Scientific Approach To Preserve Non-Wood Fiber – A Case Study

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ABSTRACT

With the depletion of forest resources, using agro-residues as raw materials for manufacturing of writing & printing paper has become increasingly important. Agro-residues are the most potential fiber resource, which are helpful to sustainable development of Indian paper industries. Based on a great deal of researches, this paper summarizes and discusses some problems in using agro-residues as raw materials for producing good quality pulp. In order to achieve the same, raw material storage, preparation and selective usage of material are important. This paper deals how good quality paper can be manufactured with Sarkanda (saccharum munja) using selective fungicide namely Hexaconazole 5% EC in the stored Sarkanda stacks in raw material stock yard to minimize it's deterioration under extreme environmental factors, such as temperature, rain and internal fungal degradation etc. during long storage. (Say 7 to 8 months.)

Keywords: Saccharummunja,Sarkanda stack, Stockyard, deterioration, fungicide Hexaconazole, Chemical spray, Hollocellulose content, raw material preservation

Introduction

ABC Paper Ltd. is engaged in manufacturing of Pulp and Paper from Wheat straw, Sarkanda grass (Saccharum Munja), Poplar, Eucalyptus and Bamboo. The supply chain of the Sarkanda Grass is organized through a contract arrangement with farmers and contractors residing in and around 250 km radius from the plant. This arrangement ensures reliable and timely delivery of the Sarkanda Grass to the mill. This raw material is stored as buffer stock in an open stock yard for 7-8 months to meet the regular requirement of the raw material in certain proportion.

Unfortunately Sarkanda has many disadvantages as a raw material when compared to wood. First of all it is to be stored for 7-8 months, and the pulp mill has to operate for 12 months in a year. During this period of storage the material has to be protected from harsh weather conditions to avoid degradation otherwise it will become unsuitable for making good quality pulp and paper.Sarkanda has low bulk density which incurs additional cost on storage and protection against fire and microbial deterioration. Dust and fines content of Sarkanda on prolong storage results in loss of biomass at the screens and generation of fines. Sarkanda is prone to microbial degradation due to external forces such as temperature, humidity and rain resulting in deterioration of cellulosic fiber and drop in the yield and strength of the pulp.

So, it was decided to identify the various means and methods to keep the stored raw material with minimum damage. Accordingly an in-house study was initiated to preserve this raw material with suitable chemical / fungicide, so that degradation could be minimized.

Experimental

A suitably designed basement was made to store sarkanda in order to have proper ventilation and chemical spray carried out during storage to avoid microbial / fungal attack (Ageing of Sarkanda). The Sarkanda used for experiment was procured from various locations and then compared with conventional (normal) stacked material.

After conducting several laboratory trials for a period of over 8 months, Hexaconazole 5% EC was selected to use as a fungicide to avoid deterioration on storage. Pulping experiments were carried out in our lab autoclave digester (consisting of six bombs each of 2.5 liter capacity rotating in an electrically heated polyethylene glycol bath). Cooking, pulping and bleaching experiments carried out similar to our process conditions.

Technical Specification of Chemical Spray (Fungicide)

Product Profile: TATA

(Sprayed on Stack No.501)
Technical Name - Hexaconazole 5% EC,
Formulation Name - Contaf
Acidity (as H_2SO_4) - 1.0 % (max.),
Moisture Content - 1.0 % (max.)
Acetone Insoluble Material - 1.0 % (max.)
Contaf is a 5% EC formulation of Hexaconazole, An excellent Triazole fungicide. It has a Broad Spectrum Protectant Eradicant and Systemic Fungicidal Action.

Product Profile: SHRIRAM RAKSHAK

(Sprayed on Stack No.515-A)
Technical Name - Hexaconazole 5% EC,
Formulation Name Contaf
Hexaconazole Technical (Based on 92 % purity) - 05.5 % w/w
Emulsifiers (Blend of anionic and nonionic) - 10.0 % w/w
Styrinated phenol ethylene oxide condensate - 5 % w/w & Dodecyl benzene sulphonic acid calcium salt 5 % w/w
Solvent - Aromax - 84.5 % w/w

Necessity of Fungicides

Fungicides are chemical compounds or biological organisms used to kill or inhibit fungi or fungal spores. Fungi are capable of causing serious damage in agro - residues and various grasses resulting in critical losses of yield, quality and profitability. In the study of plant disease (phytopathology),

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chemicals used to control oomycetes are also referred to as fungicides. Fungicides can either be contact or systemic. A contact fungicide kills fungi when sprayed on its surface; a systemic fungicide has to be absorbed by the plant. Plants and other organisms have developed chemical defenses over a period of time, (via natural selection), which impart an advantage against microorganisms such as fungi.

