

Chemical Free Hand Made Paper From Date-Palm (*Phoenix Dactylifera-L*) Levaes

Ghosh S.K. and Nag D.

ABSTRACT

Date-Palm leaf (sustainable agri-residue) is an excellent raw material for making pulp and paper of various grades due to the presence of high alpha cellulose (50-55%), hemi cellulose (26-30%) and ultimate fibre-length (1.25 to 2.50 mm). The presence of high amount of hemi cellulose in the pulp is found to be effective in the beating operation and formation of bonds between the fibres in the paper sheet. Hemi cellulose and alpha cellulose contribute immensely towards tensile strength, bursting strength, tear strength & folding endurance to the paper sheet without using any natural and synthetic polymer or any additive.

Introduction

India's paper industries are reeling under twin pressure of scarcity of raw material and serious technology gap. Thoughtful comments and suggestions were on technology upgradation including plant and machinery.

The total domestic demand for paper, in India is 7.2 million tonnes where as production is only 6.7 million tonnes. At present gap between consumption and production is 0.5 million tonnes.

Ten countries (China, India, U.S.A, Mexico, Indonesia, Thailand, Colombia, Brazil, Argentina & South Africa throughout the world have been giving thrust for the production of non-wood pulp. They classified it in three categories,

- (i) Agri-residues- Bagasse, Straws from wheat and rice, Date-Palm Leaves.
- (ii) Annual Crops- Kenaf, Jute ,Hemp, Mesta, Jute stick
- (iii) Wild plants- Grass and costly bamboo.

Among Asian countries, yearly production of pulp in China is 12.15 million tonnes where as in India it is only 1.1 million tones. So the creation of sustainable resource of non wood raw material for paper Industry is extremely needed in India. The major contribution to non-wood fibres for making paper over the world comes from straws (50%), bagasse (12-15%) with other fibre constituting the remaining portion. Date-Palm Leaf, the

agri-residue, may be utilized for making pulp and paper alone or in blends with other agri-residues. About 0.6 million tonnes of date-palm leaves(DPL) are available in India. No work has yet been reported to develop hand made paper from DPL by mechanical pulping process in India. In the world, only Iraq has done some work on hand made paper by chemi-mechanical process, The present study is to examine the potential use of DPL, and to evolve improved methods of preparation of pulp and paper without using any chemical.

EXPERIMENTAL

Manufacturing of pulp and paper from DPL(Mechanical Pulping Process)

The paper making process from DPL has three simple Steps:

Preparation of fibres:

Air dried Date-Palm Leaves were chopped to 1-1.5 cm in size and kept in plain water overnight for 24 hours in room temperature to make the leaves soft and clean because a portion of pectin, dirt and other foreign materials are removed to reduce the energy consumption for softening chips prior to beating operation unlike thermo-mechanical (™) pulping from logs. Water was poured in the beater machine (Electrically driven) till half of the tank (Oval cemented shape) is filled with water. The ratio of liquid : raw material was maintained at 1:10. The small chips float partly and partly immersed in water around the beater when the beating treatment proceeds. The mechanical process to break down DPL chips into pulp requires no chemical. It

is due to the mechanical action of the fine toothed saw between the base plate and rotating fine toothed saw around the arms of the beater.

For recycling the chips, foreign materials inside the chips and lignin in leaf cells are broken and are partially removed. Since lignin is not fully removed from pulp, yields of pulp exhibited relatively high, about 90-95%. However, due to aging, pulp by mechanical process is often used for newspaper, carry bag, file cover and other non-permanent goods.

Mechanical hydration of fibre takes place during beating process. When the beating treatment proceeds, the internal film structure is loosened and the fibres swell rapidly to about twice the original diameter. Swollen hemi cellulose on the surface of the fibres take an active part in the formation of bonds between the fibres in the paper sheet. It acts as glue. The more surface material is swollen and partly dissolved in water, the stronger is the surface tension forces when drying and larger will be the areas of contact between fibres leading to formation of a strong and even surfaced sheet.

Sheet formation

The pulp slurry (after two hours of beating treatment) is drained out through attached delivery pipe to another blow tank made of cement where pulp mixture (if blending of pulp is required) is further diluted resulting in a very thin slurry. The slurry is drained through a fine wire-mesh screen to form fibrous web of particular size and collected as web sheet on nylon cloth and subsequently stacked on each other.

3.4 MECHANICAL PULPING PROCESS FLOW CHART

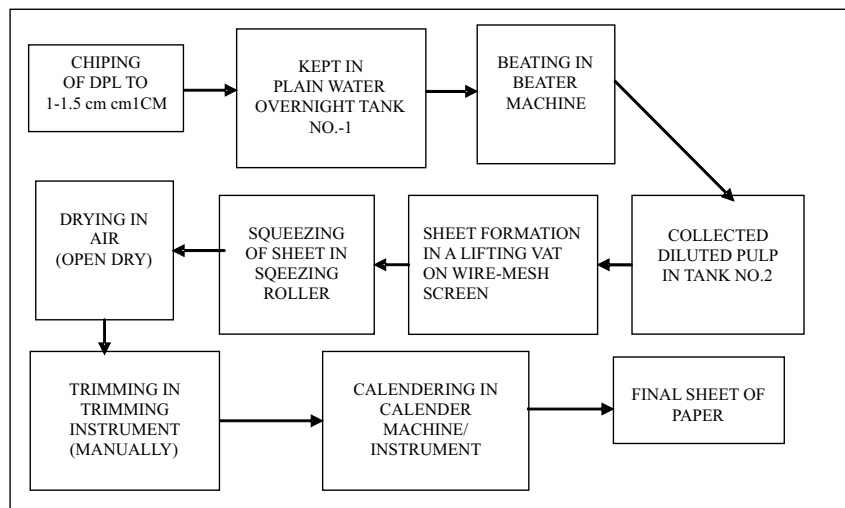


Table-I

Chemical constituents of some Agri-residues

	Alpha-cellulose(%)	Hemi cellulose(%)	Lignin(%)	Ash (%)
Rice Starw	26	30	23	0.8
Bagasse	39	32	20	3.3
Date-Palm Leaves(DPL)	50	26	15	1.8

Table-II

Strength parameters of different grades of paper made of Date-Palm Leaves (DPL) alone or its blends by different process.

