Studies on Pulping and Paper Making Characteristics of some Common Reeds

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Abstract

From some common reeds of Assam. Laboratory were carried out to evaluate the feasibility to produce pulp and paper studies and to determine the presence of silica on bleached paper. For pulping by the Sulphate process, at 13% active alkali (as Na_2O) for 2 h 15 min. at 165±5°C, yielded 45-46.8% unbleached pulp where as by the Soda-AQ process at 13% caustic soda with 0.1% AQ yielded 45.4-47.5% unbleached pulp. The two-stage hypochlorite bleaching yielded 40-41% and 41.7-42.8% respectively with 72-74% brightness (MgO=100). Standard handsheets at freeness 300 cc CSF unbleached and bleached papers of 60 gm/m² yielded moderated strength properties. The presence of silica in the bleached paper in terms of speck count (sq.mm/m²) was found within permissible limits as per TAPPI standard specifications. From these studies it may be emphasized that these varieties of reeds may be a potential source of supplementary cellulosic raw material for paper industry.

INTRODUCTION

Some of the common varieties of reeds like Melastoma malabathricum, Eupatorium odoratum and Thysanolaema maxima, grow abundantly in the forests, marshy land and river valleys in Assam. These reeds are tall, tufted perennial grass with robust, smooth stem and culms, possess certain paper-making characteristics. The proximate chemical analysis shows that the cellulose, lignin and pentosan contents are quite comparable with the conventional bamboo and wood used for pulp and papermaking, although the ash and silica contents are high. These plants find no appropriate commercial utilization, except using themas partition wall, hutments and as fuel for domestic purposes by the villager. In recent years, due to acute shortage of fibrous raw materials particularly the conventional bamboo and wood, it has become imperative for the papermakers to utilize nonwood plant materials as an alternative measure to meet the raw materials demand. The present importance of non-wood plant materials as papermaking raw materials is enormous. It is reported that the total worldwide nonwood plant pulping capacity is increasing faster than that of wood pulping capacity. In China, the production of nonwood pulping capacity is twice than that of the wood pulp (1). Besides China, North Korea, Romania, The Soviet Union and Iraq are well ahead of India in industrial utilization of nonwood plants like reeds to produce different types of papers and paperboards. In addition, reed pulp for viscose rayon has been produced in Romania (2). The nonwood plant materials, in general include the agricultural residues, such as bagasse, wheat straw and rice straw, the naturally growing plants such as reeds, bamboo and sabai grasses and the plants which are grown for their fibre contents such as kenaf, crotolaria, jute, hemp, sisal, etc. (3).

Reeds like Melastoma and malabathricum, Eupatorium odoratum and Thysanolaema maxima, are some of the nonwood plants that grow abundantly in the forests, marshy land and river valleys in Assam. These plants possess certain paper making characteristics although silica present in the sheath is quite high. These plant materials find no appropriate commercial utilization in some of the developing countries besides India. Therefore, to study their suitability for pulp and paper making aspect, Laboratory scale experiments were carried out on pulping of these varieties of reeds and to examine the presence of silica on paper and paperboards and their physical strength properties.

These reeds are tall perennial grass and annual yield is about 4 tonnes/hactare/annum which is

considered to be one of the highest in comparison to other nonwood plants. These plants are at present not as valueadded products utilized, except for construction partition of walls in the rural hutments as well as fuel for domestic purposes (4). Although these plant materials are available in abundance in the forests of Assam, the raw materials preparation such as harvesting, cutting, baling, transportation, storage etc. has not yet been well organised for commercial production of pulp and paper in Assam.

Melastoma malabathricum is a shrub found near water courses and moist and humid places in the forest. The bark is reddish brown in colour and the leaves are lanceolate to oblong. Eupatorium odoratum is a coarse straggling shrub and it is an obnoxious reed that grows in the plains and foothills, interfering with the natural regeneration of timber trees. Thysanolaema maxima is a tall reed like perennial grass found plenty in shady slopes in the forests, especially on damp, steep banks along ravines and water courses throughout the country (5). Pulping of reeds by the conventional Sulphate and Soda Anthraquinone pulping were carried out in the Laboratory to study the presence of silica on the bleached papers and paperboards. The results are presented in this paper.

EXPERIMENTAL

Raw material

The specified reeds such as Melastoma malabathricum, Eupatorium odoratum and Thysanolaema maxima, were collected from the North bank of the mighty river Brahmaputra in the district of Jorhat, Assam. The fibrous materials were brought in bundles of about 3.9-3.5 metre length containing 30-40% moisture. The materials were washed, dried and then cut into chips of 2.0-2.5 cm length. The chips were screened for the accepted sizes for conducting the experiments in the laboratory.

Proximate Chemical analysis

The proximate chemical analysis of selected species were carried out as per standard methods. The materials were first washed to make free from dust and foreign matters and then dried and cut into chips and powdered in a Willy Mill. The fractions passed through 40 mesh and retained on 60 mesh (-40+60) were used for chemical analysis. The length and diameter of the fibres of well digested bleached and disintegrated pulp were measured under the microscope. The results are presented in Table 1.