Fungicides should only be applied when it is absolutely necessary, as they are harmful. Lowering the amount of fungicide in the environment lowers the selection pressure for resistance to develop. Doses suggested by the manufacturers should always be followed. These doses are normally designed to give the right balance between controlling the disease and limiting the risk of resistance development. It is also recommended to use fungicides in a protective manner, rather than curing already infected material.

Methodology adopted for chemical spray (fungicide)

A suitable place in stock yard area has been selected, necessary civil work has been carried out by providing air ventilation to the raw material stack with pocket ventilation arrangement. Spraying of Hexaconazole 5% EC (Contaf) was done to avoid microbial/fungal attack on raw material.

Two stacks were selected for experimental purpose, utilizing two best quality supplies available in the market to see the impact on storage to enable us to select a proper fungicide between the two. Necessary details like B.D. quantity, dosage rate and dimensional details of the stacks have been recorded as given below (table-1)

Civil Work: Dimensions & Cost

Length of the base - 80 feet
Width of the base - 20 feet
Bar Width - 9 Inch
Bar Height - 1 foot
Bar Spacing - 1 foot
Cost of Base - Rs.22,700 for one base (Rs.45, 400 for two bases)

Photographs of the basement and dimensional drwg. are shown in Fig.1 (a)&(b).

Brief Description of the Spraying Process

Fungicide was sprayed on specially designed concrete base before unloading of Sarkanda vehicles. Hexaconazole was sprayed after every 2 feet elevation to prevent the deterioration and microbial/fungal attack. First day, the piling of Stack was done to approx. 2.0 feet height and then stopped for 24 hours (for absorption). On second day, piling of Stack again started with fungicide spray on upper most layer of the material and then with continuous spray of Hexaconazole during unloading to 4.0 feet height.

From third day onwards, same procedure was repeated to 6.0 feet, 8feet, 10feet and 12feet height. Unloading of material was done in normal fashion as followed in daily routine. Piling of Stack took six days as in normal case and after completion of Stack the material was kept as such for five months to see the impact on quality, yield, degradation and microbial / fungal attack on it during storage. Instructions were issued to concerned persons of Stock Yard and Pulp Mill not to use the material for five months. Complete piling of stack is shown in Figure-2(a), (b), (c), (d).

Figure 1 (a) Base for Sarkanda Grass Stack in stock yard

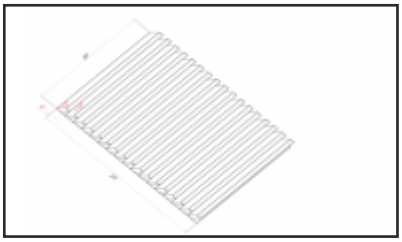


Figure 1(b) Dimensions of base for Sarkanda Grass Stack in Stock Yard, 20ft. X 80 ft.

Figure 2 (a) Spraying of Hexaconazole before piling of Stack

Figure 2 (b) Spraying of Hexaconazole after Piling of Stack to 4.0 feet ht.

Figure 2 (c) Spraying after Piling of Stack to 6.0 feet height

Figure 2(b) Completion of Stack at 12.0 feet Height

TABLE 1
EXPERIMENTAL STACK QUANTITY AND CHEMICAL SPRAY DETAILS

Particulars	Stack No.501	Stack No.515-A
Chemical used	Hexaconazole 5 %EC	Hexaconazole 5 %EC
Formulation Name	Contaf	Contaf
Dilution of the chemical	40 times (40gpl)	40 times (40gpl)
Sprayed Chemical	3 Liter	2999.806gm
Dose	21.43 ppm	20.10 ppm
Name of the Supplier	Rallis(TATA Make)	SHRIRAM RAKSHAK
Price of the chemical	Rs.355/- per 500 ml	Rs.500/- per liter
Dimension of Stacks	Length:80 feet Width:20 feet Height:12 feet	Length:80 feet Width:20 feet Height:12 feet
Quantity of the material stacked	A.D -139.945 M.T B.D -62.073 M.T	A.D -149.170 M.T B.D -60.126 M.T

Methods Adopted For Testing

Following standard methods were applied for different analysis:

Proximate chemical analysis
TAPPI Standard Methods
Laboratory beating of pulp
TAPPI T: 200
Kappa No. TAPPI T: 236
Hand sheets formation
TAPPI T: 205
Testing of Pulp hand sheets
TAPPI T: 220

Result & Discussion

Comparison of Proximate analysis of sprayed stacks with normal stack

The material of experimental stack was used after five months and composite samples were drawn intermittently during consumption. Samples were sent to C.P.P.R.I. for proximate analysis to compare the results of treated and untreated material. The results of proximate chemical analysis with and without chemical treatment are given in Table-2 and in Figure-3 (a) & (b).

