

Bamboo as a Solution for Food Packaging

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Introduction

Grows rapidly

The green gold

Poor man's timber

Plant with many faces



Longer Fiber & High Tensile Strength

Easy to grow in India

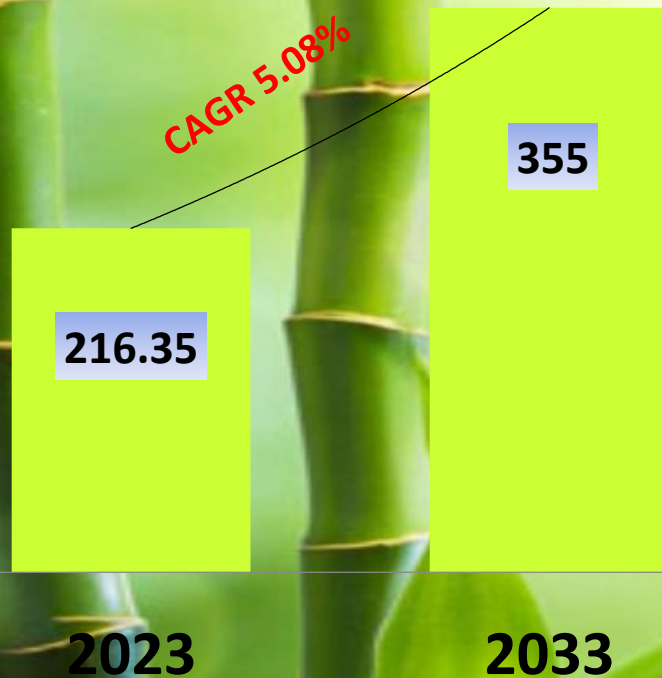
Multiple end used, Pulp and Packaging Industry

- Bamboo is a perennial grass belongs to grass family Poaceae.

Scenario of Ecofriendly Food Packaging

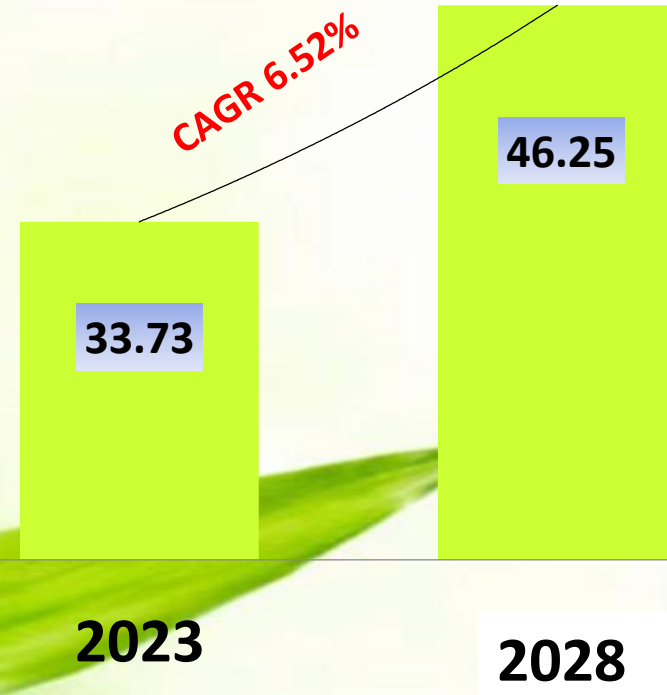
Global Food Packaging Market

■ market Value for food packaging (US \$ billion)



India Food Packaging Market

■ market Value for food packaging (US \$ billion)



Various Packaging & Their Merits

Plastic Packaging	Recycle Fiber	Virgin Fiber /Bamboo packaging
Non bio degradable it takes 20 to 500 years	Bio compostable	Bio compostable & safe for environment
Cheaper to produce but hazardous	High investment infrastructure facilities	Cheaper to produce
Required non renewable natural resources to produce	Recovery rate of around 50 per cent	Sustainable and easy to grow
Produce toxic substance when it breaks down and harms the environment	Recycle pulp have some toxic chemicals, bleaching agents and hydrocarbons	Natural pulp with antibacterial properties

Development of Basic Properties for Food Packaging Grade paper or board by Surface Coating

