

DEDICATION

To my family with

special love

ACKNOWLEDGEMENT

I thank Allah the most gracious the most merciful for giving me the health to accomplish this work.

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ABSTRACT

Preparation and physicochemical characterization, emulsification and rheological properties of glucuronic acid and glucuronates from *Acacia senegal* var *senegal* gum were studied using standard methods.

Standard characterization methods were used to obtain average value of moisture, ash, specific rotation, intrinsic viscosity, pH, nitrogen, protein, number average molecular weight, acid equivalent weight and refractive index of *Acacia senegal* var *senegal* gum, they were found to be 8.42%, 3.5%, -24.87°, 12.0 ml g⁻¹, 4.6, 0.35%, 2.23%, 4.1×10^5 Da ,1239.6 and 1.336 respectively.

The sugar composition study using HPLC technique shows the percentage of the average values of galactose, arabinose, rhamanose and glucuronic acid for *Acacia senegal* var *senegal* gum, the values were found to be 40.70, 33.79, 9.31 and 15.65 respectively.

The cationic composition study using atomic absorption technique shows that calcium has the highest value followed by, potassium, magnesium and sodium. As for the rest of the elements namely Fe, Cu and Zn only trace values were obtained for the gum *Acacia senegal* var *sengal*.

Glucuronic acid was prepared from *Acacia senegal* gum by the removal of metal ions using ion exchange chromatography. Glucuronates of (Na, K, Ca and Mg) were prepared using glucuronic acid by adding respective cations. Scanning electron microscope (SEM) proved successful production of glucuronic acid and glucuronates.

The measured pH values were 2.6, 6.9, 6.5, 4.9, and 4.5 for glucuronic acid, Na, K, Ca and Mg glucuronates respectively. Intrinsic viscosities of glucuronic acid, Na, K, Ca and Mg glucuronates in 1M NaCl were determined. The

measured viscosities were 8.53, 2.47, 0.11, 0.05 and -1.24 ml g⁻¹ for glucuronic acid, Na, K, Ca and Mg glucuronates respectively and 10.82, 14.33, 12.9, 10.12 and 9.38 ml g⁻¹ for glucuronic acid, Na, K, Ca and Mg glucuronates respectively in 0.5M NaCl where they were 18.47, 45.82, 30.72, 11.76 and 10.83 ml g⁻¹ for glucuronic acid, Na, K, Ca and Mg glucuronates respectively in deionized water. The intrinsic viscosity have been measured in dilute 3% concentration and pH of 5.5 and the results were 118.37, 116.73, 21.27, 18.91 ml⁻¹ for Na, K, Ca and Mg glucuronates respectively.

The equivalent conductivities of glucuronic acid and glucuronates have been measured in water at 25°C. The results showed a very sharp nonlinear increase with decreasing polyelectrolyte concentration.

The rheological study of the *Acacia senegal* gum and glucuronates show Newtonian behavior with linear relationship between stresses and shear rate while glucuronic acid show non-Newtonian behaviour (Pseudoplastic) and hence it is shear thinning. The study also show viscous behaviour of the gum with G'' dominate G' in the lower region of the frequency range tested; viscous behaviour of the *Acacia senegal* gum and glucuronates dominates the elastic behaviour. After a certain frequency a cross-over of G' and G'' is seen; as frequency increase G' < G''. glucuronic acid show different behaviour G' and G'' profiles are parallel (no cross-over) with G' > G''.

The emulsion of Na, Ca and Mg show stability until 3 days while *Acacia senegal* gum form multiple peaks from 3 days and completely separated in 7 days. The emulsion of K and glucuronic acid results clearly showed that no change was found in emulsions during the incubation for 7 days at 60°C which means that they have better emulsifying properties over the time range and temperature.

ملخص البحث

لقد تمت تحضير و توصيف الخصائص الفيزيوكيميائية، الخصائص الاستحلابية والخصائص الريولوجية لحمض الجلوكيوريك وأملاحه من صمغ الاكاسيا سنغال صنف السنغال باستخدام طرق قياسية.

أظهرت النتائج بأن متوسط الرطوبة، الرماد، الدوران النوعي، اللزوجة الضمنية الرقم

الهيدروجيني، النتروجين، البروتين، متوسط الوزن الجزيئي العددي، الوزن المكافئ و معامل الانكسار لصمغ الهشاب من منطقة الدمازين كانت: 8.42%، 3.5%، 24.87%، 12.002 مل/جرام، 4.6 %، 0.35%، 2.23%، 4.1×10^5 جرام/مول، 1239.6 و 1.336 على التوالي.

أظهرت دراسة محتوى المواد الهيدروكربونية باستخدام الكروماتوجرافيا السائلة ذات الضغط العالي أن النسبة المئوية المتوسطة لقيم كل من الجلاكتوز، الأربينوز، الرامانوز وحمض الجلوكيوريك لصمغ الهشاب كانت: 40.70%، 33.79%، 9.31% و 15.65% على التوالي.

