CHEMICAL AND PHYSICAL STUDIES ON EGYPTIAN AND SUDANIAN COTTON

BY

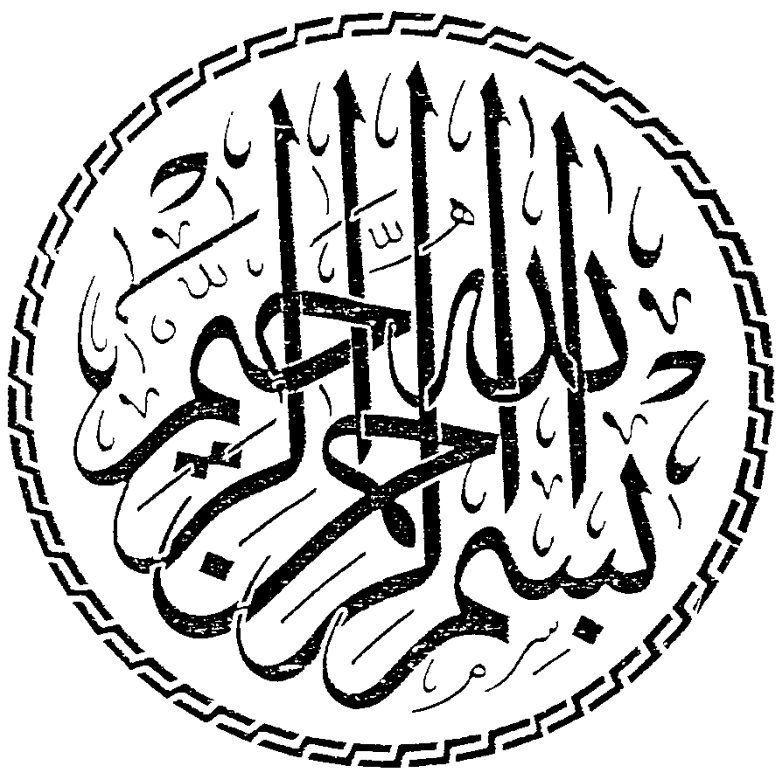
HESHAM REDA HAMED MOHAMED
B.Sc. Science (Cairo)