Pulping

Pulping was done by the conventional Sulphate and Soda Anthraquinone processes in a 10 Litre capacity electrically heated, rotary, stainless steel digester, provided with pressure and temperature controller and recorders. The moisture content of the chips was determined, prior to digestion.

Sulphate pulping

Sulphate or kraft pulping was done by digesting 500 gm (oven dried) chips with 13% cooking

Table 1. Proximate chemical analysis and fibre dimensions of reeds.

Property	Melastoma Malabathricum (MM)	Eupatorium odoratum (EO)	Thysanolama maxima (TM)
Solubility, %			
Cold water	16.8	12.6	10.4
Hot water	20.2	16.8	12.6
1% NaOH	32.8	28.5	33.2
Alcohol-Benzene (1:2)	5.2	4.2	8.6
Pentosan, %	18.6	21.3	23.4
Cellulose, %	52.8	54.3	57.7
Lignin, %	22.4	25.8	24.5
Ash, %	7.4	8.8	4.6
Silica, %	1.8	1.9	2.8
Fibre dimension			
Fibre length, *mm	1.78±1.35	1.56±1.10	1.86±0.65
Fibre diameter, *μm	12.21±2.36	12.28±2.42	11.45±2.06

* Mean values ± standard deviation : Five observations per mean.

chemical (NaOH : Na_2S = 3:1) as Na_2O and 20% sulphidity, maintaining material to liquor ratio (M:L) of 1:4. The digestion was done at 165±5°C for 90 minutes (plus 45 minutes for raising the temperature to the maximum). After the digestion, the pressure in the digester was released and the black liquor was collected for analysis such as black liquor concentration in °Tw at 60°C, total residual active alkali as Na_2O etc. The pulp was then discharged into a screen for washing to make it free from alkali.

Soda Anthraquinone pulping

In the Soda-AQ process, 500 gm (o.d.) chips was charged into the digester with 13% caustic soda as Na_2O and 0.1% anthraquinone on the weight of the dry material. The material to liquor ratio of 1:4 was kept at a cooking temperature of 165± 5°C for 135 minutes including 45 minutes to raise the temperature to the maximum was followed. After the digestion, the pulp was washed throughly with water to remove any unreacted chemicals left out during pulping. The pulping conditions, kappa numbers, knots and rejects and the screened pulp yields are given in Table 2.

Bleaching of pulp

The Kraft and Soda Anthraquinone pulps thus obtained were bleached in a two-stage hypochlhorite bleaching. In the first stage, hypochlorite at 60% of total chlorine requirement was added at a pulp consistency of 10% for 60 minutes at 30°C with occasional slow agitation. The pulp was thereafter washed throughly with fresh water before second stage hypochlorite treatment. The results are presented in Table 3.

In the second stage of bleaching, hypochlorite at 40% of total chlorine demand was added to the pulp at a consistency of about 10% and the pulp was kept at 40 ± 2°C for 120 minutes with occasional slow agitation. The pulp was then washed throughly. The yield and the brightness of bleached pulp were recorded and the physical characteristics of the bleached sheets were determined as per TAPPI standard methods and the results are given in Table 3.

Papersheet formation and testing

The unbleached and bleached pulps were separately disintegrated and subsequently beaten in a Standard Laboratory Valley beater at 1.5% consistency to get a freeness of 300 cc CSF (Canadian Standard Freeness). Standard sheets of 60 ± 1 gm/m² were made from unbleached and bleached pulps on the British Standard Laboratory Sheetformer. The sheets were dried in a hot air circulating oven and conditioned at 65 ± 2% relative humidity at 25 ± 2°C for 120 minutes and then tested for different strength properties as per TAPPI standard methods (6). The results of unbleached and bleached paper sheet properties are presented in Table-4.

Table 2. Pulping conditions of reeds, black liquor analysis and yield of pulps.

Raw material taken	Total chemical as	Digestion temp. at maximum Na_2O °C %	Digestion time upto maximum min.	Digestion time at maximum min.	Black Liquor analysis at °Tw min.	Black Liquor analysis 60°C residual active alkali as Na_2O gpl	Kappa No. Total	Unbleached pulp yield (on o.d. basis) Total pulp %	Knots & rejcets %	Pulp %
Sulphate process										
Melastoma malabathricum	13.0	165±5	45	90	13.0	4.8	18	50.0	5.2	46.8
Eupatorium odoratum	13.0	165±5	45	90	12.8	3.6	16	49.8	4.8	45.8
Thysanolaema maxima	13.0	165±5	45	90	13.5	3.2	16	50.0	4.6	45.4
Spda-anthraquinone Process										
Melastoma malabathricum	13.0+0.1	165±5	45	90	12.8	3.6	17	52.5	5.0	47.5
Eupatorium odoratum	13.0+0.1	165±5	45	90	11.9	3.2	15	50.0	4.6	45.4
Thysanolaema maxima	13.0+0.1	165±5	45	90	13.0	3.8	14	51.0	4.4	46.6

Table 3. Conditions of bleaching, pulp yield and brightness of pulps.