تمت دراسة محتوى العناصر باستخدام جهاز طيف الامتصاص الذري لصمغ الهشاب، سجل عنصر الكالسيوم أعلى قيمة يليه البوتاسيوم ثم الماغنسيوم ثم الصوديوم. أما بقية العناصر (الحديد، النحاس، الزنك) أظهرت قيم صغيرة جدا. الجلوكيوريك

تم تحضير حمض الجلوكيوريك من صمغ الهشاب بإزالة العناصر الموجودة فيها باستخدام كروماتوجرافيا التبادل الايوني. تم تحضير أملاح (الصوديوم، البوتاسيوم، الكالسيوم والمغنسيوم) لصمغ الهشاب من حمض الجلوكيوريك بإضافة عناصر (الصوديوم، البوتاسيوم، الكالسيوم والمغنسيوم) بنفس نسب وجودها في صمغ الهشاب أيضا باستخدام كروماتوجرافيا التبادل الايوني.

أظهر مسح الميكروسكوب الالكتروني علي سطح الاملاح نجاح عملية التبادل الايوني.

أظهرت النتائج ان الرقم الهيدروجيني لحمض الهشاب وأملاحه من الصوديوم، البوتاسيوم، الكالسيوم والمغنسيوم هي 2.6، 6.9، 6.5، 4.9، 4.5 علي التوالي.

تمت دراسة اللزوجة الضمنية لحمض الجلوكيوريك وأملاحه من الصوديوم، البوتاسيوم، الكالسيوم والمغنسيوم في محلول ملح الطعام تركيزة 1مول وكانت النتائج علي النحو التالي: 0.11، 2.47، 8.53، 0.05 و 1.24- مل/جم علي التوالي. وكذلك كانت نتائج اللزوجة الضمنية في محلول ملح تركيزة 0.5 مول جاءت النتائج علي النحو التالي: 10.82، 14.33، 12.9، 10.12 و 9.38 مل/جم لحمض

الجلوكيورنيك وأملاحه من الصوديوم، البوتاسيوم، الكالسيوم والمغنسيوم علي التوالي. ايضا تمت دراسة اللزوجة الضمنية في المياة المقطرة (خالية من الايونات) وكانت النتائج علي النحو الاتي 18.47، 45.82، 30.72، 11.76 و 10.83 مل/جم. أظهرت الدراسة ان اللزوجة الضمنية لاملاح الجلوكيورنيك يرتفع عند التراكيز المنخفضة 3% ورقم هيدروجيني 5.5 وكانت نتائج الدراسة كالآتي: 118.37، 116.73، 21.27 و 18.91 مل/جم ، لكل من ملح الصوديوم، البوتاسيوم، الكالسيوم و المغنسيوم علي التوالي.

تمت دراسة الخصائص التوصيلية المكافئة لحمض الجلوكيورنيك وأملاحه عند درجة حرارة 25°C وأظهرت النتائج علاقة غير خطية مع زيادة حادة في التوصيلية عند نقصان تراكيز البولي الكتروليت.

أظهرت الدراسة الريولوجية لصمغ الهشاب وأملاحه أنه يسلك سلوكاً نيوتوني بينما يسلك حمض الجلوكيورنيك سلوك غير نيوتوني . كما أبرزت الدراسة الريولوجية أيضاً أن محلول الصمغ المائي ومحلول أملاحه سلوكه يتصف باللزوجة و أن صفة اللزوجة تتغلب على صفة المرونة في التردد القليل و عند زيادة التردد يحدث تقاطع بين اللزوجة والمرونة ويتغير سلوك الصمغ ليصبح بين اللزوجة والمرونة بعدها تتغلب صفة المرونة علي اللزوجة . أما حمض الجلوكيورنيك ياخذ سلوك مغاير أذ أنه لا يوجد تقاطع بين صفة اللزوجة و صفة المرونة.

أظهرت دراسة خصائص الصمغ وأملاحه الاستحلابية أن مستحلب ملح الصوديوم والكالسيوم والمغنسيوم تتشابه في خصائصها الاستحلابية وأنه يتمتع بقدرات استحلابية أفضل من صمغ الهشاب أما ملح البوتاسيوم والحمض فأنهما يتمتعان بقدرات استحلابية أفضل منهم جميعاً.

LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization of the United Nation
WHO	World Health Organization
JECFA	The joint Expert Committee of Food additives of the FAO/WHO
SEM	Scanning electron microscopy
US	United states Pharmacopoeia
USFDA	United States Food and Drug Administration
IIED	international institute of environment and development
IES	institute of environmental studies
AG	Arabino Galactan
AGP	Arabino Galactan protein
GP	Glycoprotein
HIC	Hydrophobic Interaction Chromatography
UV	Ultra violet
M _n	number average molecular weight
HPLC	High Performance Liquid Chromatography
SAOS	Small amplitude oscillatory test
NCF	Nitrogen conversion factor
AFFF	Aqueous film-forming foam

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