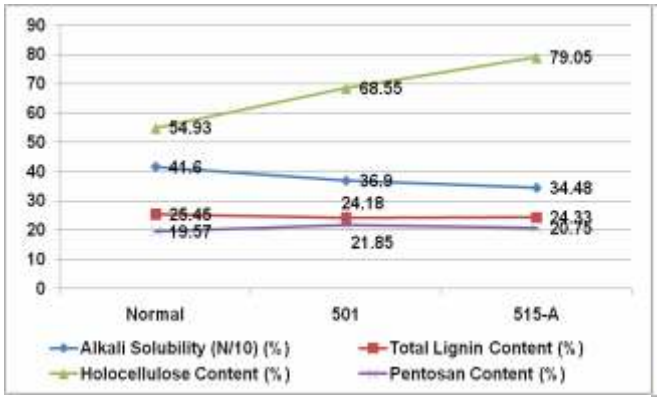
The results clearly indicates that there is a substantial increase in holocellulose and alpha-cellulose content in Sarkanda stack sprayed with fungicide as compare to conventional stack (without spray). Ash content in experimental stack material was also observed on lower side.

TABLE 2
PROXIMATE ANALYSIS OF K.GRASS

Parameter	Unit	Results (On Raw Material basis)		
Raw Material	?	Sarkanda	Sarkanda	Sarkanda
Stacking	?	Conventional	Experimental	Experimental
Fungicide Name	?	?	TATA	SHRIRAM
Set No.	?	A	B	C
Identification of Stack	?	Normal	501	515-A
Cold Water Solubility	(%)	5.15	4.75	3.98
Hot Water Solubility	(%)	8.63	5.36	6.26
Alkali Solubility (N/10)	(%)	41.6	36.9	34.48
Total Lignin Content[1]	(%)	25.45	24.18	24.33
Holocellulose Content[2]	(%)	54.93	68.55	79.05*
Ash Content	(%)	12.06	5.29	5.15
Alcohol/Benzene Solubility	(%)	3.1	2.8	2.6
Pentosan Content	(%)	19.57	21.85	20.75

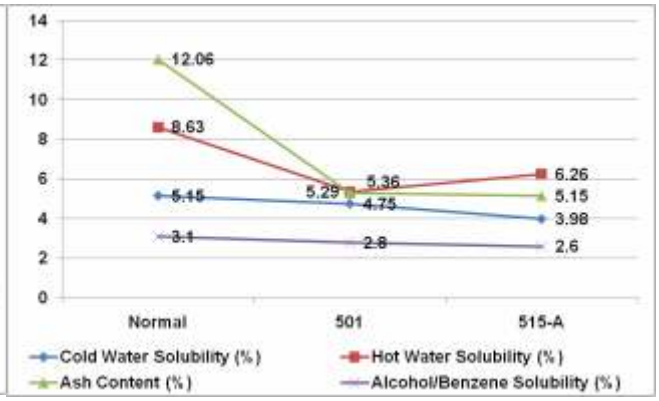
1. Total Lignin corrected for Ash Content
2. Holocellulose after Ash & Lignin correction.

FIGURE-3(a)



Comparison of Cold Water, Hot Water, Alcohol/Benzene Solubility and Ash Content of Sarkanda

FIGURE-3(b)



Comparison of Alkali Solubility (N/10), Total Lignin, Holocellulose and Pentosan Content of Sarkanda

TABLE-3
COOKING & PULPING STAGE OF K.GRASS

Stack	-	Conventional	Exp.-501	Exp.-515 A
M/s Fungicide	-	-	TATA	SHRIRAM
Set No.	-	A	B	C
Raw Material	Unit	Sarkanda	Sarkanda	Sarkanda
O.D. Weight	Gram	200	200	200
NaOH Added	%	15.0	15.0	15.0
Cooking Aid	%	0.05	0.05	0.05
Cooking Time	Hours	4	4	4
Bath Ratio	Numeric	1;4	1;4	1;4
K.No.	Number	24.0	23.4	23.5
R.A	Gpl	2.6	2.4	3.0
Total Solid (B/Liq.)	%	10.60	10.20	10.70
p H (B/Liq.)	Value	11.20	11.30	11.22
^{O}Tw (B/Liq.)	Degree	11.00	10.00	10.00
p H of Pulp	Value	8.20	8.22	8.30
Unbleach Yield	%	46.8	48.0	47.5
Brightness	%	24.6	24.6	24.8

