Tephrosia Candida-Annual source of non-wood fibrous raw material for paper and board

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ABSTRACT

Tephrosia Candida DC (Family Leguminosae) is a annual gregarious shrub, found in tropical Himalayas from Kumaun to Bhutan, Assam and other parts of eastern India. Stems are slender, sometimes woody, attain a height of 1.2-4.5 metres. Propagation is by seeds. *T. candida* is occassionally planted as ornamental and avenue trees. The dry biomass of the plant is 10-11 ton per hectare Fibres of average 0.75 mm in length at 45% yield (unbleached), could be obtained from this raw material. The laboratory handmade paper sheets exhibited good properties, with burst factor 45, breaking length 5575 metres and tear factor 50. Hence it can be suggested that *T. candida* may become a potential source of raw material for pulp and paper making either or in combination with other conventional paper making raw material. This cellulosic raw material could help to meet the future demand for pulp and paper making raw material, if properly exploited

INTRODUCTION

Tephrosia Candida (DC) popularly known as Medaloa in Assamese possessess certain properties which are attractive from the pulp and paper making point of view. *T. candida* is annually renewable source of non-wood fibrous material which could become a useful supplemental material like some other annual source of paper making raw materials[1] for pulp and paper in view of shortage of conventional fibrous material like bamboo and wood. Concentrated efforts have been made to introduce some fast growing nonwood fibrous material for the manufacture of pulp & paper throughout the world[2, 3, 4, 5, 6, 7]. In India a number of workers have already studied the pulp and paper making properties of certain nonwood fibres with special reference to their application in pulp and paper industry [8, 9, 10, 11, 12, 13, 14]. *T. candida* is also such type of probable non-wood fibrous raw material which may become a useful potential raw material for pulp and paper industry if properly and systematically exploited.

The plant is propagated by seeds. The seeds may be dibbled in rows 60—90 cm apart during the monsoon or sown earlier if irregation facilities are available. The plant even survive for 3—5 years.

T. candida is occasionally grown for ornamental and for avenues, but now-a days it is being increasingly cultivated for wind breaks shade and fancing etc. It is also cultivated for nursing and mulching in the plantation of tea, coffee, coconut and rubber. It may be used as a green manure particularly on poor soils, and is also useful for soil conservation. The shrub is not relished by cattle. It tolerates light, shade and can withstand water logging, draught and pruning[15].

The stems are slender, sometime woody, round and upto 25 mm in diameter and 1.2-4.5 m in height. The stem portion of the plants were selected for a study on the pulp & paper making prperties. Experiments have

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been conducted with the raw material at RRL-Jorhat on Bio-mass production as well as its feasibility to use as a raw material for pulp and paper industry[16].

EXPERIMENTAL

Proximate analysis

The proximate analysis of *T. candida* was carried out by standard procedures by the Techhnical Association of pulp and paper Industry, USA (TAAPI 1980). The stalk was washed and then dried in an oven. The dried material was powdered in a wily mill and sieved. The fraction passed through 60 BSS mesh and retained on 80 BSS mesh (i.e.—60±80) was used for proximate analysis (Table-I).

TABLE—I
PROXIMATE ANALYSIS

Sl. No	Test	Percent on O.D. basis
1.	Moisture content of the sample	9.8
2.	Cold water solubility	2.7
3.	Hot water solubility	3.8
4.	1% Caustic soda solubility	36.2
5.	Alcohol-Benzene (1:2) solubility	7.5
6.	Pentosan content	17.6
7.	Lignin content	21.3
8.	Cellulose (Cross & Bevan)	48.2
9.	Ash content	1.3

Fibre dimensions

The lenght and the diameter of fibres of digested bleached and washed material were measured under a microscope and the average, maximum and minimum results were recorded in Table-II.

Table-II—FIBRE DIMENSIONS OF TEPHROSIA CANDIDA

Sl. No.	Characteristics	Fibre length (mm)	Fibre diameter (micron)
1.	Minimum	0.38	15.0
2.	Maximum	1.50	10.0
3.	Average	0.75	13.0

PULPING

Matured plants *Tephrosia candida*, collected from the experimental farm of RRL, Jorhat, were used for pulping The stem protion of the plants were selected and chipped manually to the average chip size of 2—2.5 cm. The moisture content of the chips were determined prior to put it for digestion. All the chemicals used for digestion and other analytical works were of analytical reagent grade.

