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Synthesis, Characterization and Flocculation Properties of *Acacia tortilis* Grafted with Styrene

A Dissertation Submitted in Partial Fulfillment of the Requirements of the Master Degree in
Industrial Chemistry

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Dedication

To the soul of my father, to my mother, husband, sisters and brothers

Acknowledgement

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Abstract

The aim of the present study was to prepare and characterize *Acacia* gum grafted polymers as well as their application as flocculating polymers. The grafted gum samples were prepared using varying concentrations of the monomer and gamma radiation doses. The samples were characterized by FTIR, TGA, viscosity, pH measurement and grafting efficiency. The results have shown that the main factor which affects the grafting efficiency is the monomer concentration. It was found that both the radiation dose and the amount of the monomer have considerable effects on the viscosity of the aqueous solutions of the grafted samples. Sample 3c and 1b have shown the highest viscosity values of 49 cp and 44 cp compared to the crude sample for which the viscosity was 10 cp. The thermal analysis has shown three steps of degradation of the crude gum at 199.3, 284.0 and 439.7 °C and their accompanying mass loss were 10%, 40% and 60%. Moreover, all the grafted copolymers were thermally stable than the crude gum. Finally, the synthesized graft copolymer showed improved flocculation characteristics in comparison to the crude gum.

مستخلص البحث

هدفت هذه الدراسة لتحضير وتشخيص صمغ الأكاسيا المدمج ودراسة تطبيقاتها كمواد ذات خصائص تجميعة. حُضرت العينات المدمجة باستخدام تراكيز متباينة من المونومر وكذلك من جرعات أشعة جاما، شُخصت العينات باستخدام مطيافية الأشعة تحت الحمراء، والتحليل الحراري الوزني، واللزوجة، وقياس الأس الهيدروجيني، وكذلك كفاءة الدمج. بينت النتائج أن كفاءة الدمج تعتمد بصورة أساسية على تركيز المونومر. بالإضافة الى ذلك فقد وُجد أن كل من جرعة الأشعة وتركيز المونومر لها آثار كبيرة على لزوجة المحاليل المائية للعينات المدمجة. أظهرت العينتان 3c و 1b أعلى قيم للزوجة وهي 49 cp و 44 cp مقارنة بالعيينة الخام والتي لها لزوجة تبلغ 10 cp. بينت نتائج التحليل الحراري أن العينة الخام تتفكك في ثلاث مراحل عند درجة حرارة 199.3 و 284.0 و 439.0 درجة مئوية. وقد وجد أن العينات المدمجة أكثر إستقراراً حرارياً من الصمغ الخام. أخيراً فقد وُجد أن للعينات المدمجة خصائص تجميعة أفضل من الصمغ الخام.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPLANATION
A.	Acacia
Co	Cobalt
Cs	Cesium
K	Kilo
Ca	Calcium
Mg	Magnesium
Na	Sodium
Fe	Iron
C	Carbon
H	Hydrogen
O	Oxygen
N	Nitrogen
FAO	Food and Agriculture Organization
E.g.	Example
ml	Millimeter
G	Gram
PH	Power of Hydrogen Iron
Cm	Centimeter
m	Meter
deg	Degree
mid	Middle
mj	Millie joule
Wt.	Weight
Mwt	Molecular weight
DMF	Dimethyl Formamide

KGy	Kilo gray
GE	Grafting efficiency
Wg.	Weight of pure grafted copolymer
Wp	Weight of polysaccharide
FTIR	Fourier Transform Infrared Spectroscopy
V	Volume
K cal	Kilo calorie
Kg	Kilo gram
TGA	Thermo gravimetric analysis
Ac	Acrylamide
TG	Thermogravimetry
mg	Milli gram
cP	Centipoise
(w/v)	The amount by weight (mass) of a solid substance dissolved in a measured quantity of liquid.
DSC	Differential scanning calorimetry

LIST OF SYMBOLS

SYMBOLS	MEANING
β	Beta
γ	Gamma
κ	Kappa
*	Asterisk
&	And
$^{\circ}\text{C}$	Centigrade
%	Percent
/	Division slash
eV	Electron volt
MeV	Millielectronvolt
cm^{-1}	Centimeter power ⁻¹

CHAPTER ONE

INTRODUCTION

1.2 Introduction

Polysaccharides are polymeric carbohydrate structures which are formed by repeating units joined together by glycoside linkages and contain various degrees of branching, polysaccharides have been used extensively for their functional properties, such as thickeners, gelling agents, stabilizers, interfacial agents, flocculants and encapsulates, in such applications as food, adhesives, coatings, construction, paper, pharmaceuticals, and personal care (Whistler *et al.*, 1993, Stephen *et al.*, 2006, Cheng *et al.*, 1999). Graft copolymer has a preformed polymer acting as a backbone to which polymeric chains are attached at different sites. Thus, graft copolymer consists of a polymer backbone with lateral covalently linked side chains.

The intrinsic structure and properties of nonionic, anionic, and cationic gums make them found extensive application in various areas, but the raw gum also emerges some drawbacks and cannot meet all application requirements for some special purpose. Thus, the modification of gums with small molecules was conducted because the derivatives can not only bring the favorable properties due to the introduction of functional groups, but also keep the intrinsic advantages of gums to the greatest degree (Dodi *et al.*, 2011), and so the chemical modification always plays a dominant role to improve gums and open prospects for extending the application of raw gums.

1.2 Objectives of the study

The objectives of this study was to:

1. To optimize the preparation of *Acacia tortilis* gum grafted with monomers using varying concentrations of the monomer and fixed amount of the gum.
2. To use gamma irradiation as an initiator for grafting because of its successful and wide applicability.
3. To examine the applications of the grafted samples as flocculating materials.