

CHEMICAL CHARACTERISTICS AND UTILIZATION OF AK (CALOTROPSIS PROCERA) FIBRES

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Summary. *Two series of Ak samples, one collected at random from ten different sources at the flowering stage and the other at various stages of maturity had earlier been studied for a number of physical characteristics (14). The series were now investigated for major chemical characteristics. Their hollocellulose, α -cellulose, lignin, pentosan and ash contents were determined. Also, losses due to alcohol-benzene solubility, α -hydrolysis, β -hydrolysis and acid purification were examined in these samples.*

Introduction. Ak (*Calotropis procera*) is a common wild plant of our plains, ascending to 1300 metres (4,11). It has fibre in the seed floss as well as in the stem. The usefulness of these fibres and cultivation of the plant on a commercial basis have been reviewed in an earlier investigation (14).

Although its usefulness had been shown as early as 1852 (11), little data are available on the characteristics of its bast fibres and that too are at variance as reviewed earlier (14). Part of this variation may be due to biological and site factors, but a part of the variations in the scanty reports may also stem from the confusion with its sister species *C. gigantea* and the differences in the methods adopted for analysis.

In view of the above, investigations were undertaken on physical as well as chemical characteristics of the fibres. The results on the physical characteristics, effects of time of harvesting, manner of extraction of the fibres, and the level of moisture have been reported in an earlier report (14). The present paper concerns complementary investigations on major chemical characteristics.

Materials and Methods. Samples were collected in two different manners and subjected to various extraction techniques as described in detail in the first paper (14). Briefly, Series 'A' comprised 10 samples collected at random, while series 'B' had been collected at various stages of maturity, as summarised below (Table I).

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Table I

Stages of maturity and methods of fibre extraction

Series	Sample No.	Stage of maturity	Method of extraction of fibres
A	1-10	Flowering (July)	Direct extraction without retting or steaming.
B	1.	Preflowering (March)	"
	2.	Preflowering (March)	Stripping and retting of strips in a closed tank.
	3.	Early flowering (June)	Direct extraction.
	4.	Early flowering (June)	Retting of strips.
	5.	Flowering (Sept.)	Direct extraction.
	6.	Flowering (Sept.)	Retting of strips.
	7.	Late flowering (Dec.)	Direct extraction.
	8.	Late flowering (Dec.)	Retting in stagnant water.
	9.	Late flowering (Dec.)	Retting in slowly flowing water.
	10.	Late flowering (Dec.)	Retting of strips.

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 sub-sample 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 T6m-50 (12).

Ash content. The samples were subjected to a temperature of 600°C for three hours in a laboratory furnace.

Hollocellulose. A number of different methods are available for determination of 'cellulose content', resulting in difficulties in comparison of results. For the purposes of present studies, therefore, cellulose content in its two extreme

forms, crude and pure, viz 'hollocellulose' and ' α -cellulose' was determined. For the former, essentially the chlorite method of Jayme as adopted by Sen Gupta *et al* (10) (single treatment) was employed.

α -Cellulose. The chlorite method in conjunction with the well-established ACS method of treatments with 17.5% and 9.5% NaOH solutions, as adopted by Chatterjee (1), was employed.

α -Hydrolysis. The method employed boiling the original ground sample with 1% NaOH solution under reflux for 5 minutes (5).

β -Hydrolysis. The original ground sample was boiled with 1% NaOH solution for one hour (6). This is practically equivalent to 1% NaOH solubility of TAPPI T4m-59 (13).

Acid Purification. The original ground sample was treated with acetic acid (20%), slowly heating till boiling (7).

Results and Discussion. The major chemical constituents of Series A are given in Table II.

Table II
Major Chemical Constituents of Series A (random) Samples

S.No.	Ash (%)	Hollocellulose (%)	α -Cellulose (%)	Lignin (%)	Pentosan (%)
1.	1.9	91.3	63.4	5.1	6.5
2.	1.2	92.7	63.5	5.8	6.4
3.	0.9	90.4	61.2	5.7	6.4
4.	1.1	90.3	62.7	6.3	6.7
5.	1.8	91.2	63.3	5.5	6.6
6.	1.6	93.1	62.8	6.9	6.3
7.	1.9	90.5	62.9	6.2	6.7
8.	0.9	92.8	61.7	5.4	6.5
9.	1.1	91.6	62.8	6.7	6.7
10.	1.2	91.2	63.3	6.6	6.4
Mean	1.4	91.5	62.8	6.0	6.5

The ash content ranged between 0.9% to 1.9% (mean 1.4%) hollocellulose between 90.3% to 92.8% (mean 91.5%); α -cellulose between 61.2% to 63.5% (mean 62.8%); lignin between 5.1% to 6.9% (mean 6.0%) and pentosan between 6.3% to 6.7% (mean 6.5%) in this series.

The major chemical constituents of Series B are given in Table III.

Table III

Major chemical Constituents of Series B (within plant) Samples.

