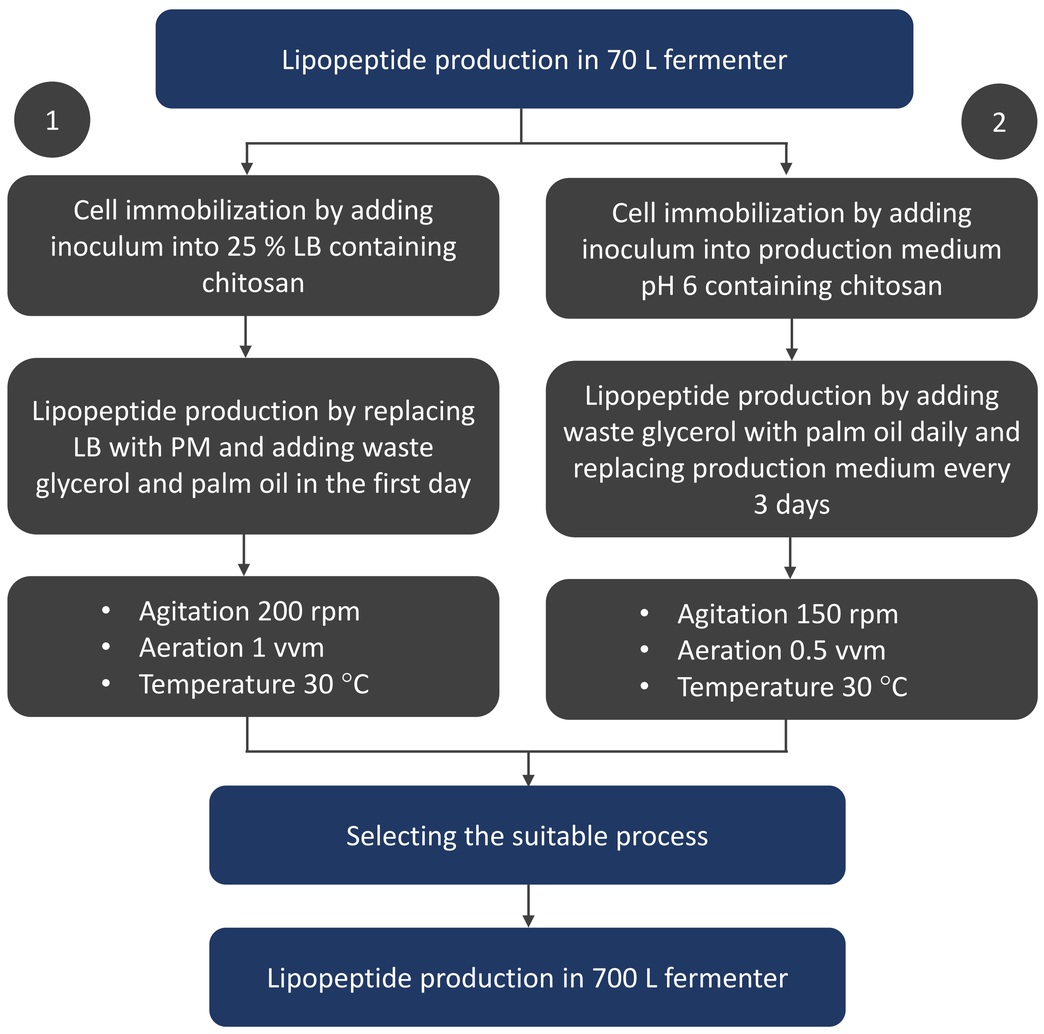
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INTRODUCTION

Lipopeptide is one of the great effective and powerful biosurfactants mostly produced by *Bacillus* sp. It has been used considerably as alternative to chemical surfactants due to their high surface activity and low toxicity. Both rapid stirring and aeration, are required to supply sufficient quantities of oxygen for Bacillus sp. growth in bioreactor, cause an uncontrollable foaming. The use of chemical anti-foams is not suitable, since they can affect the physiology of the strain and make it difficult to recover the pure products. In our previous work, *Bacillus* sp. GY19 was immobilized on chitosan to enhance lipopeptide production and prevent foam formation. The aim of this study is to scaling-up the immobilized-cell based lipopeptide production from bench-scale to pilot-scale of 70 and 700 L fermenters. This developed fermentation approach is of great importance for making the process industrially viable in the future. Since oil and gas drilling process produces large amount of solid and hazardous wastes (cutting) which contaminated by high concentration of petroleum hydrocarbon from synthetic based mud, this study aimed to apply the produced lipopeptide biosurfactant to remove total petroleum hydrocarbons (TPH) from drilling waste using bench scale soil washing process as green alternative technology for hazardous waste management.

