# *Development of Nanocrystalline Cellulose Incorporated with Biopolymers for Industrial Applications*

A Thesis
Submitted by


## *Mona Tawfik Kamer Alshemy*

*(M.Sc. Inorganic Chemistry 2010)*


*For the Requirement of the Degree*
*of*
***Doctor of Philosophy (Ph.D)***
*to*


***Chemistry Department***

***Faculty of Science***

***Ain Shams University***


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This thesis has been approved for submission by supervisors:

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Ph.D. Thesis

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# *DEDICATION*

*First Of All, I Dedicate This Work to my Beloved Mother, my Husband Dr. Aly, & my Lovely Son Mohamed*

*ALSO*

*To My Whole Family & Dear Friends*
*Deep Gratefulness*

*for*

*Their Patience, kind support, & continuous encouragement during the whole time of my Ph.D. thesis*

*Mona Al-Shemy*

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***Mona Tawfik Kamer Al-Shemy***

# Abstract

Packaging has increasingly become a dominant factor in the global market competitiveness: this implies also obtaining new raw materials with improved packaging properties. Material from locally cultivated date palm was used as a packaging additive, showing potential in improving strength and barrier properties. In particular, date palm sheath (DPS) cellulose nano-crystals (CNCs) were prepared by ammonium persulfate (APS) treatment of unbleached, bleached and mercerized fibers. The influence of the reaction parameters on the CNCs were studied. Besides APS extraction, CNCs were also isoltaed from DPS fibers using mineral acids ( sulfuric & phosphoric). The effect of cellulose polymorphs on CNC isolation were studied too. The characteristics of DPS-CNCs prepared by APS treatment were compared with those of CNCs obtained by the two acid hydrolysis treatments. The CNCs degree of substitution and surface charge density were determined by conductometric titration and zeta potential measurements, respectively. A significant particle size reduction, surface charge density diminishing, and thermal stability enhancement ensued as a consequence of cellulose mercerization. The elucidation of the structure of the prepared compounds were done via several techniques. The packaging processing with the extracted CNCs includes bio-composite and antimicrobial food package formation and jute package modulation. All the prepared bio-composites at optimum conditions showed enhanced mechanical, barrier, thermal and antimicrobial properties.

# Key words

Cellulose nano-crystal (CNC) ; Degree of oxidation ; Degree of substitution ; Cellulose polymorphs ; Bio-composite ; Food package ; Mechanical properties ; Water vapor permeability ; Water sorption isotherm ; BET model ; β-Cyclodextrin ; Clove oil ; Jute ; Thermal stability.

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