S.No.	Ash (%)	Hollocellulose (%)	α -Cellulose (%)	Lignin (%)	Pentosan (%)
1.	1.6	89.2	60.1	4.7	6.7
2.	1.8	88.8	60.8	3.6	6.9
3.	1.7	90.0	61.3	4.9	7.2
4.	1.5	90.4	61.3	4.2	6.8
5.	1.6	91.7	64.4	5.7	6.8
6.	1.3	92.9	63.7	5.4	6.6
7.	1.4	91.3	63.2	6.3	7.4
8.	1.9	90.8	61.6	5.8	7.5
9.	1.8	91.7	62.7	5.5	7.3
10.	1.9	92.5	63.8	6.6	7.5
Mean	1.7	90.9	62.3	5.3	7.1

In this (within plant) series, the ash content ranged between 1.3% to 1.9% (mean 1.7%); hollocellulose between 88.8% to 92.5% (mean 90.9%); α -cellulose between 60.1% to 64.4% (mean 62.3%); lignin between 3.6% to 6.6% (mean 5.3%) and pentosan between 6.7% to 7.5% (mean 7.1%).

As apparent from the table both hollocellulose and α -cellulose increase with maturity. Increase (with maturity) in lignin content is more marked. A slight increase in pentosan content is also apparent. These variations in chemical constituents have not been reported in the case of Ak in literature, but in other fibres e.g., kenaf such increases in the cellulose content have been revealed in the data given by Clark et al (2, 3).

The losses due to various solubilities have been reported in Table IV for Series A.

Table IV
Chemical Solubilities of Series A (random) Samples

S.No.	Alcohol Benzene (%)	α -hydrolysis (%)	β -hydrolysis (%)	Acid Purification (%)
1.	1.3	9.1	11.7	4.2
2.	1.6	8.2	10.6	4.2
3.	1.8	8.5	12.0	4.0
4.	2.0	7.7	10.8	4.1
5.	1.6	8.4	11.3	3.9
6.	1.9	8.6	11.2	4.0
7.	1.7	9.1	12.4	3.8
8.	0.9	8.5	11.2	3.8
9.	1.5	7.8	10.6	4.2
10.	2.0	8.2	11.2	4.1
Mean	1.6	8.4	11.3	4.0

The alcohol-benzene solubility ranges between 0.9% to 2.0% (mean 1.6%); α -losses between 7.7% to 9.1% (mean 8.4%); β -losses between 10.6% to 12.4% (mean 11.3%) and acid purification losses between 3.8% to 4.2% (mean 4.0).

The losses due to various solubilities for Series B have been reported in Table V.

Table V
Chemical Solubilities of Series B (within plant) Samples

S No.	Alcohol- Benzene (%)	α -hydrolysis (%)	β -hydrolysis (%)	Acid Purification (%)
1.	1.8	9.1	13.2	5.1
2.	0.8	8.3	11.5	4.3
3.	1.9	9.4	13.1	5.0
4.	2.0	7.7	11.7	4.9
5.	1.8	8.5	12.6	4.6
6.	0.7	7.0	10.8	4.2
7.	1.6	8.1	11.4	3.8
8.	0.9	6.4	9.2	4.0
9.	0.8	6.0	9.9	3.6
10.	1.5	7.2	10.1	3.9
Mean	1.4	7.8	11.4	4.3

In this case alcohol-benzene solubility ranges between 0.7% to 2.0% (mean 1.4%); α -losses between 7.0% to 9.4% (mean 7.8%); β -losses between 9.2% to 12.6% (mean 11.4%) and acid purification losses between 3.6% to 5.1% (mean 4.3%). No specific trend in alcohol-benzene solubility seems to exist while all the other three losses decrease with maturity. It appears that fibres become increasingly resistant to these solvents with maturity. Although no such data seems to be available on Ak fibres in literature, such a decrease in the solubilities is apparent from Clark et al (2, 3) and Neischlag et al's (8, 9) data on kenaf.

CONCLUSION

1. The ash content of Ak samples obtained from the northern part of Pakistan ranges between 0.9% to 1.9%; hollocellulose between 90.2% to 92.8%; α -cellulose between 61.2% to 63.5%; lignin between 5.1% to 6.9% and pentosan between 6.3% to 6.7%.
2. The hollocellulose, α -cellulose and lignin contents increase with maturity, the increase in the last case being more marked than in the first two cases.
3. The alcohol-benzene solubility ranges between 0.9% to 2.0%; α -hydrolysis losses between 7.7% to 9.1%, β -losses between 10.6% to 12.4% and acid purification losses between 3.8% to 4.2%.
4. The α , β and acid purification losses all decrease with maturity, the fibres thus becoming increasingly resistant to these solvents with maturity.
5. In the first part of these investigations (14), a slight increase in tenacity with maturity had been reported. It now appears that this increase is concomitant with parallel increases in cellulose and lignin contents and decreases in α , β and acid purification losses.
6. In conclusion, the Ak fibre may be classed as a fibre of high cellulose content as well as of high tenacity. This renders it a suitable fibre for many uses including textiles and paper.

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