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CHARACTERISTICS OF KENAF FIBRES

Part II. Chemical Characteristics

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Samples of kenaf, *vulgaris* and *viridix*, collected at four different stages of maturity, viz, pre-flowering, flowering, small pod and seed maturity, and obtained through several different methods of retting, were subjected to analyses for hollocellulose, cellulose, lignin, pentosans and ash contents as well as for solubility losses due to alcohol, α-hydrolysis, β-hydrolysis and acid purification. Various trends and relationships were examined.

INTRODUCTION

In view of the potential uses of kenaf for various purposes, especially textile and papers production, there is a growing interest in studies on its characteristics as reviewed in the first part of this study on the physical characteristics of the fibre [1]. More especially, the variations in the scanty data, as available, warrant further studies on the fibre to identity the scale of these variations as affected by differences in species, agricultural practices, and ecological conditions, particularly where utilization of kenaf available from different geographical regions is in view.

As such this series of investigation has the following objectives in view:

(i) to compare chemical characteristics (constituents and solubilities) of the fibres from the varieties, *vulgaris* and *viridix*, grown in Pakistan.
(ii) to explore the effects of stages of maturity on these characteristics; and
(iii) to investigate effects of different methods of fibre extraction on the characteristics.

The samples as employed have been fully described in the first part [1]. Briefly, these were derived from two species, *vulgaris* and *viridix*, at four different levels of maturity, viz. pre-flowering, flowering, small pod and seed maturity. Fibres were then extracted applying the following retting techniques, resulting in the corresponding samples:

Kenaf Samples

Sample No.	Stage of maturity.	Method of retting
1.	Pre-flowering.	a. Green ribbons peeled off and retted in slow flowing canal water.
2.	"	b. Plants left to dry in the field, ribbons peeled off and retted in slow flowing canal water.
3.	"	c. Green ribbons peeled off and retted in a closed tank.
4.	"	d. Whole plants left to dry in the field and retted in a closed tank.
5.	"	e. Dry plants retted in a closed tank incorporating 1% urea.
6.	"	f. Dry plants retted in a closed tank incorporating 1% sodium hydroxide.
7.	Flowering	b. As b above.
8.	"	e. As e above.
9.	Small pod	b As b above,
10.	"	e As e above.
11.	Seed maturity	b As b above.
12.	"	e As e above.

MATERIALS AND METHODS

Kenaf Samples. Kenaf samples obtained at four different levels of maturity from the two varieties, vulgaris and viridix, as described above, were employed.

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Pre-treatment. – All the samples employed for chemical characteristics were first rendered to a coarse powder (40-mesh). While testing for the following purposes a subsample was simultaneously tested each time for moisture content by drying it in an oven to allow calculations to be based on oven dry weight.

Extraction. The sample was extracted with a mixture of Alcohol-Benzene as per TAPPI Test Tm-50[2].

Ash Content. The samples were subjected to a temperature of 600° for about 3 hr. in a laboratory furnace.

Hollocellulose. A number of different methods are available for the determination of cellulose of different purity contents, resulting in difficulties in the comparison of results. For the purposes of present studies, it was considered advisable to determine two extreme substances, viz. hollocellulose and α-cellulose to get a clear view of the range instead of adopting procedures for the rather confusing "cellulose content" of different descriptions. Essentially the chlorite method of Jayme as adopted by Sen Gupta *et al* [3]. (single treatment) was employed for the determination of the hollocellulose.

α-Cellulose. The chlorite method in conjunction with the well-established ACS method of employing 17.5 and 9.5% NaOH solutions as adopted by Chatterjee [4] was employed for the determination of α-cellulose.

Lignin. The general method employing 72% H_2SO_4 with the essential details as in TAPPI Standard Test T 222, OS-74 [5] was employed for the determination of lignin.

Pentosans. TAPPI Standard Test T 19, m-50 [6] was employed for estimation of pentosans.

α-Hydrolysis. Method adopted for α-hydrolysis employed by boiling the original ground sample with 1% solution of NaOH under reflux for 5 min. [7].

β-Hydrolysis. The original ground sample was boiled with 1% NaOH solution for one hr. [8]. This is practically equivalent to 1% NaOH solubility of TAPPI [9].

Acid Purification. The original ground sample was treated with acetic acid (20%) slowly heating till boiling [10].

RESULTS

Results for the varieties *vulgaris* and *viridix* are presented in Tables 1 and 2, respectively.

DISCUSSION

In Table 3, the results given in Tables 1 and 2 are compared with data given in the literature.

