

**PREPARATION AND CHARACTERIZATION OF CELLULOSE
WHISKERS - REINFORCED SILK FIBROIN SPONGE FOR YEAST
IMMOBILIZATION FOR ETHANOL PRODUCTION**

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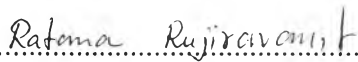
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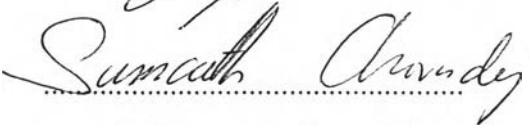
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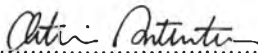

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ABSTRACT

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Keywords: Silk fibroin/ Cellulose whisker/ Yeast immobilization/ Ethanol

Silk fibroin (SF) is a natural protein produced by the mulberry silkworm (*Bombyx mori*). It was chosen as a matrix in bionanocomposite sponges for yeast cell immobilization. Cellulose whiskers (CLWs), having an aspect ratio of 80, were used as reinforcements. The bionanocomposite sponges at SF/CLWs weight ratios of 100/0, 90/10, 80/20, 70/30, 60/40 and 50/50 were fabricated by using a freeze-drying technique before being treated with an aqueous methanol solution. At any studied SF/CLWs weight ratios, Fourier Transform Infrared Spectrophotometer spectra indicated beta-sheet conformation of SF after the methanol treatment. The presence of CLWs not only increased the compression modulus but also reduced the shrinkage of the bionanocomposite sponges as well as enhanced the conformation transition of SF. The formation of beta-sheet structure of SF significantly increased water stability of the bionanocomposite sponges. The Field Emission Scanning Electron micrographs showed that the bionanocomposite sponges exhibited an interconnected porous structure, providing high surface area for immobilizing *Saccharomyces cerevisiae burgundy* KY11 yeast cells. The sponge with the SF/CLWs weight ratio of 50/50 showed the highest average number of yeast cell attachment at 3.1×10^{10} cells/g sponge. The maximum ethanol production of immobilized yeast cell was 65% higher when compared with free yeast cell fermentation system.

บทคัดย่อ

วาลิฐิ บุญยวรรธนะ : การเตรียม และการวิเคราะห์คุณสมบัติของวัสดุฟรอนจากโปรตีนไฟโบรอินจากรังไหมที่เสริมแรงด้วยเซลลูโลสวิสเกอร์ เพื่อใช้ในการตรึงเซลล์ยีสต์สำหรับการผลิตเอทานอล (Preparation and Characterization of Cellulose Whiskers- Reinforced Silk Fibroin Sponge for Yeast Immobilization for Ethanol Production) อ. ที่ปรึกษา : รศ. ดร. รัตนา รุจิวานิช และ ผศ. ดร. มานิตย์ นิธิธนากุล 131 หน้า

ในปัจจุบัน พลังงานทดแทนจากไบโอเอทานอลได้มีบทบาทมากขึ้นเพื่อบรรเทาปัญหาการขาดแคลนพลังงานฟอสซิล การผลิตไบโอเอทานอลสามารถทำได้โดยใช้จุลินทรีย์ คือ ยีสต์ ในกระบวนการหมักทางชีวภาพ งานวิจัยนี้มีจุดประสงค์ที่จะพัฒนากระบวนการหมักโดยใช้เทคนิคการตรึงเซลล์ยีสต์เพื่อเพิ่มอัตราผลิตเอทานอล โดยสังเคราะห์วัสดุฟรอนจากโปรตีนไฟโบรอินซึ่งสกัดจากรังไหมของตัวไหม *บอมบิกซ์ โมริ* ซึ่งโครงสร้างมีความเป็นระเบียบ มีโครงสร้างทุติยภูมิเป็นแผ่นพับเบต้าแบบสวนขนาน ส่งผลให้สามารถคงรูปได้ในน้ำ อีกทั้งยังมีความเข้ากันได้กับเซลล์และถูกนำมาใช้เป็นวัสดุทางชีวการแพทย์อย่างหลากหลาย เสริมแรงวัสดุฟรอนด้วยเซลลูโลสวิสเกอร์ซึ่งสกัดจากเปลือกกล้วยน้ำว้า เพื่อเพิ่มความแข็งแรงของวัสดุ ทำการขึ้นรูปวัสดุโดยการทำให้แห้งภายใต้สภาวะสูญญากาศ ซึ่งพบว่าลักษณะของวัสดุมีความเป็นรูพรุนที่ต่อเนื่อง และปริมาณของเซลลูโลสวิสเกอร์ที่เหมาะสมโดยน้ำหนักของวัสดุฟรอน คือ 50% วัสดุที่ได้มีความสามารถในการคงรูปได้ภายใต้สภาวะการหมัก และมีขนาดของรูที่เหมาะสม ทำให้ตรึงเซลล์ยีสต์ได้ 3.1×10^{10} เซลล์ ต่อกรัมของวัสดุฟรอน ซึ่งแสดงให้เห็นถึงประสิทธิภาพในการใช้เป็นวัสดุตรึงเซลล์ ผลผลิตเอทานอลที่ได้จากการหมักโดยใช้การตรึงเซลล์ในวัสดุฟรอนเพิ่มขึ้น 65% โดยน้ำหนักเมื่อเทียบกับการหมักโดยใช้เซลล์ยีสต์อิสระ นอกจากนี้การตรึงเซลล์ยีสต์ในวัสดุฟรอนยังช่วยลดผลของการยับยั้งการผลิตเอทานอลเนื่องจากสารตั้งต้นหรือผลิตภัณฑ์ที่มีความเข้มข้นสูง ซึ่งทำให้เซลล์ยีสต์ตายได้ และยังสามารถนำวัสดุฟรอนตรึงเซลล์ยีสต์กลับมาใช้ซ้ำในกระบวนการหมัก โดยมีปริมาณผลผลิตที่คงที่

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