Barrier to moisture, gases and oils

Non toxic

Resistance to physical damage

Non biodegradable surface coating

Polyethylene, waxes, polyvinylidene chloride etc are commonly used

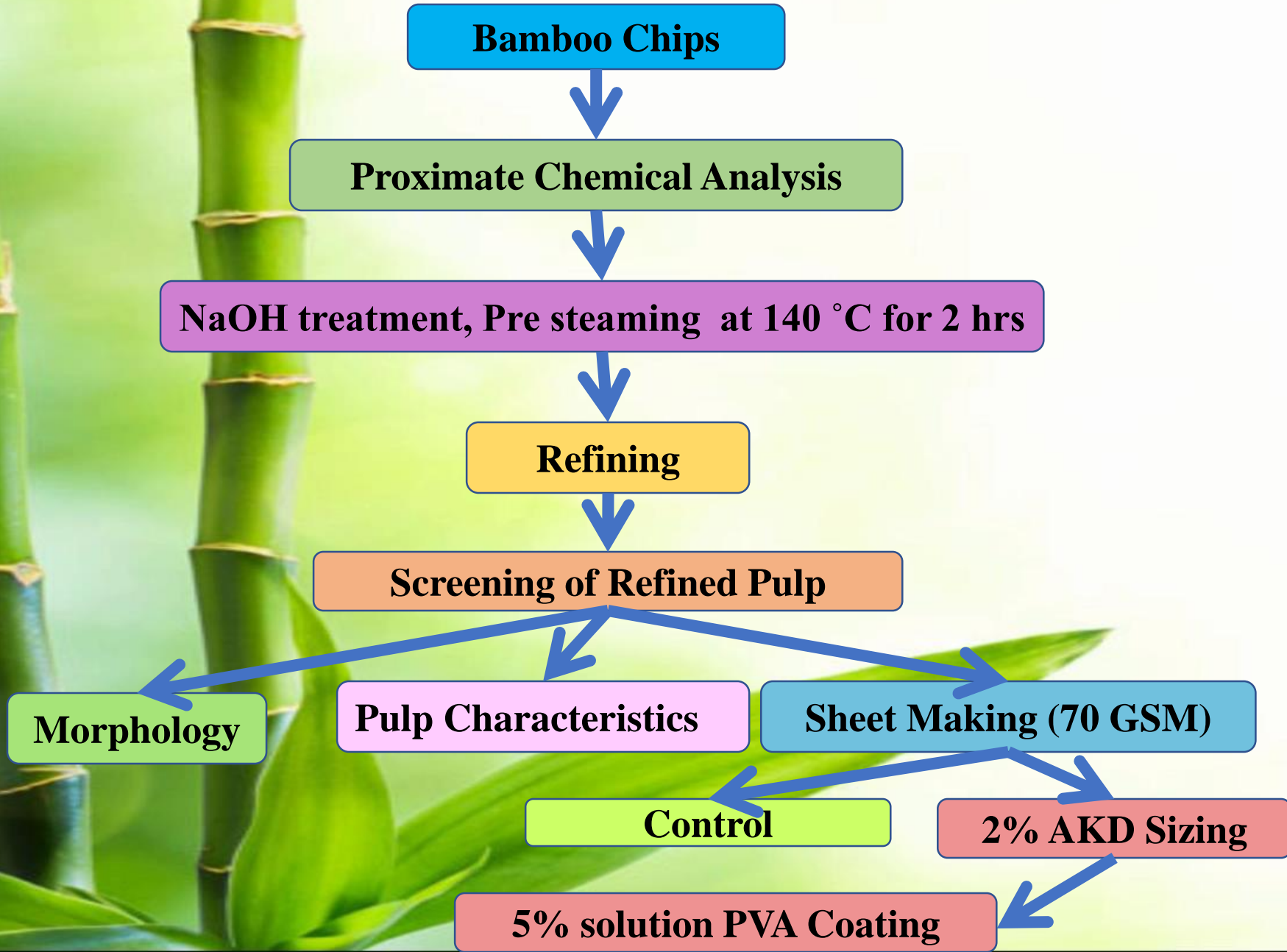
Green chemical surface coating

Oxidized starch, cationic starch, acrylamide polymer, polyvinyl alcohol.