Comparison of process parameters with experimental and control stack

In order to compare the pulp characteristics, samples were drawn from different portions of the stack. Cooking and bleaching parameter are given inTable-3,5 & 6

From the above results it is clearly evident that the pulp obtained from the fungicide sprayed stack has higher alpha-cellulose content and higher pulp yield i.e. 44.8 & 44.4 against 43.6% of control stack, shown in graph-3(c)].

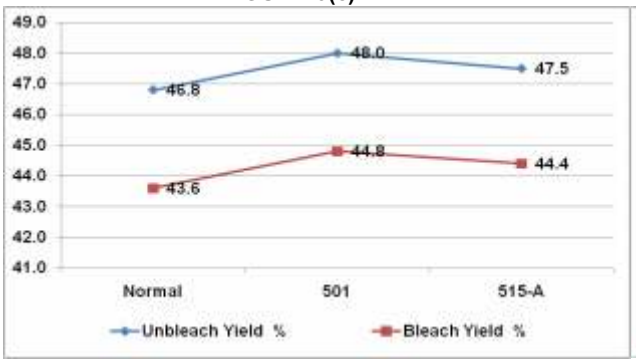
TABLE-5
CHLORINATION & EXTRACTION STAGE OF C E_P H H

Chlorination		**A**	**B**	**C**
O.D. Pulp Weight	Gram	100	100	100
Cl_2 Added	%	4.6	4.6	4.6
p H Initial	Value	3.20	3.00	2.92
Retention	Minutes	45	45	45
p H Final	Value	1.92	1.82	1.80
R - Cl_2	gpl	0.0142	0.0213	0.0142
Cl_2 Consumption	%	4.56	4.55	4.56
p H (Wash)	Value	4.27	4.29	4.33
Brightness	%	37.2	38.9	38.6
Alkali Extraction		**A**	**B**	**C**
Temperature	^{0}C	60	60	60
Alkali Added	%	2.5	2.5	2.5
H_2O_2 Added	%	0.8	0.8	0.8
p H Initial	Value	11.70	11.70	11.20
Retention	Minutes	120	120	120
p H Final	Value	9.78	9.72	9.78
p H (Wash)	Value	8.24	8.40	8.27
K.No.	Number	3.4	3.6	3.4
Brightness	%	48.0	49.2	48.8

TABLE-6
HYPO I & II STAGE OF C E_P H H

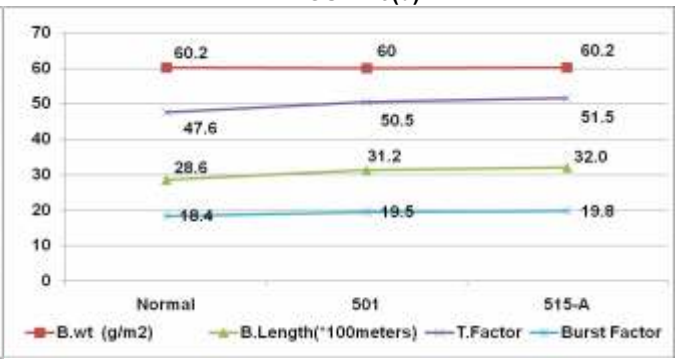
H – I Stage		**A**	**B**	**C**
Temperature	^{0}C	45	45	45
Hypo Added	%	2.2	2.2	2.2
p H Initial	Value	8.72	8.90	8.74
Retention	Minutes	120	120	120
p H Final	Value	8.33	8.21	8.17
R - Cl_2	gpl	0.0142	0.0284	0.0142
Cl_2 Consumption	%	2.19	2.18	2.19
Brightness	%	78.8	79.6	79.7
H – II Stage		**A**	**B**	**C**
Temperature	^{0}C	45	45	45
Hypo Added	%	1.2	1.2	1.2
p H Initial	Value	8.48	8.44	8.33
Retention	Minutes	120	120	120
p H Final	Value	8.00	8.11	8.07
R - Cl_2	gpl	0.00142	0.00710	0.00142
Cl_2 Consumption	%	1.19	1.19	1.19
Total Cl_2 Charged	%	8.0	8.0	8.0
Total Cl_2 Consumed	%	7.94	7.92	7.94
Brightness	%	80.20	81.00	81.20
Whiteness	CIE	67.20	68.40	68.80
L	SCI	93.72	93.88	94.88
a	SCI	-0.26	-0.22	-0.18
b	SCI	4.07	3.97	3.53
Tint	CIE	-0.90	-0.92	-0.87
Shrinkage	%	6.70	6.62	6.45
Bleach Yield	%	43.60	44.80	44.40

FIGURE-3(c)



Unbleached & Bleach yield comparison of Sarkanda pulp.