Sample	1st stage: Hypochlorite treatment at 10% consistency for 60 min. at 30°C			2nd stage: Hypochlorite treatment 10% consistency for 120 min. at 40°C		Bleached pulp yield	Brightness (MgO=100)
	Total Chlorine Chlorine added (as available chlorine %)	Chlorine consumed (as available chlorine %)	Final pH	Chlorine added (as available chlorine %)	Final pH	%	%
A	5.2	3.12	9.3	2.08	8.9	40.0	72
B	4.5	2.70	9.4	1.92	8.8	40.5	73
C	4.8	2.88	9.2	1.90	8.6	41.0	72
D	4.7	2.82	9.3	1.88	8.7	41.7	72
E	4.5	2.74	9.2	1.80	8.6	42.8	73
F	4.2	2.52	9.2	1.68	8.2	42.6	74

Table 4. Physical characteristics of papersheets made from unbleached and bleached reed pulps.

Sample	Basis weight g/m^2	Apparent density g/cc	Burst Index $K.Pa.m^2g^{-1}$	Tensile Index Nmg^{-1}	Tear Index mNm^2g^{-1}	Folding endurance Double folds	Speck counts sq. mm/m^2
Unbleached paper sheets:							
A1	60.0	1.52	3.79	41.8	3.9	110	-
B1	60.0	1.50	3.88	43.2	3.7	118	-
C1	59.8	1.50	3.68	39.6	3.6	128	-
D1	60.0	1.45	3.85	40.0	3.5	98	-
E1	60.0	1.44	3.60	41.8	3.8	114	-
F1	60.2	1.45	3.60	42.5	3.6	112	-
Bleached paper sheets:							
A2	60.1	1.50	3.60	38.4	3.8	82	82.2
B2	60.2	1.48	3.72	39.8	3.7	112	35.0
C2	59.8	1.48	3.55	40.0	3.9	108	62.5
D2	60.0	1.35	3.50	33.8	3.2	80	86.5
E2	60.0	1.36	3.54	34.2	3.2	78	Nil
F2	59.9	1.40	3.55	35.5	3.6	82	Nil

N.B. The samples for testing were conditioned at 65% relative humidity at 25±2°C for 2 h.

RESULTS AND DISCUSSION

The proximate chemical analysis of Melastoma malabathricum, Eupatorium odoratum and Thysanolaema maxima as shown in Table 1, indicate that the cellulose, lignin and pentosan contents of these materials are comparable with the conventional bamboo and non-wood plant materials used in the pulp and paper industries. The ash and silica contents of these reeds were found to be less than rice/wheat straw. These properties of reeds indicated that it could be suitably used for making pulp and paper and other cellulose based products. The fibre length of reeds varied between 5.5-23 micron with an average 12.6 micron (approx.) The epidermic cells were impregnated with cutin and silica which were responsible for the resistance to penetration of the cooking liquor, especially at low pH during pulping.

Table 2 showed the pulping conditions of reeds, yields of screened unbleached pulp, knots

and rejects and kappa numbers. In the Soda-Anthraquinone process the kappa numbers were less than the sulphate pulp, but screened pulp yield were found to be slightly higher than the sulphate pulp. The percentage of knots and rejects were less in the sulphate process than the Soda-AQ process. The black liquor analysis showed that the total residual active alkali were in the range between 3.2-4.8 gpl as Na_2O and the black liquor concentration was found to be 11.9-13.5 °TW at 60°C, where the total cooking chemical was 13% as Na_2O and 13% Na_2O + 0.1% AQ (added on o.d. weight of the material).

Table 3 showed the bleaching conditions of the pulp, yields and brightness of the pulp after two-stage hypochlorite bleaching. The chlorine demand for bleaching, the pulps were 7.0-8.5% (added on o.d. weight of the pulps). The yield of the bleached pulp was found to vary in between 40-0-42.8% with 72-74% brightness (MgO-100). It was evident that the sulphate pulp made from the reeds possesed slightly lower brightness than that of Soda-AQ pulp.

Table-4 showed the physical characteristics of unbleached and bleached papersheets. The papaersheets made from Melastoma malabathricum, Eupatorium odoratum and Thysanolaema maxima as mentioned in Table 4 showed that the presence of silica in terms of the specks count were found as 35.0-86.5 sq.mm/m^2 on the bleached papers which were within the permissible limit, as per TAPPI standard. The physical characteristics thus obtained could be well comparable with the conventional bamboo and other non-wood plant materials for making good quality pulp and paper.

CONCLUSION

It can, therefore, be concluded that the reeds like Melastoma malabathricum, Eupatorium odoratum and Thysanolaema maxima can be utilized for producing suitable pulp for making papers of common varieties. Good quality boards like duplex board, file cover, file boards, invitation cards, greetings cards, etc. can also be produced from these types of plant materials. This may be considered as a potential source of supplimentary cellulosic raw materials for the paper and allied industries in Assam in particular and the North Eastern states of India in general.

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