Objective

- To produce pulp from juvenile and matured bamboo by CTMP process.
- To accomplishment of general requirements for food packaging grade product by using environment friendly chemicals for *sizing and coating*.
- To testing of barrier properties i.e, grease proofing, resistance to air and water flow.

Schematic Diagram of Study



Materials and Methodology



1.5 year Bamboo in field



1.5 year Bamboo cutting for sampling



Bamboo plant sample

Dendro calamus strictus bamboo is planted in CPPRI (Central Pulp and Paper Research Institute) nursery and backyard.

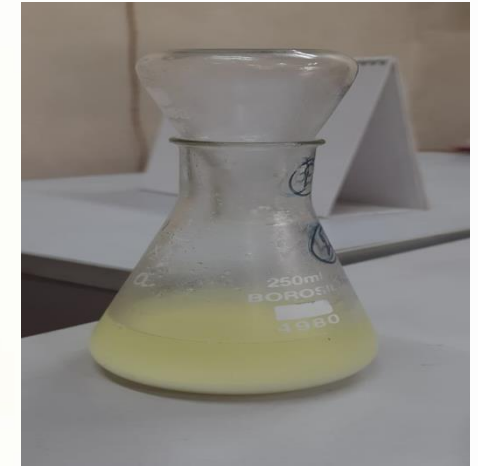
Proximate Chemical Analysis



Willy mill (Dust Making Machine)



Lignin Content



Hollocellulose



Ash Content



Extractive Content

Parameters	Juvenile Bamboo	Mature Bamboo
Lignin %	20.3	23.2
Hollocellulose %	64.4	68.2
Ash %	3.7	3.2
Extractives %	5.34	3.55

CTMP Pulping

1



2



3



4



5



6



7

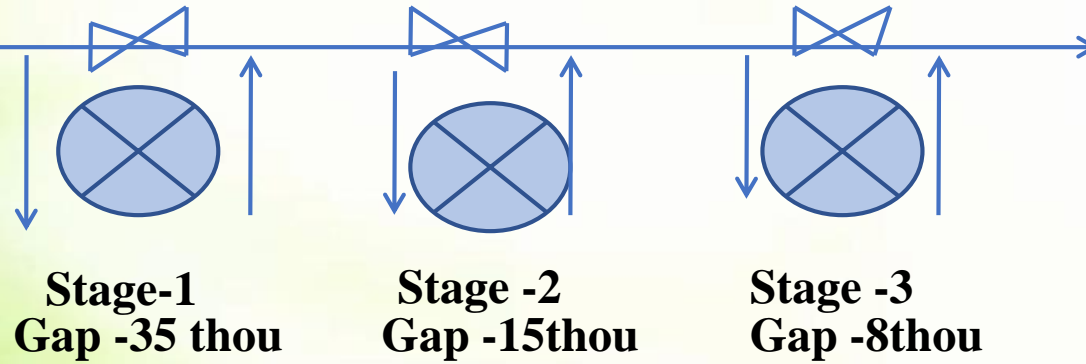


Process Condition:- Ambient to 140 °C in 60 min, at 140 °C for 2 hrs, Bath ratio – 1:3.5

Particulars	Juvenile		Mature	
	4	6	4	6
Alkali Charge %	4	6	4	6
Yield %	94.6	91.4	92.5	89.5
Total solids %	1.9	2.8	1.6	2.3