Design of fermentation process to evaluate the optimum condition

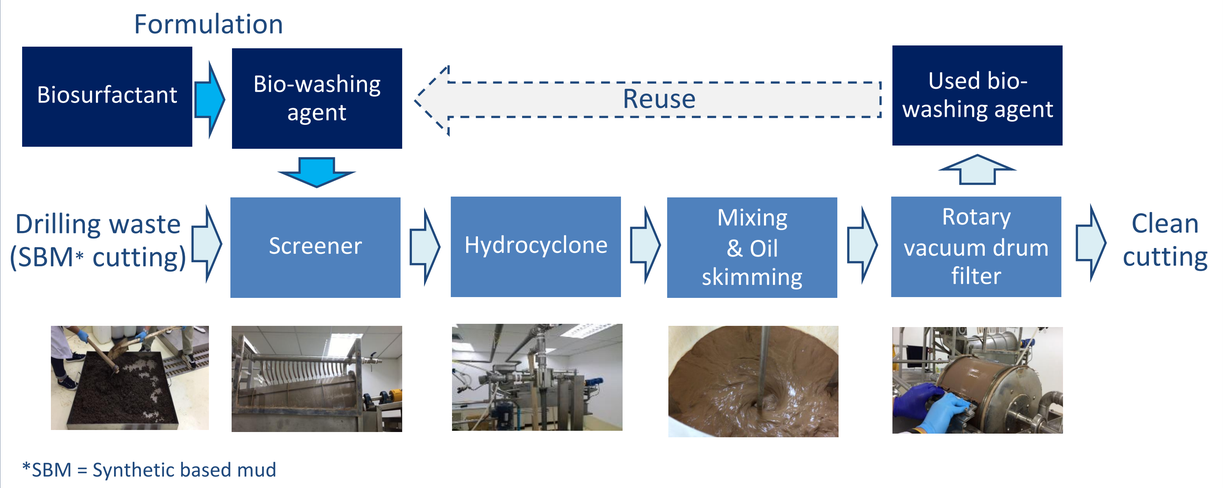


Pilot-scale fermentation from 40 L to 400 L



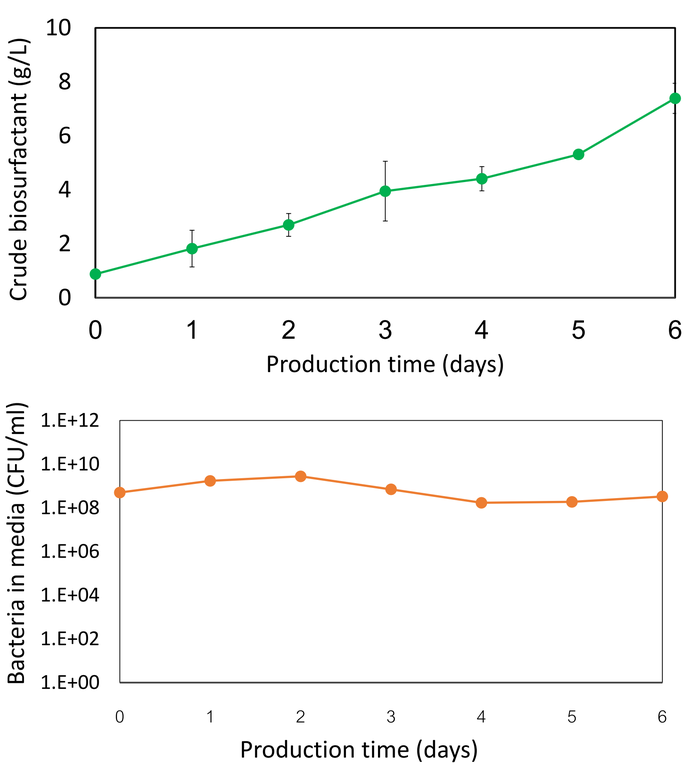
40 L Fermentation | 400 L Fermentation | Lipopeptide recovery

