ISSN: 0970-020 X; CODEN: OJCHEG
Oriental Journal of Chemistry
2011, Vol. 27, No. (1): Pg. 149-154

http://www.orientjchem.org

Studies on the Chemical Constituents and the Pulp and Paper Making Characteristics of *Ipomoea carnea* Jacq.

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(Received: August 25, 2010; Accepted: October 21, 2010)

ABSTRACT

Ipomoea carnea Jacq. a common weed, due to its high adaptability, resistance towards adverse climatic conditions grow in all types of climatic and soils marshy as well as dry. Non wood plants are more common as raw material where wood is scarce. In view of its easy availability of *Ipomoea carnea* this study was conducted to evaluate it paper making characteristics. Chemical constituents and the paper making characteristics were investigated. As per the investigation clearly indicate that *Ipomoea carnea* can be used either alone or in combination with other fibers for paper making. Types of sugars present in wood dust,holocellulose and hemicellulose fractions were also identified by paper chromatography

Key words: *Ipomoea carnea,* Chemical constituents, Sugars.

INTRODUCTION

India is on the threshold of big development for the enhancement of industries and the progress of the country. Paper is one of the industry which is expanding rapidly to fulfill the demand of pulp and paper products but it is expected that the gap between demand and supply will increase in population growth and advancement in civilization[1]. From the last three decade there is constant pressure to explore available non wood resources for pulp and paper making. To meet the raw material demand from the local areas to substitue pulp wood,which is becoming scarce and multiple uses of timber in other forest based industries has further forced the pulp and paper industry to seek other cellulosic raw material which are available in sufficient at reasonable price.

The restricted supply of high quality pulp wood and the rising prices of utilities will force paper mills to adopt new technologies to conserve energy minimum inputs,keeping environmental aspects in view much efforts have been directed towards finding a chemical pulping process giving higher pulp yield coupled with economic and environmental considerations[2].

Basis of characterisation of *Ipomoea carnea* Jacq.

Inspite of the fact that the per capita income of paper in India is very low; the indian paper industry is not able to meet the requirements of paper. Apart from the non utilization of capacity,the raw material shortage is also other reason.Under this background new source of non woody plant which has been taken under investigation is *Ipomoea carnea*,commomly known as Beshram,which can be used as a new source of raw material for pulp and paper making in developing countries.

Ipomoea carnea jacq also known as bush morning glory. It widely grows on barren waste lands.It was selected as a raw material for paper making due to its easy availability.Non cellulosic polysaccharide (NCP) plays an important role in improving the paper quality. It has been indicated that the quality as well as quantity of paper pulp is directly dependent upon the percentage of NCP. NCP is retained in the final bleached pulp.It improves the strength of the paper.Hence it is interesting to establish and search out the chemical composition and nature of non cellulosic polysaccharide for better understanding of pulp and paper making process.Literature survey reveals that the hemicellulose in wood is important for intrinsic fibre strength because it imparts maximum stress distribution between cellulosic structural elements.Its presence makes wood a strong material.

EXPERIMENTAL

Material and method

Proximate analysis of Ipomoea carnea Jacq

Ipomoea carnea jacq of around one or two years was collected .The log samples of wood were collected,cleaned,chipped and screened.The screened chips were used in the experimental work.Proximate analysis was done as per TAPPI standard procedures.Holocellulose fraction was obtained by chlorite method.The Non Cellulosic polysaccharide(NCP) or the hemicellulose portion was then extracted from holocellulose using potassium hydroxide.Its chemical composition was studied by Crowell and Brochart methods.

Determination of holocellulose and hemicellulose fraction

Alditol acteate derivatives of wood dust,holocellulose and purified hemicellulose were prepared. These samples were then subjected to Gas Liquid Chromatography for determining their sugar composition.The resolution of alditol acetate derivatives was performed on Perkin Elmer Gas Chromatograph.The stainless steel column filled with liquid phase was used.Nitrogen was used as a carrier gas with a flow of 30ml/min.The temperature of injection and block portion was maintained at 225°C.The column temperature was maintained at suitable temperature.A suitable quantity of sample solution was injected to gas chromatograph.The chromatograph obtained for *Ipomoea carnea* dust holocellulose and hemicellulose fraction was recorded.