Result of pre steaming of juvenile and matured bamboo chips

Refining of Juvenile Bamboo

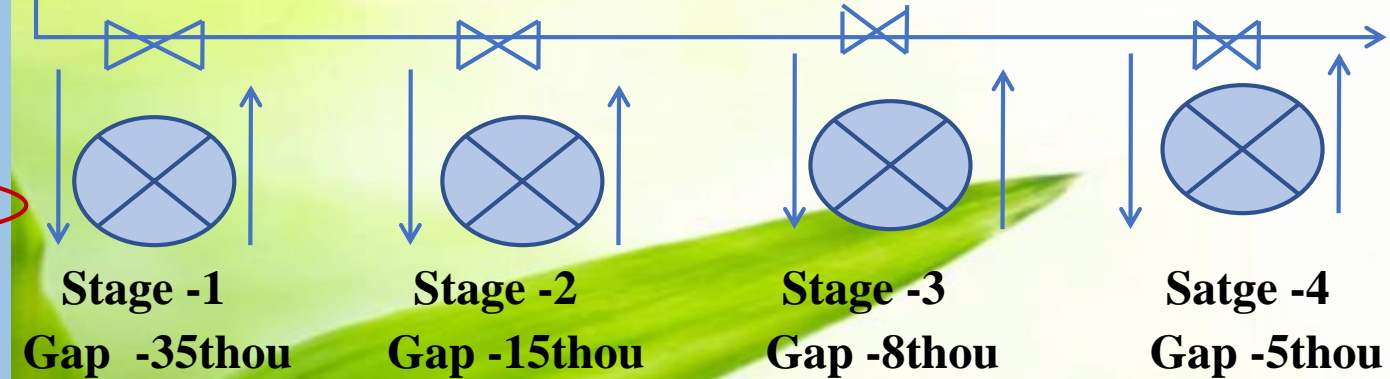


Unrefined
pulp

Consistency 4-5%
RPM-1500

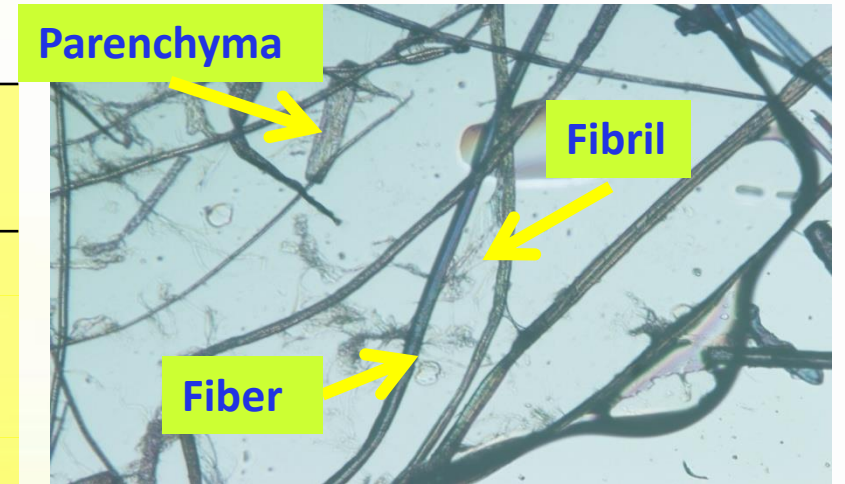
Particulars	Juvenile		Mature	
NaOH %	4	6	4	6
Unscreened pulp yield, %	87.5	86.2	85.6	84.2
Reject, %	1.2	0.9	2.0	1.6
Screened Pulp yield, %	86.3	85.2	83.6	82.6
Freeness, CSF (ml)	390	404	426	417
Brightness (%ISO)	31.1	32.3	30.6	32.1

Refining of Mature Bamboo

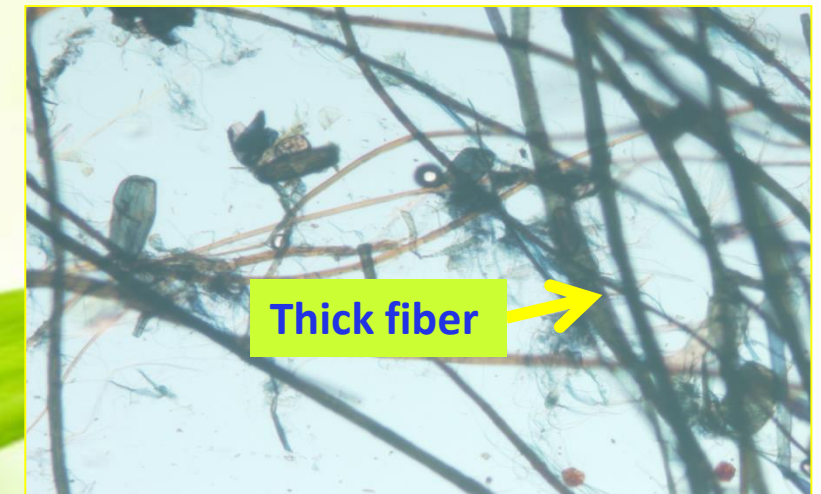


Fiber Morphology Juvenile vs. Matured Bamboo

Parameters	Juvenile Bamboo	Matured Bamboo
Average fibre length (L), mm	1.62	1.83
Average fibre width (D), μm	13.8	16.1
Average Lumen diameter (d), μm	3.52	4.00
Average Cell wall thickness (w), μm	5.14	6.05
Runkel Ratio ($2w/d$)	2.92	3.45
Slenderness Ratio (L/D)	117.4	113.7
Flexibility Coefficient, $d/D*100$	25.5	24.8
Rigidity Coefficient, $2w/D$	0.745	0.752
Solid Factor, $(D^2-d^2)*L$	109.9	132.4
Lucas factor, $(D^2-d^2)/(D^2+d^2)*$	0.877	0.878