Raw Material	Process of Pulping	Yield (%)	Burst Index (Kpa-m ² /g)	Breaking length(m)	Fold endurance No	Area Density GSM(g/m ²)	Remarks
DPL(100%)	Chemi-mechanical	48.0	1.26	1500	10-15	130	Better results obtained by mechanical pulping process
DPL(100%)	Mechanical	90.0	1.98	1800	25-30	146	
DPL:Cotton rag (50:50)	Chemi-mechanical	65.0	1.59	1769	26-35	148	
DPL:Cotton Rag(50:50)	mechanical	95.0	2.65	2558	31-48	158	

Table III

Yield & Strength Properties of paper sheets made from date-palm Leaves or its blends.

Raw material	Pulping process	Yield of pulp(%)	Freeness °SR	Fold endurance No	Burst Index (Kpa-m ² /g)	Density (g/cc)
DPL(100%)	Mechanical Beating	90.0	55	25	2.48	1.52
DPL:Cotton Rag(75:25)	- Do-	93.0	50	37	3.05	1.64
DPL:Waste paper(75:25)	-Do-	86.0	45	20	1.95	1.23

Pressure may be applied (manually) to remove additional water in a squeezing Instrument. The paper may then be removed from the mould, for further processing. Natural drying of the sheets was performed either vertically clipping or horizontally on ground surface. Finally, trimming and calendaring make the paper glossy and even surface.

Hemicellulose has great contributions for making pulp & paper by mechanical pulping process.

- Hemi cellulose, the non-cellulose polysaccharides, occur in cell wall of fibre.
- Hemi cellulose due to its amorphous nature, low molecular weight and presence of Hydroxyl group in the molecule, have a great affinity for water. This hydrophilic nature lends great contributions for making pulp.
- Mechanical hydration takes place during beating process. When the beating treatment proceeds, the internal film structure is loosened and the fibres swell rapidly to about twice the original diameter.
- Swollen hemi cellulose on the surface of the fibre
 - renders fibre more plastically deformable and fibrillate rather than breakage during beating operation.
 - Promote inter fibre/fibrils bonding in the paper-sheet after removing water from the paper sheet. Hemi cellulose acts as glue or adhesive in fine.
- The presence of Hemi cellulose in the pulp reduces time and electrical energy required to soften fibre and as a result costly digestion or cooking process may be avoided.

RESULTS AN DISCUSSIONS

Both alpha-cellulose and Hemi cellulose of Date-Palm Leaves are much higher than of rice-straw and bagasse (Table-I) and it indicates that good quality paper of desirable mechanical properties (tear, bursting and tensile strength) may be obtained by mechanical pulping process.

It also appears from Table II & III that

the hand- made paper by mechanical pulping process is superior to chemi-mechanical process and with the increase of cotton rag proportions in the mixed pulp, there is gradual increase of mechanical properties whereas gradual decrease of mechanical properties are noticed when DPL pulp is mixed with waste paper.

Conclusions

1. DPL, the agri-residue and sustainable resource can be easily blended with inferior quality cotton rag and paper waste.
2. There is no need of digestion or nor costly cooking operation. As a result, high electrical energy consumption and operation time can be saved.
3. The brightness Index, tear Strength, tensile strength can be facilitated in admixture with cotton rag of shorter fibre without using any polymer (synthetic or natural) or any additives.
4. Mechanical pulping process is cost

effective and environment friendly .

5. Main target is to gear up hand made paper technology for rural sectors and low capital investment is required to dispose off date-palm leaves available in most of the states of India.
6. The utilization of waste-paper and its blends has made significant progress in India for the last few years.
7. In fine, it is conferred that there is tremendous potentiality to use date palm leaves for making hand made paper and it will be suitable for making file-cover, carry bag, folder, box-board, writing pad, decorative paper, letter head and greetings card.
8. The process is techno-economically more acceptable.

ACKNOWLEDGMENT

Authors are grateful to Dr. S.K.Battacharyya, Director, NIRJAFT and ICAR for kind permission and providing facilities to present this paper.

Literature Cited

1. Paper Industry needs technology upgradation fund-FICCI Published in the Hindu News Update Service on 07.06.2007.
2. Day, A and Dasgupta P.C "Role of Hemicellulose in pulp and paper-Indian Pulp and papers, August-Sept. 1997
3. Thompason, J.O, Swanson J.W and wise, L.E, Tappi 36(12), 534, 1953
4. Giertz, H.W, Meddlelande, Nr, SevenSka Traforskningss intituuet, 123(1953)
5. Sanyal, A.K. and Day A, "Cellulose-Based Speciality papers"-IIPPTA, Jan March, 1977, Vol-XIV.No.-1, pp 53-55
6. Ghosh I.N, Roy A.K and Sanyal A.K, "Mixed Pulping of Jute stick and Jute Root cuttings". "Indian Pulp Paper, Feb-March 1983, pp A-20.
7. Jain R.K. Singh K. and Roy T.K., "Indian Paper Industry Raw Material Scenario, growth prospects and pathways, IPPTA J. Vol.19, No.-3, July-Sept, 2007, P-136