Study of paper making process

The entire paper making process was studied under the following parameter- Pulping,beating,fibre morphology,bleaching and paper making.All the parameters were determined by TAPPI procedure.Twenty cooks were done in bomb digester.Three variables such as temperature,time at maximum temperature and chemical change were studied at three different levels keeping time, temperature,sulphidity and bath ratio as per the statistical model.

Kappa number,percentage yield and alkail contents in black liquor were evaluated.Microscopic examination for the fiber dimension was done by the staining the mascerated fiber with Basic Fuschine dye.In CEH sequence,chlorination ,alkali extraction and hypo bleaching was done. Its viscosity and post colour number was evaluated.Pulp strength properties of both bleached and unbleached pulps were determined.Variation in strength properties of *Ipomoea carnea* pulp was done.

RESULTS AND DISCUSSION

With the help of proximate analysis one can have an idea about the test sample of wood that belong to hardwood,softwood or non woody plants.After the proximate analysis i.e wood being tested for ash content,holocellulose content,alcohol benzene solubility,lignin content and other parameter.Results of which is shown in Table 1.

Types of sugars present in wood dust,holocellulose and hemicellulose fractions were identified by paper chromatography. Chromatogram of alditol acetate of *Ipomoea carnea* showed that

Table 1: Proximate chemical analysis of *Ipomoea carnea* and comparision with other plants

S. No	Particulars	Sample I	Sample II	Sample III	Average	Bamboo	Kenaf	Bag-asse
1	Ash Content	6.14	6.20	6.10	6.14	4.1	4.2	1.9
2	Cold Water Solubility	8.43	6.21	7.53	7.39	4.4	4.0	5.1
3	Hot Water Solubility	12.60	12.05	14.10	12.9	5.8	8.6	6.3
4	Ether Solubility	3.04	3.70	3.14	3.29	1.2	2.2	2.1
5	Alcohol benzene Solubility	8.46	7.95	7.45	7.99	4.3	3.0	2.7
6	1%NaOH solubility	28.6	28.4	29.4	28.0	26	30.2	28.7
7	Pentosan content	17.60	16.89	16.9	17.12	17.7	17.9	15.8
8	Lignin content	18.08	18.01	18.00	18.03	26.2	18.0	19.2
9	Holocellulose	67.49	66.5	66.9	66.96	67.3	66.8	69.9
10	Hemi cellulose	22.40	22.67	22.89	22.65	22.1	21.4	18.4
11	Alpha cellulose	46.45	47.45	47.28	47	37	-	-
12	Acetyl content	4.32	4.49	4.59	4.46	-	-	-
13	Methoxyl content	4.76	5.25	4.79	4.93	-	-	-
14	Uronic anhydride	3.45	3.45	3.78	3.56	-	-	-

Note: The values are expressed in percent on OD woody material basis

Table 2: Sugar composition of *Ipomoea carnea*

S.	Sugar	Unit	Percentage		
No	Unit		Dust	Holocellulose	Hemicellulose
1	L.Arhamnose	%	12.85	Trace	Absent
2	L.Arabinose	%	16.74	1.8	Absent
3	D.Xylose	%	13.87	14.9	20.46
4	D.Mannose	%	8.06	Absent	Absent
5	D.Glucose	%	57.40	84.9	Absent
6	D.Galactose	%	-	Trace	Trace

