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English Abstract of the Main Articles  
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STUDIES ON THE CHEMICAL NATURE OF α -CELLULOSE AND COPPER VALUE

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In a cause of the preparation of wood pulp for rayon, it should be kept in mind that high content of α -cellulose and copper value is low. Such an idea is borne in the writer's mind from the experiment by Dr. N. Matsunami (Mem. Coll. Sci. K. Imp. Uni. A. 13 (1939) 175) which was carried out in the writer's laboratory, of raw materials such as wood pulp from Todomatsu (*Abies saccharinensis*, Mastees) grown at Naibuchi, Karafuto, and prepared by cooking with sulphite liquor at the Hokuetsu Seishi Co., Kaolang culmo (*Andropogon Sorghum*, Broth) grown in Manchuria; and the crude fibre from ramie (*Boehmeria nivea*, Hook and Arm) grown in Taihoku, Formosa.

Bleached cellulose from these raw materials were prepared by Cross-Bevan's method (I. Chem. Soc., 55 (1907) 199) and the chlorine dioxide method proposed by C. Schmidt C. Ber., 54 (1921) 1862), and the analytical results of the bleached cellulose are shown in Table II with those of the raw materials (Table I, in comparison.)

Lignin which occurs in the raw cellulose-fibres together with α -cellulose, is removed by both processes of bleaching, but pentosans remained partly in the bleached pulps. These processes, moreover, will give some chemical action on the α -cellulose, forming β -cellulose and oxycellulose.

The content of α -cellulose of wood pulps and of other bleached pulps has no marked difference in both processes, however, the chlorine dioxide method which gives bleached pulp of good quality for rayon having low copper value.

In bleaching, when oxidizing agent was used, as mentioned by Hagglund in his book "Holzchemie" (1928) p. 62, oxy cellulose content and Ca-value in bleached pulp from spruce wood will be increased but not by reducing liquor such as Klason's solution. The essential point of Cross-Bevan's method and the chlorine dioxide method, is used for bleaching chlorine and chlorine dioxide respectively.

Pentosans and β -cellulose in bleached pulp can be removed by using sodium hydroxide solution of various strength; the pulp of 99 % of α -cellulose from bleached wood pulp will be obtained when treated successively with 12.5 % NaOH solution and then 4 % NaOH, while Kaolang pulp of 99 % α -cellulose will be obtained when used alkali solutions

of different strength in three stages, namely 7 % NaOH solution is first employed to remove pentosan and then β -cellulose is washed off by use of 12.5 % NaOH and then 17.5 % NaOH.

The final purified pulps from raw materials were analysed and results are shown in Table III.

In order to prepare pulp of high content of α -cellulose, the bleached pulps were heated in an autoclave with water at 150°C for 5 hours, and the insoluble portion which was separated from the solution was dried and analysed. It was found to consist of α -cellulose, as will be seen in Table IV.

Table I

	Wood %	Ramie %	Kaolang %
H ₂ O	7.5	7.0	11.0
Ash	0.4	3.1	4.5
Water-ext.	1.8	2.2	6.2
T. N.	0.01	0.56	0.32
Lignin	7.3	6.1	24.7
Pentosan	4.6	5.6	24.6
Cellulose	88.3	90.2	47.2

Table II

Method	Wood		Ramie		Kaolang	
	A	B	A	B	A	B
Pulp yield%	87	92	78	79	42	48
Water	7.5	57	9.1	11.8	9.8	7.1
Ash	0.2	0.2	0.1	0.2	1.5	0.7
α -Cellulose	82.9	84.9	95.8	96.5	76.6	73.2
β -Cellulose	6.03	3.45	2.63	1.09	15.70	7.11
Pentosan	4.06	4.15	0.33	0.53	11.95	21.47
Furfural	2.5	2.5	0.2	0.3	7.0	12.8
Cu-val.	3.25	2.5	1.53	0.89	2.87	1.59
Sp.-vis.	5.80	5.33	7.10	12.16	3.73	5.02

Table III

	Wood		Ramie		Kaolang	
	A	B	A	B	A	B
Yield %	92	91	95	97	81	85
Water	6.7	5.8	6.2	6.1	6.0	6.4
Ash	0.1	0.1	0.1	0.1	0.2	0.1
α -Cellulose	99.3	99.5	99.9	99.4	99.5	99.7
Furfural	0.13	0.34	0.1	0.3	1.4	1.8
Cu-val.	0.86	0.61	0.98	0.64	0.7	0.4
Sp.-vis.	6.0	16.0	6.1	23.3	13.2	24.1

Table IV

	Wood		Ramie		Kaolang	
	A	B	A	B	A	B
Water	5.9	6	6.7	7	4.9	4.3
Ash	0.1	0.1	0.04	0.1	0.7	0.2
α -Cellulose	90	93	92	94	80	78
Furfural	2.1	2.3	0.4	0.4	9.5	10.3
Cu-val.	2.3	2.3	2	1.8	9.2	7.5
Sp.-vis.	4.3	6	7.1	9.2	3.6	3.9

Discussion:

Cellulose molecule was assumed from chemical hydrolysis as a polymer of anhydro glucose $C_6H_{10}O_5$ units. Each unit contains five oxygen atoms, three of which are hydroxyl oxygen, the remainder etherial. The formation of β -cellulose and other hydrolytic products from α -cellulose was assumed to depend on the chemical nature of ether oxygen. Hydroxyl group in Cellulose units is connected with the formation of oxycellulose, and also on the copper-value and the specific viscosity in Schweizer's solution of cellulose.

α -Cellulose, the associated substance of anhydro glucose unit, is evidence for the hydrogen bond in H-O existed in the unit. The nature of hydrogen bond is also indicated by the specific viscosity of cellulose. When, however, the hydroxyl group behaves in presence of electron donor except of the oxygen of OH group, to given off hydrogen atom, the acceptor, resulting with the formation of oxycellulose. C=O group in the molecule of oxycellulose will be indicated on the absorption spectra of the ultra-violet rays and also on the bromine value due to the intramolecular transformation of the group:

It is, therefore, concluded that Copper value of the cellulose pulp is effected by hydrogen bonds of hydroxyl group in α -cellulose. This conclusion is also confirmed by evidence, the numerical relation between the Copper value and specific viscosity is in reverse.

To our deep regret, Dr. Shigeru Komatsu, professor of chemistry at Kyoto University, passed away on the 21th of October. Complying with our request, he gave a lecture to some members of our association on the chemical natures of α -cellulose and copper values, on Aug. 7th. He contributed an article on the essential points of the lecture both in Japanese and in English to our journal, which we have printed here in this number. The article has unexpectedly proved the last work left by him. His studies on cellulose were profound, from which we were expecting much contribution to our industry.

We heartily express our deep sorrow at his death.

— Hisashi Nakamura, old friend of the late
Professor Komatsu.