CTMP Juvenile bamboo pulp (x4)



CTMP Mature bamboo pulp (x 10)

Pulp Processing



Pulp Screening
(Vibrating)

150Mesh
Area 0.02 m²

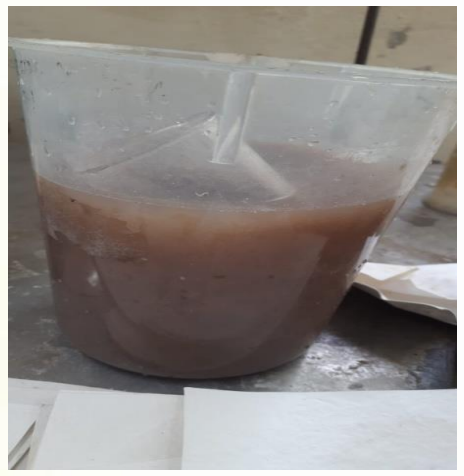


Pulp sheet former



3000 RPM

Disintegration of Pulp



Disintegrated pulp



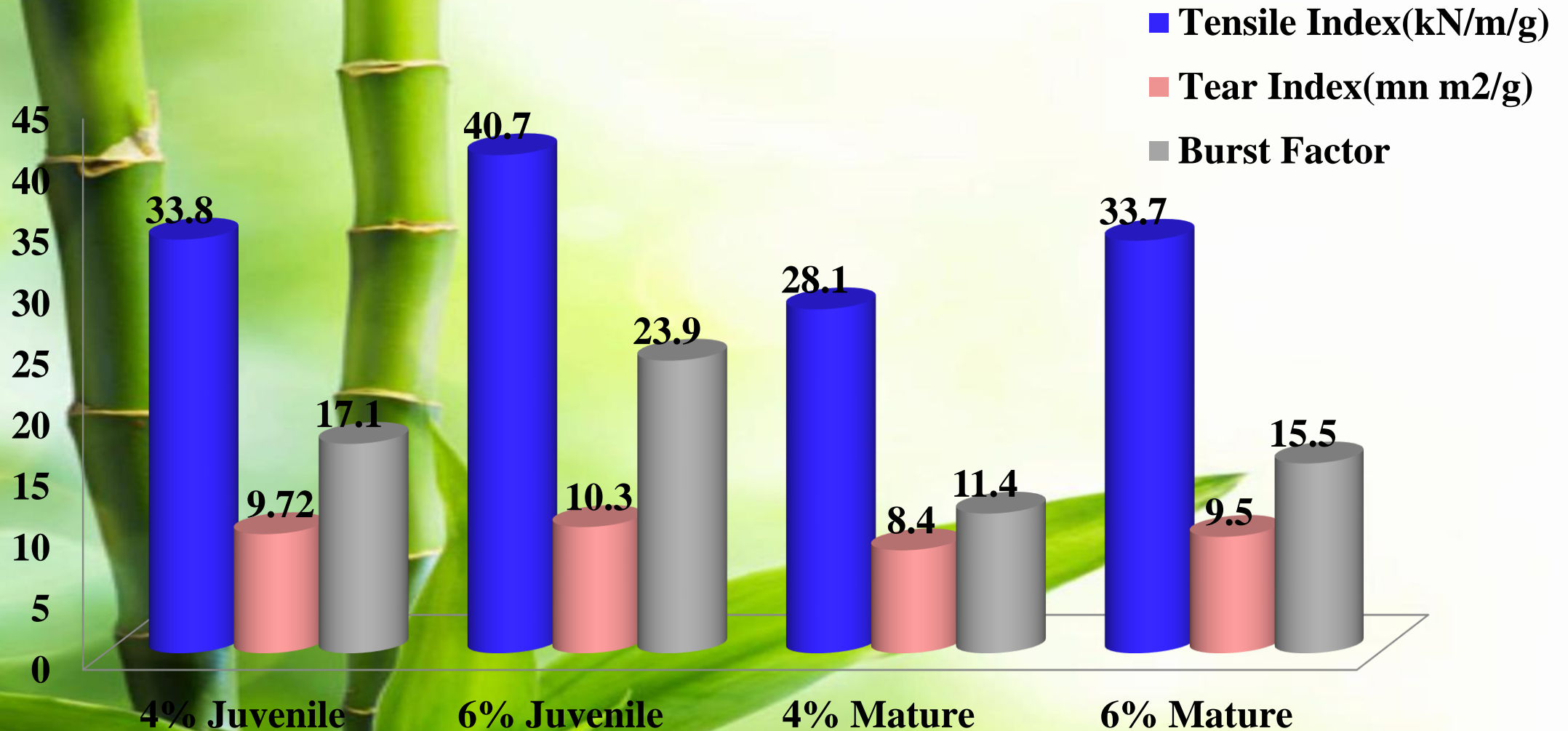
3.5 bar for 5 min
3.5 bar for 2 min

Sheet Pressing



Sheet Drying

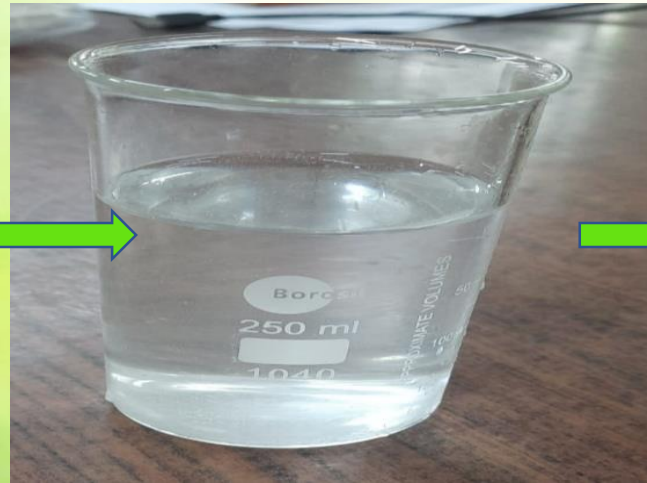
Physical Strength Properties of Juvenile and Mature Bamboo Pulp Sheet