Two types of pulping processes i.e. Sulphate and Soda-AQ were adopted for digesting the raw material. About 1 kg of the chips (on OD basis) were taken in each batch of digestion which were digested in a stainless steel electrically heated rotary digester of 10 litre capacity with a removing speed of 2.5 rpm.

In the sulphate process, 14-20% active alkali (sodium hydroxide and sodium sulphide as Na_2O) was used on OD weight of the raw material. The sulphidity was maintained at 25% The cooking was done at various temperatre ranging from 100-170°C. Likewise, the variation in cooking time was also kept between 3-5 hours The material to liquor ratio was maintained at 1:5 in all the cooks. The optimum cooking condition was obtained at 17% cooking chemicals with 4 hours of cooking time (3 hours at temperature) at 160±2°C. To optimise the cooking conditions, several batches of experimental digestion were carried out with the variation of cooking parameters like time, temperature and cooking chemicals. After the digestions the pulps were washed thoroughly with fresh water and the unbleached yield was determined (Table III).

In soda-anthraquinone process, sodium hydroxide was used from 14-20% in terms of Na_2O and the percentage of anthraquinone from 0.1—0.4% on the basis of oven dry weight of the raw material. Like sulphate process, several experiments were carried out on digestion for optimisation of the process parameters in soda-anthraquinone process and it was observed that 16% cooking chemicals as Na_2O with 0.1% anthraquinone at 165°C for 4 hrs (3 hours at temperature) showed the maximum pulp yield with good physical strength properties of paper. Yield of unbleached pulp was determined for each (Table-III).

TABLE—III

DIFFERENT COOKING CONDITIONS & YIELD OF TEPHROSIA CANDIDA

Sl. No.	Cook No.	Type of Cooking	Total chemical		Cooking temp. °C	Batch ratio	Cooking time at maximum temperature mints.	Permanganate number ($KMnO_4$ No.)	Unbleached pulp yield (on O.D. basis) %	Bleached pulp yield (on O.D. basis) %
			NaOH (as Na_2O) %	Anthraquine %						
1)	A	Sulphate	14	—	160±2	1:5	180	—	Under cooked	—
2)	B	,,	16	—	160±2	1:5	180	14.6	43.8	38.6
3)	C	,,	17	—	160±2	1:5	180	13.2	45.2	40.4
4)	D	,,	18	—	160±2	1:5	180	12.4	44.9	40.0
5)	E	,,	20	—	160±2	1:5	180	10.8	41.6	36.2
6)	F	Soda-Aq	14	0.4	165	1:5	180	—	Under cooked	—
7)	G	,,	16	0.1	165	1:5	180	13.9	46.0	41.5
8)	H	,,	17	0.1	165	1:5	180	13.0	44.8	40.4
9)	I	,,	18	0.1	165	1:5	180	11.8	43.2	39.0
10)	J	,,	20	0 1	165	1:5	180	10.0	41.5	37.2

FIBRE CLASSIFICATION :

Fibres obtained from well digested pulps were in a standard fibre classifier according to Baur McNett method provided with mesh sizes 14, 30, 50 and 100. The results of fibre classification are presented in Table IV.