In general the results obtained are in fairly good agreement with the data from the literature. The major difference in the level of value lies in the fact that the solubilities found during this work are in general smaller than those reported in the literature as in the present case the fibres

Table 1. Characteristics of variety *vulgaris*

Sample No.		1	2	3	4	5	6	7	8	9	10	11	12	Average
Constituents														
Ash	%	2.7	2.8	1.8	1.6	1.6	1.7	2.4	1.8	1.9	1.4	2.0	1.7	2.0
Hollocellulose	%	84.2	85.1	83.9	84.6	85.3	83.8	87.5	86.6	89.3	88.8	86.3	86.4	86.0
α-Cellulose	%	56.2	56.2	55.3	56.1	57.2	56.6	58.3	58.7	61.2	60.4	58.2	58.8	57.8
Lignin	%	9.8	9.7	10.1	9.9	9.6	9.5	11.9	10.6	14.5	15.4	12.5	12.8	11.4
Pentosans	%	8.6	8.2	8.7	8.7	8.1	8.7	8.4	8.8	8.9	8.9	9.1	8.9	8.7
Solubilities														
Alcohol-Benzene	%	1.6	1.4	2.0	1.9	0.9	0.8	1.3	0.9	1.6	0.8	1.1	0.8	1.3
α-Hydrolysis	%	11.1	11.3	10.8	11.0	11.4	11.2	11.7	11.4	11.3	11.2	10.8	9.7	11.0
β-Hydrolysis	%	15.0	15.2	15.1	14.5	15.0	15.3	14.8	15.2	13.5	13.2	12.4	12.1	14.3
Acid purification	%	2.5	2.4	2.8	2.4	2.9	2.2	2.9	2.8	2.7	2.6	2.0	2.1	2.5

Table 2. Characteristics of variety *viridix*

Sample No.		1	2	3	4	5	6	7	8	9	10	11	12	Average
Constituents														
Ash	%	2.4	2.8	1.9	1.7	1.5	1.9	2.3	1.7	2.6	1.5	2.1	1.2	2.0
Hollocellulose	%	85.5	84.4	84.6	84.7	85.6	84.4	87.2	87.8	88.7	89.0	87.3	86.0	86.3
α-Cellulose	%	57.3	57.6	57.5	58.2	575.4	57.8	58.5	59.2	61.9	60.9	59.4	58.3	58.7
Lignin	%	9.3	9.2	8.9	9.9	9.4	9.0	11.0	12.3	14.4	13.6	12.8	12.0	10.7
Pentosans	%	9.1	9.4	8.5	9.3	9.2	8.8	9.4	9.7	9.6	9.8	9.8	9.9	9.4
Solubilities														
Alcohol-Benzene	%	1.2	1.5	1.8	2.0	0.9	1.0	1.5	0.8	1.5	1.0	1.0	0.8	1.3
α-Hydrolysis	%	10.1	10.8	10.3	10.9	1.8	9.6	10.0	10.1	10.8	10.6	9.3	9.0	10.2
β-Hydrolysis	%	14.0	14.6	14.9	14.0	14.2	14.8	12.3	12.0	11.2	11.0	11.8	11.9	13.1
Acid purification	%	2.4	2.1	2.3	2.4	2.5	2.6	2.4	2.2	2.3	2.2	2.2	2.2	2.3

Table 3. Comparison of results with literature data

Source		Results Vulgaris	Results Viridix	Mazumdar [11]	Nieschlag [12, 13] and Clark [14, 15]	CSIR [18]	Doree [19]
Constituents							
Ash	%	1.4-2.8	1.2-2.8				
Hollocellulose	%	83.8-89.3	84.4-89.0	88.2			
α-cellulose	%	55.3-61.2	57.3-61.9	61.6			
MEA cellulose	%				36.58[a]		
free - cellulose	%				34-41[a]		
Lignin	%	9.5-15.4	9.0-14.4	8.7	7.0-18.7[b]		
Pentosans	%	8.1-8.9	8.9-9.9		9.8-24.6		
Solubilities							
Alcohol-benzene	%	0.8-2.0	0.8-2.0		2.1-7.1		
α-hydrolysis	%	9.7-11.7	9.0-10.9			6.1-17.9	
β-hydrolysis	%	12.1-15.3	11.0-14.9			2.9-22.1	19.1
Acid purification	%	2.0-2.9	2.2-2.6			0.6-6.7	3-4

(a) Clark's figures show an increase of α-cellulose with maturity, showing in two cases a slight decrease at the seed maturity stage and in one case a continuing increase,
(b) Clark's figures show also an increase up to the pod stage and a slight decline at the seed maturity stage.

have been obtained after retting, during which process already part of the extractable matter has been dissolved.

CONCLUSIONS

(i) Comparison of varieties vulgaris and viridix

Chemical constituents:

The variety vulgaris shows to be associated with a higher lignin but lower cellulose and pentosan content than the variety viridix.

Chemical solubilities:

The variety vulgaris exhibits somewhat higher hydrolysis and acid purification losses.

(ii) Influence of the stages of maturity

Chemical constituents:

Ash content decreases with maturity, while hollocellulose, α-cellulose and lignin increase up to the small pod stage. However there is a slight decrease at the seed maturity stage. Pentosans show a slight increase with maturity.

Chemical solubilities:

All solubilities decrease in general with maturity.

(iii) Influence of retting method

Chemical constituents:

Canal retted samples show generally a higher ash content.

Chemical solubilities:

Most solubilities were the least with samples retted in tanks, containing 1% sodium hydroxide.

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