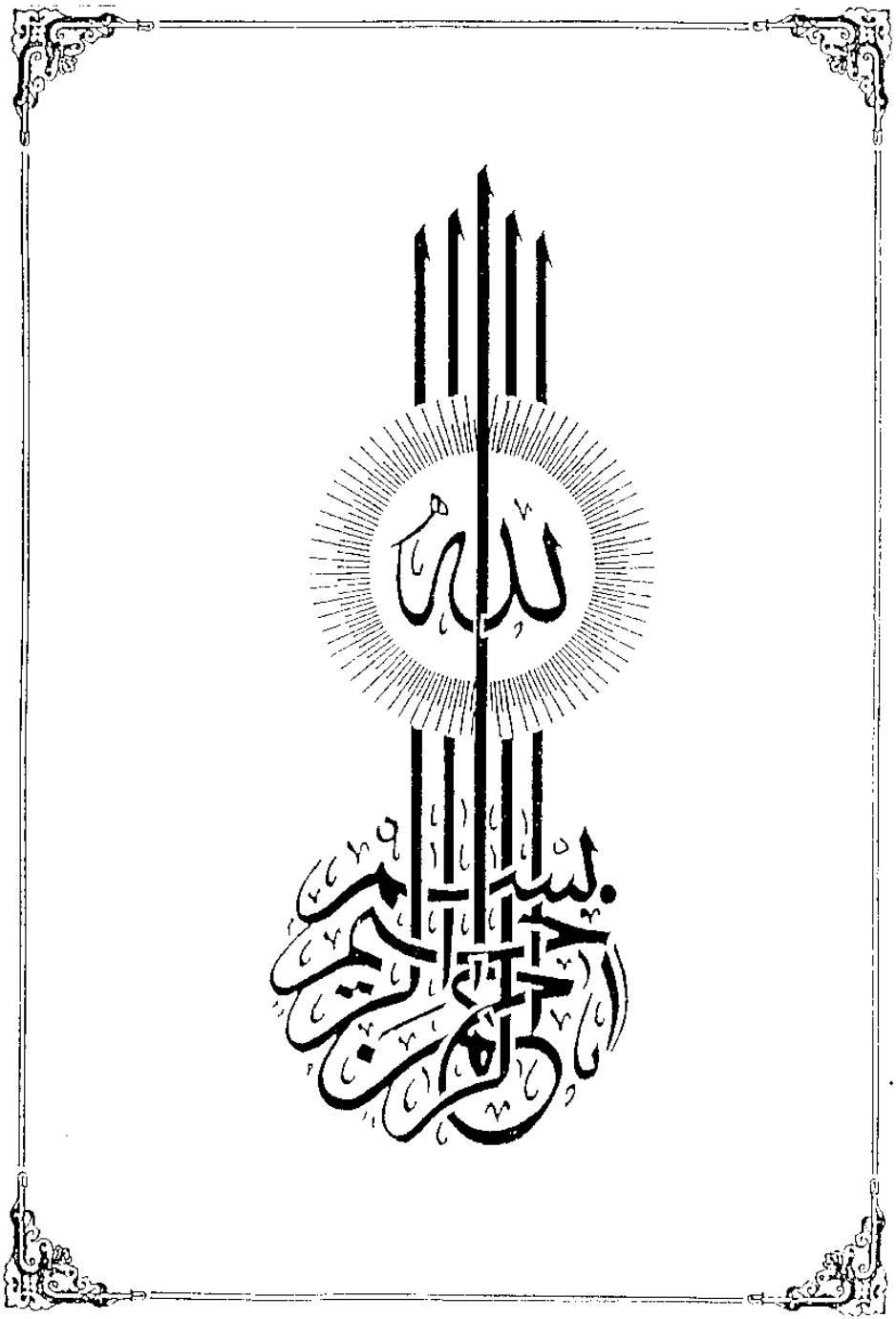
A THESIS

Submitted for the Degree of
MASTER of Science
in
Organic Chemistry

DEPARTMENT OF CHEMISTRY
FACULTY OF SCIENCE
AIN SHAMS UNIVERSITY

1985





ACKNOWLEDGMENT

I am greatly indebted to Prof. Dr. Gamal Eldin M. Moussa, Professor of Chemistry, Faculty of Science, Ain Shams University, for his continuous encouragement and supervising the work.

I would like to express cordial thanks to Prof. Dr. Samir A. El - Laithy, Professor, National Center for Social and Criminological Research for guidance, help and advice and to Dr. Nabil M. Safy Eldin, Lecturer, National Center for Social and Criminological Research, for suggesting the subject investigation and helpful discussions.

CONTENTS

AIM OF THE WORK

The aim of this work is to study the effect of sodium hydroxide treatment with wide range of concentrations at lower temperature on the Egyptian and Sudanese cotton fibers and the resulting changes in the chemical, physical and sub - microscopic properties were investigated.

Another objective of this work is to compare between the previous properties of the Egyptian and Sudanese cotton fibers after treatment with different concentrations of alkali. It is also intended to study the changes in the reactivity of the two cotton fibers towards xanthation. It was among the aims of this work to find out the optimum condition of alkali treatment of the Egyptian and Sudanese cotton fibers which cause improvement in their accessibility in mercerization processes, in facilitating penetration of water and alkali inside the fibers and also better reactivity towards xanthation without considerable degradation of the fibers, and at the same time higher chemical purity.

INTRODUCTION

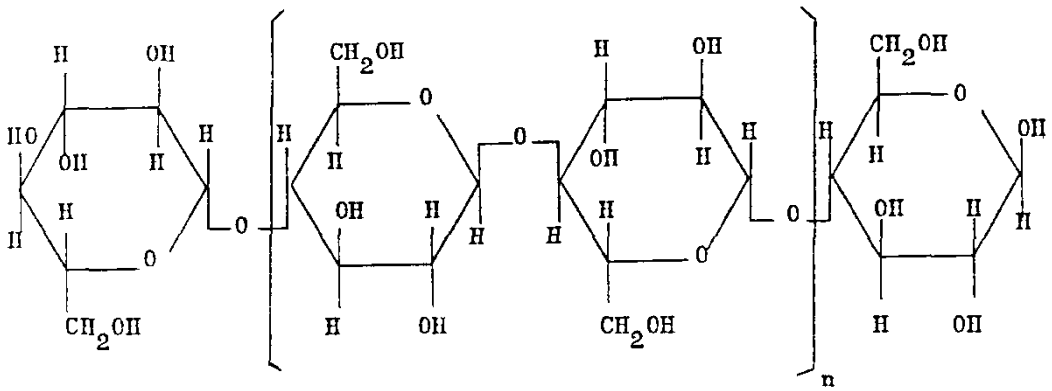
INTRODUCTION

I - STRUCTURE OF CELLULOSIC PULPS

1) Cellulose (1) :-

Cellulose pertains to the class of carbohydrate. It contains 44.4 % of carbon, 6.2 % of hydrogen and 49.4 % of oxygen. An insigth into molecular structure of cellulose was first obtained when it was shown that cellulose can be quantitively hydrolyzed to glucose, indicating that the cellulose molecule is composed of a series of glucose units. It was shown that each glucose unit in the cellulose molecule contains three free hydroxyl groups, composed of two secondary alcohol groups and one primary alcohol group, which are arranged in position 2,3, and 6, respectively, on the glucose unit. The d - glucose anhydrides of the beta - form are interconnected by 1,4 - glucosidic oxygen bonds.

