BIOSURFACTANT PRODUCTION FROM *PSEUDOMONAS AERUGINOSA* SP 4 USING SEQUENCING BATCH REACTORS

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ABSTRACT

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Biosurfactant production in two identical units of sequencing batch reactors (SBRs) was investigated by using a crude oil-contaminated soil isolated *Pseudomanas aeruginosa* SP 4. The SBR units, having a working and draining volume of 1,500 and 500 ml, respectively, were operated at a constant temperature of 37°C under aseptic conditions. The sedimentation, decanting, and feeding step used for all experiments were 50, 5, and 5 min, respectively. Biosurfactant production was studied with palm oil being used as a carbon source and fish steaming waste or mineral medium being used as a nutrient source for growing *Pseudomonas aeruginosa* SP 4. Effect of nutrient sources, oil loading rates, and cycle times on surface tension reduction, and COD and oil removal were investigated. Among the two nutrient sources, the mineral medium gave the highest reduction of surface tension at an oil loading rate of 2 kg/m^{3}d. An oil loading rate of 2 kg/m^{3}d with the mineral medium provided the effective surface tension reduction of 28.1 mN/m, corresponding to a COD removal of 88% and an oil removal of 94%. From aeration time profile during a steady state cycle, a minimum surface tension was reached at aeration time in the range of 6 to 10 h. In comparing the biosurfactant production with 1-d cycle and 3-d cycle under the same extent of oil concentration (0.6% w/v), the highest surface tension reduction obtained was 58% with 1-d cycle.

บทคัดย่อ

ศศิวรรณ มากสังข์ : การผลิตสารลดแรงตึงผิวชีวภาพจากจุลินทรีย์ *Pseudomonas aeruginosa* SP 4 โดยเครื่องปฏิกรณ์แบบกะต่อเนื่อง (Biosurfactant Production from *Pseudomonas aeruginosa* SP 4 using Sequencing Batch Reactors) อ. ที่ปรึกษา : รศ. ดร.สุเมธ ชวเดช ศ. ดร.มาซาฮิโกะ อาเบะ และ ผศ. ดร.รัตนา รุจิรวนิช 98 หน้า

การผลิตสารลดแรงตึงผิวชีวภาพในเครื่องปฏิกรณ์แบบกะต่อเนื่องจำนวน 2 ชุด ที่มีลักษณะเหมือนกัน ได้ถูกศึกษาโดยใช้จุลินทรีย์ *Pseudomonas aeruginosa* SP 4 ซึ่งทำการคัดแยกมาจากแหล่งปิโตรเลียมที่มีดินปนเปื้อนน้ำมันเป็นเวลานาน หน่วยของเครื่องปฏิกรณ์แบบกะต่อเนื่องมีปริมาตรในการทำงานคือ 1,500 มล. และปริมาตรในการดึงสารผลิตภัณฑ์คือ 500 มล. เครื่องปฏิกรณ์แบบกะต่อเนื่องนี้ควบคุมอุณหภูมิไว้ที่ 37 องศา และทำการทดลองภายใต้สภาวะปลอดเชื้อ เวลาที่ใช้ในการตกตะกอน ดึงสารผลิตภัณฑ์ออก และเติมสารขาเข้า ตลอดการทดลองคือ 50, 5 และ 5 นาที ตามลำดับ การศึกษาการผลิตสารลดแรงตึงผิวชีวภาพนี้ใช้น้ำมันปาล์มเป็นแหล่งคาร์บอน และ น้ำนึ่งปลาหรือสารอาหารแร่ธาตุ (mineral medium) เป็นสารอาหารเพื่อใช้ในการเจริญเติบโตของ *Pseudomonas aeruginosa* SP 4 อิทธิพลของสารอาหาร ปริมาณน้ำหนักของน้ำมัน และเวลาวัฏจักร ที่มีผลต่อการลดลงของแรงตึงผิว และการย่อยสลายซีโอดีและน้ำมัน ได้ถูกศึกษา จากการเปรียบเทียบสารอาหารที่ใช้สำหรับปริมาณน้ำหนักของน้ำมัน 2 กก./ม^3 วัน พบว่า สารอาหารแร่ธาตุมีประสิทธิภาพในการลดแรงตึงผิวสูงที่สุด ในการใช้สารอาหารแร่ธาตุที่ปริมาณน้ำหนักของน้ำมันที่แตกต่างกัน พบว่า การเติมปริมาณน้ำหนักของน้ำมัน 2 กก./ม^3 วัน มีประสิทธิภาพในการลดค่าแรงตึงผิวได้ต่ำที่สุดถึง 28.1 มิลลินิวตันต่อเมตร ซึ่งสอดคล้องกับการย่อยสลายซีโอดี 88% และการย่อยสลายน้ำมัน 94% จากการศึกษาค่าแรงตึงผิวระหว่างการให้อากาศในระยะเวลา 1 วัฏจักร พบว่า ได้รับค่าแรงตึงผิวต่ำสุดที่ช่วงระยะเวลาให้อากาศ 6-10 ชั่วโมง การเปรียบเทียบการผลิตสารลดแรงตึงผิวชีวภาพที่เวลาวัฏจักร 1 และ 3 วัน ภายใต้ปริมาณความเข้มข้นของน้ำมันที่เท่ากัน (0.6% w/v) พบว่า ได้รับเปอร์เซ็นต์การลดลงของแรงตึงผิวสูงสุด 58% ที่เวลาวัฏจักร 1 วัน

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ABBREVIATIONS

CFU	Colony-forming unit
CMC	Critical micelle concentration
CMD	Critical micelle dilution
C:N	Carbon per nitrogen ratio
COD	Chemical oxygen demand
C:P	Carbon per phosphorous ratio
CSTR	Continuous-flow stirred tank reactor
EC	Emulsification capacity
FSW	Fish steaming waste
HRT	Hydraulic retention time
LPS	Lipopolysaccharide
MLSS	Mixed liquor suspended solids
MM	Mineral medium
OLR	Oil loading rate
OOME	Olive oil mill effluent
PCBR	Packed column bioreactor
PHA	Polyhydroxyalkanoate
SBR	Sequencing batch reactor
SSF	Solid state fermentation
SS-SBR	Soil slurry-sequencing batch reactor
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorous
TSS	Total suspended solids