Table 3: Optimization of cooking condition

S. No	Particulars	Unit	1	2	3	4	5	6	7	8	9
1	Temperature	°C	160	165	170	160	165	170	160	165	170
2	Cooking condition	%	17	18	19	17	18	19	17	18	19
3	Bath ratio	Ratio	1:4	1:4	1:4	1:4	1:4	1:4	1:4	1:4	1:4
4	Time to Temp.	Hrs	1.5	1.5	1.5	2	2	2	2.5	2.5	2.5
5	Unbleached pulp yield	%	42.4	42.17	39.9	42.6	40.49	39.87	42.87	41.63	38.18
6	Pulp Kappa No.	Num	23.07	22.05	17.92	24.13	19.24	16.84	25	19.45	15.56
7	Reject	%	1.19	1.2	0.07	1.72	1.04	0.07	2.98	0.68	0.05
8	Free Alkali	Gm/l	2.53	4.87	5.16	2.56	4.0	5.56	2.8	4.27	4.99
9	Viscosity	Centipoise	6.3	6.8	4.6	6.7	5.2	4.7	7.4	5.4	3.3

Sulphidity of cooking liquor =20%; Time to max temp=1.5hrs hemicellulose contain only xylose as shown in Table 2.

Experimental results indicate that optimum conditions for ipomoea pulping were found to be as follows: Percentage of active alkali 17%, time1.6hrs, temperature 160°C, kappa number 25±1, viscosity 8 cps and yield 44% as shown in Table 3.

The study of pulp strength properties indicate that beating the unbleached pulp from 20 to 56°SR increases burst index as well as breaking

Table 4: Bauer Mcnett fibre classification of unbleached pulp

S. No.	Mesh Size	Ipomoea Unbleached Pulp
1	+16	4.2
2	-16+30	9.1
3	-30+50	28.7
4	-50+200	34.7
5	-200	23.9

Table 6: Optimisation of chlorination

S. No.	Average chlorine on OD unbleached pulp %	Residual Chlorine
1	4	0.88
2	5	1.86
3	5.5	2.41
4	5.75	2.88
5	6	4.26
6	6.25	10.88

Table 5: Fibre morphological data

S. No.	Particulars	Average Fibre Length (l)mm	Average Fibre Width (d) micron	Average Cell Wall Thickness (t)micron	Wall Fraction (2t/W*100)%
1	*Ipomoea carnea*	0.61	33.24	1.45	9
2	*Dendrocalamus strictus*	1.75	15.5	5.0	65
3	*Hibiscus cannabinus*	1.53	28.0	5.2	36
4	*Teminalia tomentosa*	1.31	13.96	3.71	53
5	*Strychnos nuxvomica*	1.32	16.43	5.69	69
6	*Eucalyptus cirnodona*	0.97	12.88	4.18	66
7	*Pine caribea*	2.25	41.5	6.0	29

Table 7: Hypochlorite treatment

S. No.	Average chlorine on OD pulp %	Residual Chlorine %	Brightness % ISO	Viscosity CED cps	Post Color number	Shrinkage on pulp basis
1	0.5	2.8	80	12	3	10.1
2	1.0	5.4	81.8	12	4.9	10.1
3	1.5	10.0	82.8	9.1	5.3	12.3
4	2.0	17.8	83.6	8.7	5.5	14.1
5	3.0	28.0	84.8	6.6	6.9	17.5
6	4.0	32.8	86.2	4.6	10.3	20.2

Consistency=10% Temperature= 30°C

Retention time =3 hrs Buffer =to maintain pH 9.0-9.5

length by about 60% & 30% respectively.However it reduces tear index as well as breaking length by about 20%,while in case of 85% bleached pulp beating from 24°SR to 55°SR increases the values of all the above three parameters by 41%, 37%, and 13% respectively. However beyond 55°SR fall in burst index and breaking length values takes place.It can be concluded that tear index for both bleached and unbleached pulps remain more or less constant upto 30°SR .While burst index as well as breaking length improved without adversely effecting the tear index.