Applications of drilling waste decontamination process



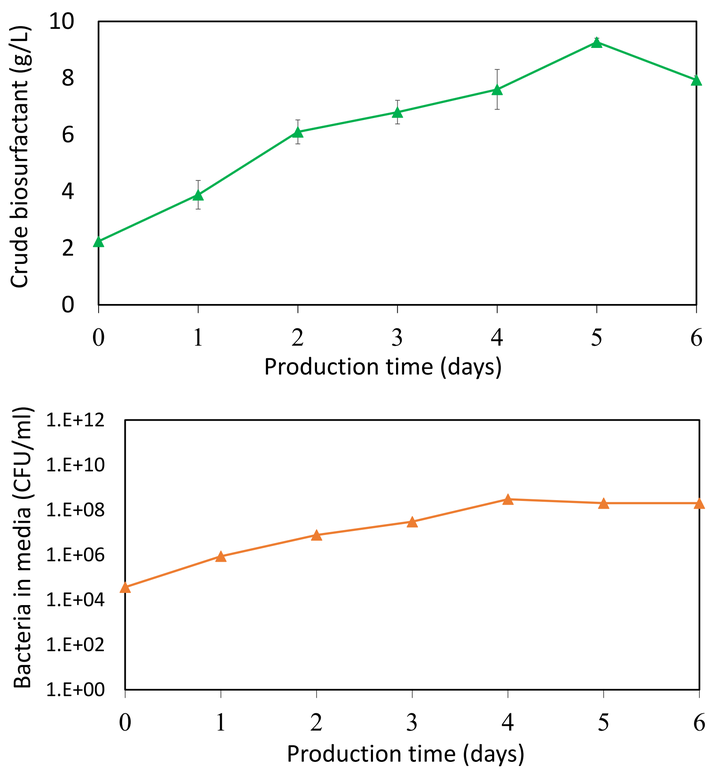
*SBM = Synthetic based mud

40 L Fermentation



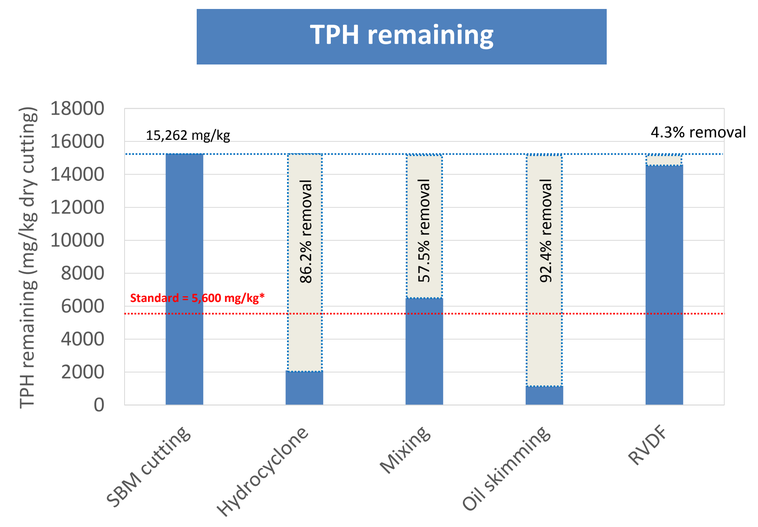
- 1st fermentation condition → Large number of foam produced in the first day of fermentation resulting to air outlet filter clogging and low lipopeptide production.
- 2nd fermentation condition → There were not found lipopeptide reduction and overflow foam problem.
- The highest lipopeptide concentration was 7.389 g/L.

400 L Fermentation



- Fed-batch fermentation was operated for 6 days at agitation of 150 rpm, aeration of 0.5 vvm and temperature of 30 °C. Waste glycerol and palm oil were supplemented daily.
- No over-flow foam problem.
- The highest lipopeptide concentration was 9.267 g/L.

TPH decontamination from drilling waste



- Bio-washing agent was successful to remove TPH from drilling waste up to 92.4% removal efficiency
- TPH remaining in soil was passed the Australia TPH standard in soil for residential area (<5,600 mg/kg)
- However, rotary vacuum drum filter (RVDF) process was not successful to dry clean cutting because floating oil was adsorbed on filter and re-contaminated to clean cutting
- New final process is recommended to substitute the RVDF process for clean cutting separation from slurry

CONCLUSIONS

Lipopeptide was successfully produced from chitosan-immobilized *Bacillus* sp. GY19 in pilot-scale fermenters by combining fed-batch fermentation strategy with reducing agitation rate in the larger fermenter. Moreover, it was approved that bio-washing agent formulated from lipopeptide biosurfactant was successful to apply for TPH decontamination from drilling waste.

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