Surface Coating of Prepared Sheet



Uncoated 2% AKD seized sheets



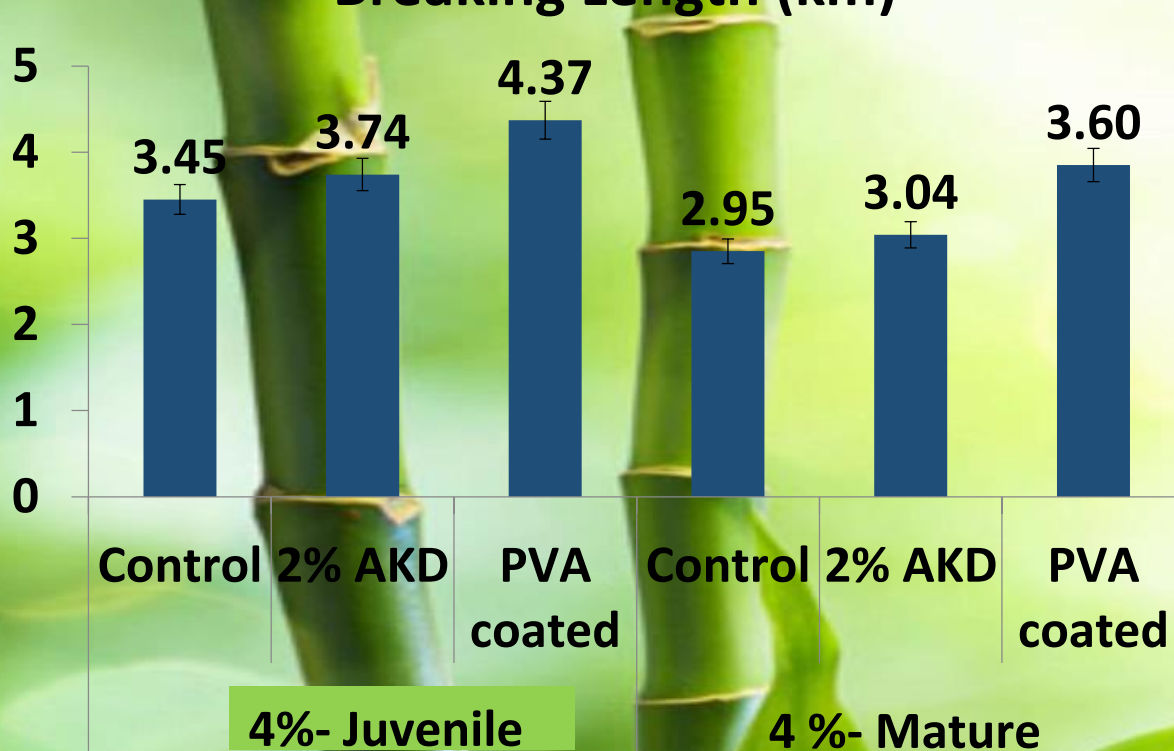