On the basis of Bauer McNett fiber classification, it was found that most of the fiber passes through 16 & 30 mesh screens but are retained on 50 & 200 mesh indicating a high percentage of short fibers.Microscopic examination revealed that ipomoea fibers are shorter in length and bigger in diameter than those of kenaf, bamboo and hard wood fibers.Diameter resembles that of tropical pine.A wide lumen with thin wall is present.On delignification this lumen collapses to form a doubly walled ribbon like structure,because

Table 8: Strength properties of *Ipomoea carnea* and bamboo kraft pulps

S. No	Furnish Ipomoea: Bamboo		Blending Before Beating			Blending After Beating			Chips Blending		
	Ipomoea	Bamboo	Burst Index	Tear Index	Tensile Index	Burst Index	Tear Index	Tensile Index	Burst Index	Tear Index	Tensile Index
1	100	00	3.80	4.01	70.42	3.92	3.71	70.42	3.82	3.72	70.42
2	90	10	3.92	4.44	70.01	3.84	3.80	69.40	3.74	3.75	68.44
3	80	20	4.32	4.81	69.98	3.60	4.07	68.60	3.72	3.89	65.79
4	70	30	4.33	4.88	69.50	3.94	4.21	67.25	3.94	3.92	65.34
5	60	40	4.37	4.89	69.49	4.10	4.30	65.9	4.02	4.05	64.95
6	50	50	4.61	4.90	69.32	4.20	4.70	65.7	4.11	4.32	64.66
7	40	60	4.76	5.00	68.78	4.24	5.03	65.65	4.15	4.83	63.72
8	30	70	4.84	5.00	68.47	4.31	5.09	64.65	4.17	5.21	63.22
9	20	80	4.86	5.16	68.4	4.80	5.30	64.32	4.21	5.22	64.3
10	10	90	5.30	5.42	67.92	5.20	5.45	64.10	4.27	5.38	63.9
11	00	100	5.34	5.49	62.50	5.35	5.62	64.09	4.34	5.42	63.42

Table 9: Physical properties of *Ipomoea carnea* pulp bleached with bamboo

Furnish		Brightness%	Post colour no.	Breaking	Porosity
Ipomoea %	Bamboo %	ISO		Length	
100	00	84.0	7.42	7.86	0
90	10	84.10	7.44	7.65	0
80	20	83.45	7.46	7.42	4
70	30	83.76	7.69	7.08	9
60	40	83.70	7.92	6.99	16
50	50	83.35	8.24	6.84	25
40	60	82.90	8.28	6.14	25
30	70	82.75	8.53	6.02	50
20	80	82.70	9.07	7.24	55
10	90	82.55	9.33	7.21	63
00	100	81.05	9.65	6.96	100

Bleaching conditions for Bamboo pulp of 26 Kappa Number C=6.6%, E =1.6%, Hypo =4.6 %

of this structure exhibits plastic deformation properties, offering more surface contact and interfiber deformation properties offering more surface contact and inter fiber bonding. This is expected to give good mechanical strength and less porosity to the paper obtained from *Ipomoea carnea*. Results are shown in Table 4 and 5.

Bleaching experiment results shown in table VI&VII indicate that 6% available chlorine after chlorination is optimum,beyond which the percentage residual chlorien becomes unsuitable for commercial processes.the optimum conditions for getting high brightness after hypo treatment were found to be the extraction of chlorinated pulp with 1.5 NaOH , temperature 50^{o}C, consistency 10%, time 2 hrs.

The pulp can be bleached to 80-81% (ISO) brightness by 0.5 % chlorine during hypo stage maintaining 12 cps viscosity and 4.9 post colour number.These conditions are fairly low in comparision to bamboo 85% brightness can be maintained with 6cps viscosity and 7 post colour number.This condition is also difficult in case of bamboo pulp because then the total chlorine contents will be 9-10% and this is unsuitable for paper quality.It is also found that porosity in bamboo fiber decreases when it was blended with *Ipomoea carnea*.Blending should be done after beating the pulps separately as beating properties of the two are different. Results are shown in Table 7 and 9.

CONCLUSION

The study clearly indicates that ipomoea can form a potential source of raw material for pulp and paper making.It can be concluded that on the experimental observation that the blending of long fibered pulps with short fibered pulps after beatingthe pulps gives better strength properties when compared with other pulps. It can be concluded that the hemicellulose contain only xylose.

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