The cellulose molecule thus consists of a long,straigth chain of glucose anhydride units arranged in cellbiose pairs. The end units of cellulose macromolecule chain differ somewhat in composition from the middle glucose units, $C_6H_{10}O_5$. One of the end unit, $C_6H_{11}O_6$, has an aldehyde group. The other end unit, $C_6H_{11}O_5$, contains four hydroxyls (there are three hydroxyls in the middle units).



The structure of cellulose materials is complex and varied. Not only do various supermolecular morphological forms of structure exist, but the macromolecule itself may contain units of a different chemical nature and the molecular weight and forms of macromolecules may vary within wide limits ; morever, the degree of macromolecular orientation as well as the types of intermolecular interaction may also be very different. There are various structural modifications of cellulose capable of interconversion.

Units of another chemical nature may be compared in composition of cellulose macromolecule. It has been establised, for instance, that in preparation of pure cellulose there is a certain amount of glucuronic acid residues, as well as units with methoxyl groups. Cotton cellulose contains approximately one methoxyl group per 85 - 190 elementary units. There is one carboxyl group per approximately 100 elementary units. Wood cellulose contains a number of carboxyl groups. These groups are few in number unless the cellulose has been seriously degradad, but they are present in sufficient number that the cellulose acts as a weak monobasic acid. The carboxyl groups occur at a frequency

of about one for every hundred or more glucose units. They are located mainly in number 6 position, although they may also be found in number 2 and 3 positions.

2) Hemicellulose :

The hemicellulose are characterized by a much lower degree of polymerization than cellulose, being about 155, compared to a value of 4000 or more in case of native cellulose.[2] They are composed of polymers of pentoses such as xylan and arabinan, and polymers of hexoses, e.g., mannan and galactan. Mixed polymers as glucoxylan and arabinogalactan, derivatives of sugars (e.g., methyl pentosans), and oxidized sugars containing the uronic acid grouping are also included. The hemicellulose consist of two main classes, the cellulosans and polyuronides.

a- Cellulosanes :-

The cellulosanes included all those hemicellulose which are built up of simple sugars. They include both the hexosans and the pentosans. The cellulosanes are not easily removed by alkali as they are strongly associated with cellulose.

b- Polyuronides :-

These are hemicelluloses which contain large amounts of hexo-uronic acids, some methoxyl and acetyl groups, and some free carboxylic acid groups. It is impossible to remove all lignin

without lossing a considerable amount of hemicellulose fractions. This is because the polyuronides are strongly attached with lignin. However, some association exists with cellulose.

3) Lignin

Lignin is an amorphous macromolecular compound with a lower degree of polymerization than cellulose. The exact shape of the lignin molecule is still unknown, but definitely it does not have the linear structure of cellulose. It is composed of propylbenzene building units. It contains both alcoholic and phenolic hydroxyl groups, methoxyl groups, and carbonyl groups.[3]

II - STRUCTURE, PHYSICAL AND CHEMICAL COMPOSITION OF COTTON FIBERS

Cotton fibers are small cells with very thin wall and its interior surface is filled with sap (protoplasm) during the life of the fibers. After the fiber is seperated from the seeds, the sap dries up and a small granular residue remains on the interior walls of the lumen. The average fiber length of different kinds of cotton various from 22 to 50 mm. The diameter, from 18 to 25 microns. Depending on the variety and degree of maturity of the fiber, its breaking strength various from 0.5 to 10 grs. (on the average 4 - 5 grs.) and the elongation at rupture is 4 - 13 % (on the average 7 - 8 %). The density of the cotton fiber is equal to 1.53. The moisture content in mature fiber attains 5.5 to 6.5 %, but on storing it in humid permises it may be higher.

Viewing under the microscope, the fiber is a thin flat strip which for the greater part is cork screwed and narrowing at the ends, more to the top and less to the bottom end. The fiber top end is conical and closed, while the bottom end by which it is attached to the seed is regardly torn. The microscopic picture of the cross section of a swollen cotton fiber (Fig. 1) reveals the presence of growth rings on the secondary wall.These rings are constituted of cellulose layers of different density and,possibly, of higher and lower orientation.

The main admixture accompanying cellulose in cotton fiber

which can be determined by quantitive analysis, are nitogenous substances, pectins, wax - like substances, ash, and others. Mature cotton fiber contains on the average (in percent of absolute dry substance) as following Table (I) (4)

Table (I)

Cellulose	94.0
Wax - like substance	0.6
Organic acids	0.8
Pectins (calculated as pectic acid)	0.9
Nitrogenous substances	1.3
Ash	1.2
Noncellulosic polysaccarides	0.3
Unidentified substances	0.9
	100.0