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SYNTHESIS AND APPLICATIONS OF QUATERNARY AMMONIUM CHITOSAN
AS ADDITIVES IN HAIR-CARE PRODUCTS

Mr. Teerachai Kerdcholpetch

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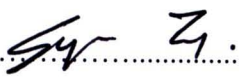
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เส้นผมของมนุษย์มีประจุลบ ณ สภาวะที่มีพีเอชสูงกว่าค่าไอโซอิเล็กทริก (~ 3.67) ดังนั้น ส่วนผสมที่มีประจุบวกสามารถเคลือบติดเส้นผมได้ง่าย ในงานนี้ได้สังเคราะห์อนุพันธ์ไคโทซานที่มีประจุบวกสองชนิดคือ เอ็น,เอ็น,เอ็น-ไทรเมทิลแอมโมเนียมไคโทซานคลอไรด์ (TMC) และเอ็น-[(2-ไฮดรอกซิล-3-ไทรเมทิลแอมโมเนียม)โพรพิล]ไคโทซานคลอไรด์ (HTACC) ที่มีระดับควอเทอร์ไนเซชัน (DQ) ต่างๆ กันเพื่อใช้น้ำยาปรับสภาพเส้นผมแบบชะโลมทิ้งไว้ ได้ยืนยันโครงสร้างทางเคมีของอนุพันธ์ที่สังเคราะห์ได้ด้วยโปรตอนเอ็นเอ็มอาร์และเอฟทีไออาร์ จากการทดสอบความเป็นพิษต่อเซลล์ในหลอดทดลองโดยวิธีเอ็มทีที พบว่า ความเป็นพิษของ HTACC ต่อเซลล์ชนิด HaCaT ขึ้นอยู่กับ %DQ ได้เลือกใช้ TMC (22%DQ) และ HTACC (24%DQ) ในสารปรับสภาพเส้นผม เพราะสารทั้งสองมีความเป็นพิษต่ำที่สุดและยังมีต้นทุนการสังเคราะห์ต่ำ น้ำยาปรับสภาพเส้นผมที่เตรียมได้นี้สามารถเคลือบติดบนเส้นผมได้ดังผลการวิเคราะห์จากกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราดและเอทีอาร์เอฟทีไออาร์ไม่โครสเปกโทรสโกปี นอกจากนี้ ยังได้วิเคราะห์สมบัติการทนต่อแรงดึง, เนื้อสัมผัส และการหวีแบบเปียกของเส้นผมพบว่าน้ำยาปรับสภาพเส้นผมที่เตรียมได้นี้สามารถปรับสภาพเส้นผมที่ถูกต้องและยืดให้มีความแข็งแรงเพิ่มขึ้นและให้ความนุ่มลื่นในการสัมผัสมากกว่าผลิตภัณฑ์ที่ขายตามท้องตลาด ผลการศึกษานี้สมควรที่จะนำไปสู่การประยุกต์ใช้เชิงพาณิชย์ของสารประกอบไคโทซานที่มีประจุบวกในอุตสาหกรรมนอมเส้นผม

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ลายมือชื่ออาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก

วราวุฒิ

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At any conditions with pH above the isoelectric point (~ 3.67), the surface of hair bears a net negative charge. Therefore, positively charged ingredients can be easily coated on it. In this work, two positively charged derivatives of chitosan, *N,N,N*-trimethylammonium chitosan chloride (TMC) and *N*-[(2-hydroxyl-3-trimethylammonium)propyl]chitosan chloride (HTACC), with varying degrees of quaternization (*DQ*) were synthesized for use in “leave-on” conditioners. The chemical structures of the charged derivatives were verified by ^1H NMR and FTIR. From *in vitro* cytotoxicity study by MTT assay, %*DQ* dependent on toxicity against HaCaT cells line was observed for HTACC. TMC (22%*DQ*) and HTACC (24%*DQ*) were used as cationic ingredients in the conditioner because of their lowest toxicity as well as synthesis costs. The prepared leave-on conditioners were able to coat on hair as evidenced by scanning electron microscopy and ATR-FTIR microspectroscopy. In addition, tests for hair’s tensile properties, texture, and wet combing were also evaluated. The prepared conditioners could increase the strength and the smooth feel of waved and straightened hairs more than did the commercial product. This study can in fact pave the way for commercial application of the positively charged chitosan compounds in hair-care industry.

Field of Study : Petrochemistry and Polymer Science Student’s Signature : *teerachai*

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LIST OF ABBREVIATIONS

Å	: Angstroms
ATR	: Attenuated total reflectance
DD	: Degree of deacetylation
DQ	: Degree of quaternization
eq	: Equivalent
FBS	: Fetal bovine serum
FTIR	: Fourier transform infrared
Ge	: Germanium
GTMAC	: Glycidyltrimethylammonium chloride
HaCaT	: Human keratinocyte cells line
IRE	: Internal reflection element
CH ₃ I	: Iodomethane
kV	: Kilovolt (10^3 V)
LSM	: Laser scanning micrometer
LO	: Leave-on without cationic polymers
LO+1%quat	: Leave-on with 1%w/w polyquaternium-10
LO+1%chitosan	: Leave-on with 1%w/w chitosan
LO+1%TMC	: Leave-on with 1%w/w TMC
LO+1%HTACC	: Leave-on with 1%w/w HTACC
MCT	: Mercury-cadmium-telluride
MTT	: Miniature tensile tester
µm	: Micrometer (10^{-6} m)

nm	: Nanometer (10^{-9} m)
HTACC	: <i>N</i> -[(2-hydroxyl-3-trimethylammonium)propyl]chitosan chloride
HEPES	: <i>N</i> -(2-hydroxyethyl)piperazine- <i>N</i> -(2-ethanosulphonic acid)
TMC	: <i>N,N,N</i> -trimethylammonium chitosan chloride
NMR	: Nuclear magnetic resonance spectroscopy
ppm	: Part per million
SEM	: Scanning electron microscopy
w/w	: Weight per weight
ZnSe	: Zinc selenide
MTT	: 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide