Mixed Pulping of Bamboo and Khagra Reed and Evaluation of Paper Characteristics

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*ABSTRACT:-- Khagra reed, **Neyraudia reynaudiana** is one of the important non-wood plants, that grows abundantly in the forests of the North Eastern states. Laboratory scale experiments were carried out for mixed pulping of bamboo and khagra reed chips and conditions of pulping were optimised. It was found that bamboo and reed chips mixed in the ratio 4:1, when cooked with 16% active alkali (as Na_2O), for 2 h at 170 $\pm$ 2°C gave unbleached pulp with 44.4% yield, which was easily bleachable. Standard paper sheets from both unbleached and bleached pulps were formed and their physical strength properties were evaluated. The study carried out has indicated that mixed pulping of bamboo and reed is possible and khagra reed may be a potential source of supplementary cellulosic raw material for paper industry.*

INTRODUCTION

The major source of cellulosic raw material of the Indian pulp and paper industry is the bamboo[1]. The demand for the fibrous raw materials are increasing day by day. In view of the limited availability of bamboo and its high cost of plantation and low annual yield[2], the existing bamboo forests in the country will not be able to meet the entire requirement of cellulosic raw materials. The short-fall of pulpable wood and bamboo would be 48 lakhs and 5 lakhs tonnes respectively towards the end of the century[3]. To supplement this shortage of bamboo and wood raw materials in recent years, importance has been given on utilisation of non-wood plant fibres as a potential source of alternative materials for pulp and paper industry. The non-wood plant mateirals, in general include the agricultural residues such as bagasse and 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, crotalaria, jute, hemp, abaca, sisal, etc.[4].

Khagra, **Neyraudia reynaudiana**, is one of the important non-wood plants that grows abundantly in the forests of North eastern part of India. This is a tall perennial grass and the annual yield is about 4 tonnes/hectare/annum which is considered to be one of the highest in comparison to other non-woody plants[4]. This non-woody plant at present, is not profitably utilised except for construction of walls and partition in the rural hutments and for generating fire.

Attempts were made to produce pulp and paper from reeds by many workers throughout the world, [5,6] but there is no report on mixed pulping of bamboo and reed. Therefore, in the present communication, the results of mixed cooking of bamboo and khagra reed chips at different proportions have been reported along-with the physical strength characteristics of papersheets made from such pulp stock.

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EXPERIMENTAL

Raw material

Bamboo and khagra reeds were collected from reserved forests in Tuli, Nagaland. The fibrous materials were brought in bundles of about 3.0-3.5m length and with 30-40% moisture. The materials were 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 analysis of bamboo and khagra reed were carried out by adopting TAPPI standard methods. The materials were first washed free of dust and then dried and powdered in a Willey Mill. The fractions passed through 60 BSS mesh and retained on 80 BSS (i.e. -60, +80) were used for proximate analysis. The data on proximate chemical analysis are given in Table-1. The length and the width of the fibres of well digested, bleached pulp were measured under a microscope and the results are recorded in Table-2.

MIXED COOKING

All the chemicals used were of analytical reagent grade and added on the basis of oven dry material. The digestions were carried out in a 10 L electrically heated stainless steel rotary digester, provided with pressure and temperature recorders.

Kraft pulping

In the first set of experiment, the chips of bamboo and khagra reeds were mixed together in the ratio of 2:1 respectively. 500 gm of the mixed chips were cooked with 16% and 17% cooking liquor ($NaOH : Na_2S = 3 : 1$) as Na_2O, (20% sulphidity), maintaining m : l ratio of 1 : 4 at 170 ± 2°C for 120 minutes (plus 120 minutes for raising the temperature to the maximum). After the cooking, the digester pressure was released and the black liquor was collected for analysis. The cooked material was discharged onto a 60 mesh screen for washing. The pulp was washed free of alkali.

In the second and third sets of experiment, the chips of bamboo and khagra reed were mixed in the ratio of 3 : 1 and 4 : 1 respectively. The cooking conditions followed were the same as earlier.

Pulping conditions and the characteristics of the unbleached pulp are given in Table-3.

Table-1

Proximate chemical analysis of Bamboo and Khagra reed

Properties	Results on oven-dry sample, %	
	Bamboo	Khagra reed
* Cold water solubility	3.4	4.5
* Hot water solubility	4.2	6.4
* 1% NaOH solubility	18.8	26.4
* Alcohol : Benzene solubility (1 : 2)	2.8	4.6
* Cross & Bevan cellulose	62.5	58.4
* Lignin	24.5	22.2
* Pentosan	18.4	20.6
* Ash	2.3	2.5

Table-2

Fibre dimensions of Bamboo and Khagra reed

Characteristics		Bamboo	Khagra reed
* Fibre length,	(mm)		
	minimum	0.72	0.38
	mixiumum	3.82	3.02
	average	2.70	1.75
* Fibre width,	(μm)		
	minimum	4.0	6.0
	maximum	58.0	22.0
	average	22.0	14.0

Table-3

Cooking conditions of Bamboo and Khagra reed mixed at different proportions

Cook No.	Mixing ratio Bamboo : Khagra reed	Total chemical as Na_2O %	Cooking temp. at maximum °C	Cooking time min. Upto maximum	Cooking time min. at maximum	$KMnO_4$ number	Unbleached pulp yield (on o.d. basis) Unscreened %	Rejects %	Screened %
A1	2 : 1	16	170 ± 2	120	120	16.0	40.0	0.9	39.1
A2	2 : 1	17	170 ± 2	120	120	15.8	39.2	0.8	38.4
B1	3 : 1	16	170 ± 2	120	120	16.2	39.7	0.5	39.2
B2	3 : 1	17	170 ± 2	120	120	16.0	40.2	0.3	39.9
C1	4 : 1	16	170 ± 2	120	120	16.3	44.4	0.3	44.1
C2	4 : 1	17	170 ± 2	120	120	16.6	43.2	0.4	42.8

For bleaching, pulps from batches A_2, B_2 and C_1 were taken. The pulp was bleached using CEH bleaching sequence in which in the first stage, hypochlorite at 60% of total chlorine demand was added. Washed pulp from the first stage was alkali extracted and then another hypochlorite treatment was given. The conditions of bleaching and the results are presented in Table-4.

Papersheet formation and testing

The unbleached and bleached pulps were separately disintegrated and subsequently beaten in a stainless steel lined laboratory valley beater to freeness of 45°SR.

Standard papersheets of 60 ± 0.5 gm/m² were prepared from unbleached and bleached pulps in a British Standard Laboratory sheet making machine. The papersheets were air dried and conditioned at 65% relative humidity at 25 ± 2°C for 2 h and then tested for various strength properties as per TAPPI standard methods. The results of the unbleached and bleached papersheets properties are presented in Table-5.

RESULTS AND DISCUSSION

The results of the proximate chemical analysis of khagra reed and bamboo as shown in Table-1, indicate that cellulose (Cross and Bevan), lignin and pentosan etc., are comparable. The ash content of khagra reed is however found to be slightly more than that of bamboo.

Table-3 gives conditions of mixed pulping of bamboo and khagra reed chips. From the results, it is evident that mixing of chips, i.e. bamboo : khagra reed at ratio 4 : 1 gives higher yield of pulp with minimum rejects and less $KMnO_4$ number, while cooking with 16% and 17% active alkali as Na_2O, at 170 ± 2°C for a period of 2 h. It is also evident from the table that good quality pulp with rejects within permissible tolerance could be obtained in other cooking conditions with the mixing ratio as shown. However, considering the yield, rejects and