TABLE—IV

FIBRE CLASSIFICATION OF TEPHROSIA CANADIDA

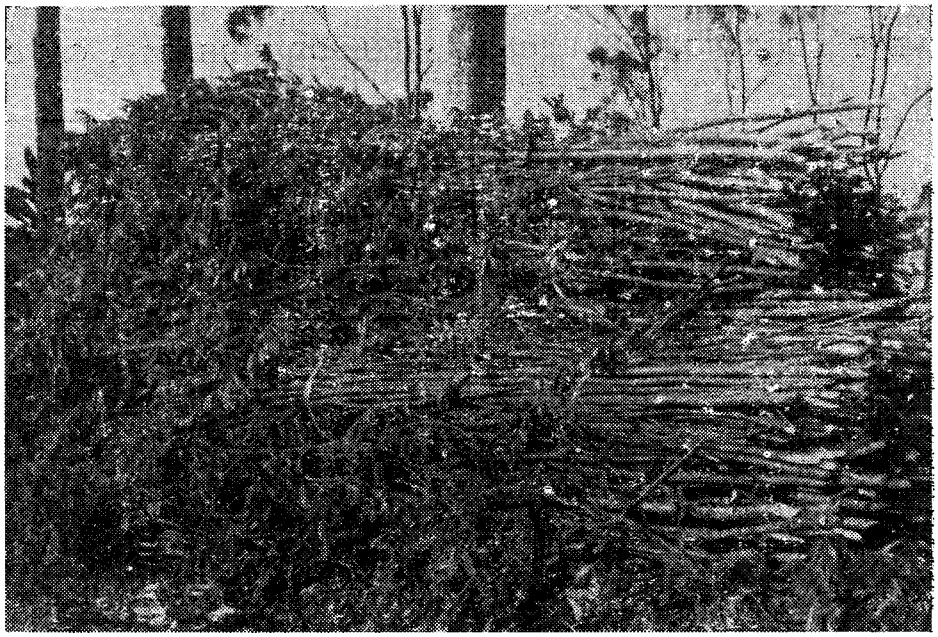
Sl. No.	Mes size	Unbleached fibre retained %
1)	+ 14	8.6
2)	— 14 + 30	7.8
3)	— 30 + 50	47.9
4)	— 50 + 100	26.3
5)	—100	15.2

BLEACHING :

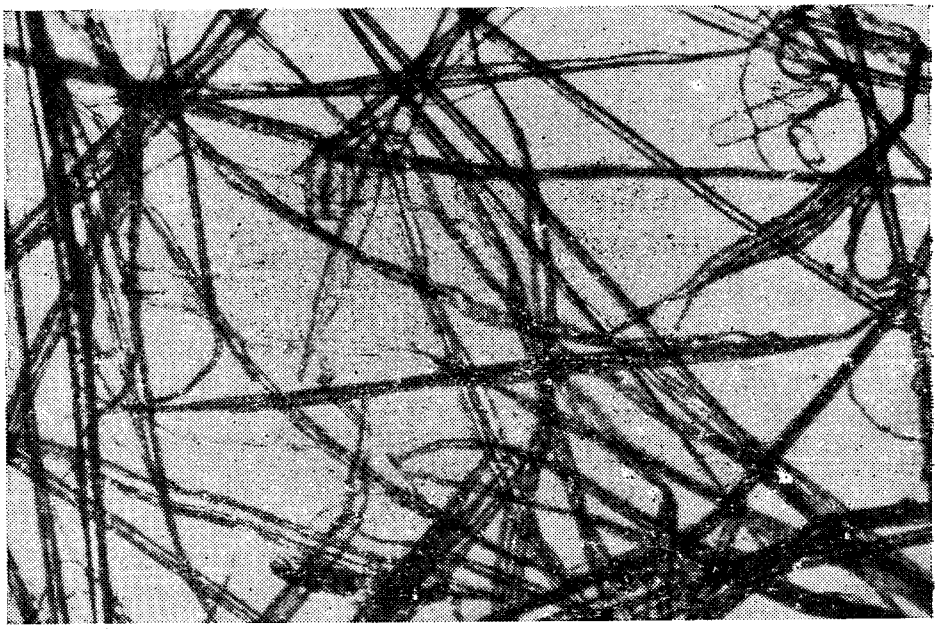
The unbleached pulp was bleached in a two stage hypochlorite bleaching sequence with an intermediate alkali extraction.

In the first stage, hypochlorite at 60% of total chlorine requirement was added according to the demand at a pulp consistency of 10% for about 120 minutes at 30°C with occasional slow agitation. The pulp was again washed thoroughly before 60°C. The pulp was again washed thoroughly before giving the second stage hypochlorite treatment.

In the second stage of bleaching, hypochlorite at 40% of the total chlorine demand was added to the pulp at a pulp consistency of about 10% and kept at 30°C for 120 minutes with occasional slow agitation. The pulp was then washed thoroughly with fresh water and the yield of bleached pulp was determined. The brightness of the pulp was tested (Table V).



