

# THE STUDY OF SILK SERICIN/CLAY AEROGEL STRUCTURE

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## ABSTRACT

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Clay aerogel is light weight, low density and high porosity material produced from bentonite via freeze-drying technique which the morphology is suitable for several biotechnological applications including 3D scaffold. In this study, silk sericin/PVA/clay aerogel, the new material to use as scaffold for tissue engineering, was prosperously prepared. Silk sericin, the glue like protein from silk cocoon, is cooperated with clay aerogel due to the ability to enhance cell growth and cell viability. Silk sericin was extracted from 4 species of traditional Thai silk cocoon; Nang Noi, Nang Lai, Dok Bua and Luang Pairote. Nevertheless, silk sericin/clay aerogel forms fragile material. To over this problem, poly(vinyl alcohol) was employed to improve the mechanical properties. The aim of this study was to prepared silk-sericin/PVA/clay aerogel by freeze-drying technique using glutaraldehyde as cross-linked agent and studied the influence of silk sericin, clay contents, cross-linked agent and species of silk to the properties of the aerogel. The increasing of silk sericin content powerfully increased in thermal and mechanical properties. In contrast, the increasing of clay and glutaraldehyde strongly increased mechanical properties but reduced the thermal stability. Base on *in vitro* direct contact test and MTT assay using human gingival fibroblast cell, the silk sericin/PVA/clay aerogel can be a good candidate for 3D scaffold for tissue engineering in order to uses in periodontal disease. Additionally, silk sericin content, glutaraldehyde concentration, species of silk and variable of human cell had an influence on the cell viability and mitochondria activities.

## บทคัดย่อ

เสาวนีย์ ลิขิตอัมพร : การศึกษาโครงสร้างเคลย์แอโรเจล/ผงไหมซีริซิน (The Study of Silk Sericin/Clay Aerogel Structure) อ. ที่ปรึกษา : รศ. ดร. รัตนาวรรณ มกรพันธุ์ 141 หน้า

เคลย์แอโรเจลเป็นวัสดุที่มีน้ำหนักเบา ความหนาแน่นต่ำ และมีความเป็นรูพรุนสูง เคลย์แอโรเจลสามารถสร้างขึ้นจากการนำดินเบนโทไนด์ไปผ่านกระบวนการที่เรียกว่าการแช่แข็งแห้ง เมื่อพิจารณาโครงสร้างของเคลย์แอโรเจลที่เกิดขึ้น โครงสร้างที่มีความพรุนสูงและรูพรุนเป็นแบบต่อเนื่องมีความเหมาะสมสำหรับการนำไปใช้ในงานทางด้านวัสดุเทคโนโลยีชีวภาพ รวมถึง โครงเลี้ยงสามมิติ งานวิจัยนี้มีจุดประสงค์ในการเตรียมเคลย์แอโรเจล/ผงไหมซีริซิน โดยกระบวนการแช่แข็งแห้ง เนื่องด้วยมีงานวิจัยพบว่าผงไหมซีริซินมีคุณสมบัติในการเร่งการเจริญเติบโตทั้งในไฟโบรบลาสและออสทีโอเบลาเซลล์ เคลย์แอโรเจลชนิดใหม่นี้มุ่งหวังเพื่อนำไปใช้เป็นโครงเลี้ยงเซลล์สามมิติเพื่อใช้สำหรับงานทางด้านวิศวกรรมเนื้อเยื่อ มุ่งเน้นในการรักษาโรคทางด้านปริทันต์ ผงไหมซีริซินถูกสกัดมาจากไหมแตกต่างสายพันธุ์ทั้งหมดสี่ชนิด คือนางน้อย นางลาย ดอกบัวและเหลืองไฟโรจน์ เนื่องด้วยเคลย์แอโรเจล/ผงไหมซีริซินเกิดเป็นวัสดุที่มีสมบัติเชิงกลต่ำ ดังนั้นพอลิไวนิลแอลกอฮอล์จึงถูกนำมาใช้เพื่อปรับปรุงสมบัติเชิงกล นอกจากนี้กลูตารัลดีไฮด์ถูกนำมาใช้เพื่อจุดประสงค์ให้เกิดการสร้างการเชื่อมขวางของผงไหมซีริซินและพอลิไวนิลแอลกอฮอล์เพื่อทำให้โครงสร้างของเคลย์แอโรเจลสามารถคงรูปอยู่ในอาหารเลี้ยงเซลล์ได้ จากงานวิจัยพบว่า การเพิ่มปริมาณของผงไหมซีริซินส่งผลให้เกิดการปรับปรุงทางด้านสมบัติเชิงกลและสมบัติทางความร้อน แต่เมื่อปริมาณของดินเบนโทไนด์และกลูตารัลดีไฮด์มากขึ้นส่งผลให้เกิดการปรับปรุงสมบัติเชิงกล แต่สมบัติทางความร้อนต่ำลง จากการศึกษาการเจริญเติบโตของเซลล์ภายใต้สภาวะเลียนแบบร่างกายมนุษย์ โดยใช้เซลล์เหงือกจากอาสาสมัคร พบว่า เคลย์แอโรเจล/ผงไหมซีริซินสามารถนำไปใช้เป็นโครงเลี้ยงเซลล์สามมิติทางด้านวิศวกรรมเนื้อเยื่อเพื่อรักษาโรคทางด้านปริทันต์ได้ โดยการเจริญเติบโตของเซลล์ขึ้นอยู่กับปริมาณของผงไหมซีริซิน ความเข้มข้นของกลูตารัลดีไฮด์ สายพันธุ์ของไหม รวมถึงความแตกต่างของเซลล์ในแต่ละบุคคลด้วย

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**ABBREVIATIONS**

Cel	Cellulose
DB	Dok Bua species
Gel	Gelatin
GC	Glyceraldehyde
GT	Glutaraldehyde
HGF	Human gingival fibroblast cell
LP	Luang Pairote species
MBA	N, N-methylene-bisacrylamide
MMT	Montmorillonite clay
MTT	(3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide)
NL	Nang Lai species
NN	Nang Noi species
NR	Natural rubber
OD	Optical density
PVA	Poly(vinyl alcohol)
SS	Silk sericin
SR	Swelling ratio
T	Temperature

**SYMBOLS**

$\rho$	Mass density
$M$	Mass
$V$	Volume
$d$	Interlayer spacing
$\lambda$	X-ray wavelength
$\theta$	Diffraction angle