Table-4

Conditions of bleaching, pulp yields and brightness

Cook No.	Chlorination 3% consistency, 60 min at 25°C.			Alkali extraction 10% consistency, 60 min at 60°C.		Hypochlorite treatment 10% consistency, 120 min at 30°C		Bleached pulp yield	Brightness (Mgo=100)
	Total chlorine added as available chlorine %	Chlorine consumed %	Final pH	NaOH %	Final pH	Chlorine added as available chlorine %	Final pH	%	%
A2	5.0	4.50	2.0	1.5	11.0	2.35	8.0	36.2	74.0
B2	4.5	4.05	2.0	1.5	10.5	3.00	8.6	38.5	76.0
C1	4.8	4.32	2.0	1.5	11.0	3.20	8.8	40.0	77

Table-5

Strength properties of papersheets from unbleached and bleached pulps

Pulps from batches	Bulk density (cc/g)	Tensile Index ($N.m.g^{-1}$)	Burst Index ($Kg.Pa.m^2g^{-1}$)	Tear Index ($m.N.m^2g^{-1}$)	Folding endurance (double folds)
UNBLEACHED PULP SHEETS					
A2	1.51	47.56	3.28	6.96	87
B2	1.46	52.37	3.58	7.67	110
C1	1.40	54.74	3.78	7.84	120
BLEACHED PULP SHEETS					
A2	1.62	48.30	2.99	5.78	80
B2	1.58	49.72	3.31	6.27	95
C1	1.47	52.95	3.51	7.06	112

$KMnO_4$ number of the pulps, cooking with 16% active alkali as Na_2O, at 170 ± 2°C for 2 h may be taken as optimum.

Table-4, shows the bleaching conditions of mixed pulps. The pulps from the selected sets of experiments, were bleached by two-stage hypochlorite bleaching with an intermediate alkali extraction, employing identical conditions. The chlorine demand for bleaching was 7-8% (added on o.d. weight of the material). The yield of the bleached pulp was 40% with 74-77% brightness of the pulp.

From Table-5, it is evident that paper made from both unbleached and bleached pulps from batch C_1, where bamboo and khagra reed chips were mixed in the ratio 4 : 1 and cooked with 16% active alkali as Na_2O, the strength properties such as tensile, burst, and tear indices are more than that obtained from other two batches. It is also seen that the properties improve with the increase of bamboo chip proportion in the mix. So also the increasing amount of khagra reed chips, gives paper with lower strength properties.

CONCLUSION

* It may be concluded that mixed pulping of bamboo and khagra reed chips is possible and paper with adequate physical strength properties can be made out of the mixed cooked pulps.
* The optimum strength properties could be obtained from mixing of bamboo and khagra reed chips in the ratio 4 : 1, when cooked with 16% active alkali as Na_2O, at 170 ± 2°C for 2 h.
* Thus, khagra reed, **Neyraudia reynaudiana** may be considered as a potential source of supplementary cellulosic raw material for paper industry.

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REFERENCES

1. Bhargava, R.L., Pulp and Paper Manufacture, Vol.3. Secondary fibres and non-wood pulping. Ed. F. Hamilton & B Leopold. Joint Textbook Committee. TAPPI Press, Atlanta pp 71-81, 1983.
2. Tiwary, K.V., Jivandra, Non-wood plant fibres pulping, Progress Report No.14, TAPPI Press, Atlanta. pp 25-35, 1983.
3. Ghosh, S.R., Saikia, D.C., Goswami, T, Chaliha, B.P., Barua, J.N. Utilization of water hyacinth, Eichhornia crassipes for paper & board making. International conference, Hyderabad, (India), UNEP Report & Proc. Series, No.7, Nairobi, 1984, pp 461-474.
4. Atchison, Joseph, E. Non-wood plant fibres pulping. Progress Report No.4, TAPPI Press, Atlanta, pp 69-70, 1973.
5. Yu, Yuji, Reed pulping in china, Non-wood plant fiber pulping. Progress Report No.14, TAPPI Press, Atlanta, pp 21-24, 1983.
6. Wiedermaun, Alfred; Pulp and Paper Manufacture, Vol.3, Secondary fibers and Non-wood pulping. Ed. F. Hamilton & B. Leopold. Joint Textbook Committee. TAPPI Press, Atlanta, pp 94-105, 1983.