Tephrosia Candida (In Bundles) After Harvesting



Photomicrograph of Fibre 100 X of Tephrosia Candida

Table-V

DETAILS OF BLEACHING CONDITIONS OF TEPHROSIA CANDIDA

Sl. No.	Particulars	A	B
1)	Step I : Hypo treatment		
	Consistency (cy) (%)	10	10
	Hypo as available chlorine added in pulp (%)	3.6	3.18
	Temperature (°C)	30	30
	Time (minutes)	120	120
	pH (initial)	10.0	10.0
	pH (final)	9.2	9.4
	Brightness	42	42
2)	Step II : Alkali extraction		
	Consistency (cy) (%)	10	10
	Alkali solution added (%)	1	1
	Temperature (°C)	60	60
	Time (minutes)	60	60
3)	Step III : Hypo treatment		
	Consistency (cy) (%)	10	10
	Hypo as available chlorine added in pulp (%)	2.4	2.12
	Temperature (°C)	30	30
	Time (minutes)	120	120
	pH (initial)	10	10
	pH (final)	8.7	8.8
	Bleached pulp yield (%)	40.4	41.5
	Brightness	70	72

A = Sulphate pulp
B = Soda-Aq pulp

SHEET MAKING AND TESEING

The unbleached and bleached pulps were separately disintegrated and subsequently beaten in a stainless steel, lined laboratory valley beater to get a pulp of desired freeness.

Standard sheets of 60 ± 1 g/m² were prepared from unbleached and bleached pulps on a British Standard laboratory sheet making machine. The sheets were dried in air and conditioned at 65% RH at 27°C for two hours and then tested for various strength properties (Table VI & VII).

RESULTS AND DISCUSSION

Table I & II show some properties of *T. candida*:

The properties of pulps are given in Table III. The yield of unbleached sulphate pulp was slightly lower than that of the unbleached soda-aq. pulp. In both the processes the pulp was well cooked and recoreded nil rejects. Both the pulps could be bleached easily by two stage hypochlorite treatment with an intermediate alkli extraction (H-E-H) and employing identical conditions (Table V). The chlorine demand for both the pulps was 6%. The brightness of the bleached pulp in recorded.

The properties of unbleached and bleached paper sheets are given in table VI & VII. The properties of the handmade sheets showed that good qulity writing and printing paper could be obtained from this raw material. The plants, if systematically cultivated can

Table-VI

PHYSICAL CHARACTERISTICS OF UNBLEACHED PAPER

Sl. No.	Cook No.	Basis Wt. g/m²	Bulk density cc/gm	Breaking length (metre)	Burst factor	Tear factor	Folding endurance (double fold)
1)	A	—	—	—	—	—	—
2)	B	59.8	1.48	4978	41	48	198
3)	C	60.0	1.49	5575	45	50	275
4)	D	60.3	1.51	5180	43.6	46	216
5)	E	60.1	1.47	5066	42.4	45	243
6)	F	—	—	—	—	—	—
7)	G	60.0	1.48	6244	51	65	396
8)	H	60.1	1.48	5570	50.6	59	375
9)	I	59.7	1.29	5880	49	61	298
10)	J	60.3	1.49	5864	50.2	58	358

Table-VII

PHYSICAL CHARACTERISTICS OF BLEACHED PAPER

Sl. No.	Cook No.	Basis wt. g/m²	Bulk density cc/gm	Breaking length (metre)	Burst factor	Tear factor	Folding endurance (double fold)
1)	A	—	—	—	—	—	—
2)	B	60.1	1.44	3336	30	38	42
3)	C	60.0	1.41	3650	34	42	45
4)	D	60.2	1.30	3466	33	41	38
5)	E	59.7	1.41	2940	29	39	44
6)	F	—	—	—	—	—	—
7)	G	60.0	1.36	4486	37	48	52
8)	H	59.8	1.40	4288	36	41	50
9)	I	60.2	1.41	3960	29	46	49
10)	J	60.3	1.41	4110	33	39	43

become a potential supplemental raw material for the pulp and paper industry in India.

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