FIGURE-3(d)



Strength properties comparison of Sarkanda bleach pulp

TABLE-4
STRENGTH PROPERTIES OF K.GRASS PULP HAND SHEETS

Un-bleach Pulp				
Particulars	**Unit**	**A**	**B**	**C**
^{0}SR		24	24	24
B.wt	(g/m^2)	60.2	60.0	60.2
B.Length	(meters)	3270	3340	3365
T.Factor		66.2	68.2	67.8
Burst Factor		20.7	21.7	21.8

TABLE-7
STRENGTH PROPERTIES OF K.GRASS PULP HAND SHEETS

Bleach Pulp				
Particulars	**Unit**	**A**	**B**	**C**
^{0}SR		28	28	28
B.wt	(g/m^2)	60.2	60.0	60.2
B.Length	(meters)	2860	3120	3200
T.Factor		47.6	50.5	51.5
Burst Factor		18.4	19.5	19.8

Comparison of Un-bleached and Bleached Pulp Strength Properties of fungicide sprayed stack and control stack

Strength Properties of Un-bleached & Bleached pulp were also determined after beating the pulp in Lab Valley Beater at standard conditions. Hand sheets were made to see the impact on strength properties of conventional stack pulp in comparison to fungicide sprayed stack. Strength proprieties are given in Table-4 and Table-7.

It is evident from Table-4 and Table-7 that there is substantial improvement in strength properties (unbleached and bleached pulp) of fungicide sprayed stack as compared to normal stack pulp. Breaking length increased by 9.1 & 11.8%, burst factor increased to 6.0 & 7.6% and tear factor increased by 6.7 & 8.3% as compare to normal stack pulp at same ^{0}SR [shown in figure-3(d)].

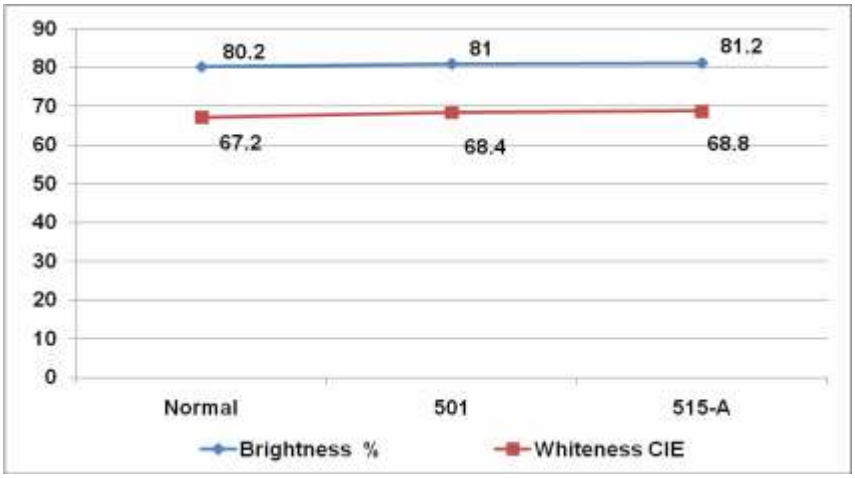
Comparison of Brightness and Whiteness of fungicide sprayed stack and conventional stack

Substantial increase observed in brightness and whiteness of bleached pulp in experimental stacks i.e. 1.0 & 1.2% and 1.8 & 2.3% [as given in graph-3(e)] in comparison to normal stack pulp.

Conclusions

It is evident from the experiment that spraying of fungicide along with pocket ventilation base before stacking is an important and necessary activity to preserve the raw material from deterioration. High holocellulose content noticed in case of experimental stacked material than normal stacked material. Fungicide sprayed stack requires lower chemicals for cooking & bleaching to achieve desired pulp properties. Pulp produced from fungicide treated material showed higher yield & strength properties. The study has shown that raw material degradation can be avoided by chemical spray (of fungicide) & providing proper pocket ventilation during storage at an affordable cost.

FIGURE-3(e)



Brightness & Whiteness of Sarkanda Bleach Pulp

Acknoledgement

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