5% PVA solution



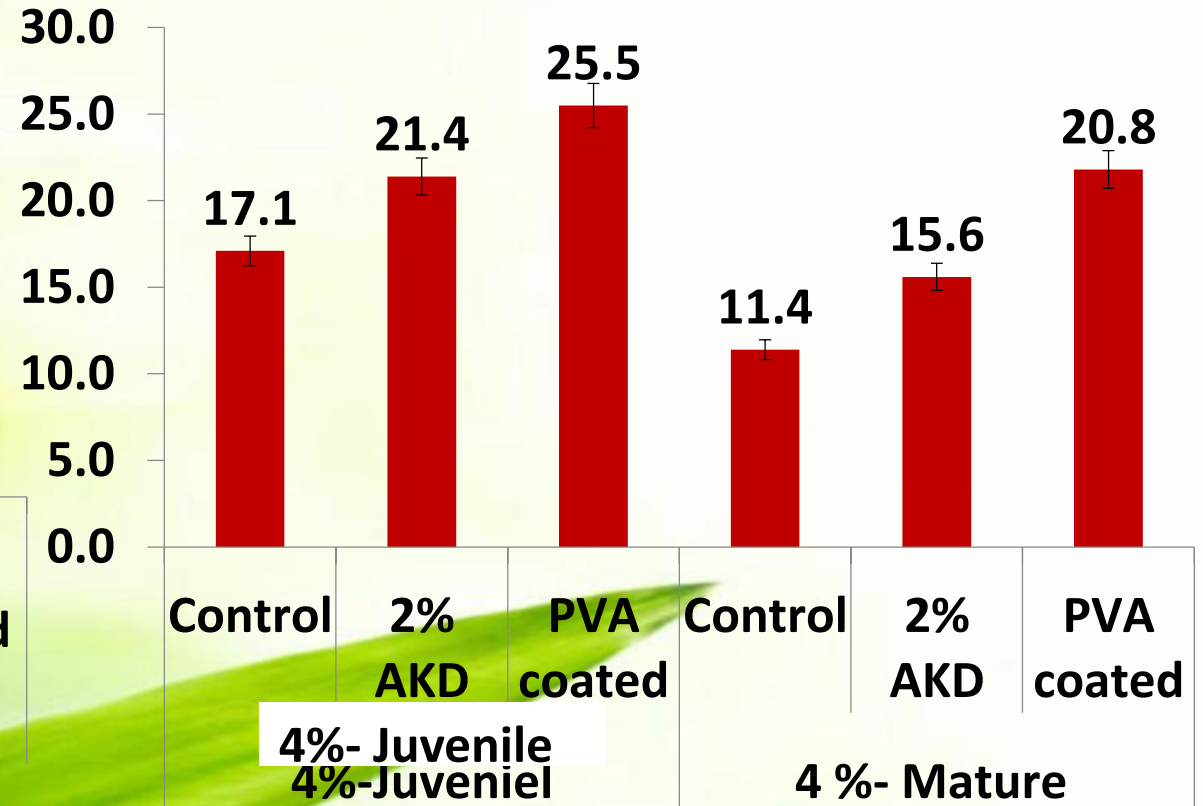
PVA Coated Sheet

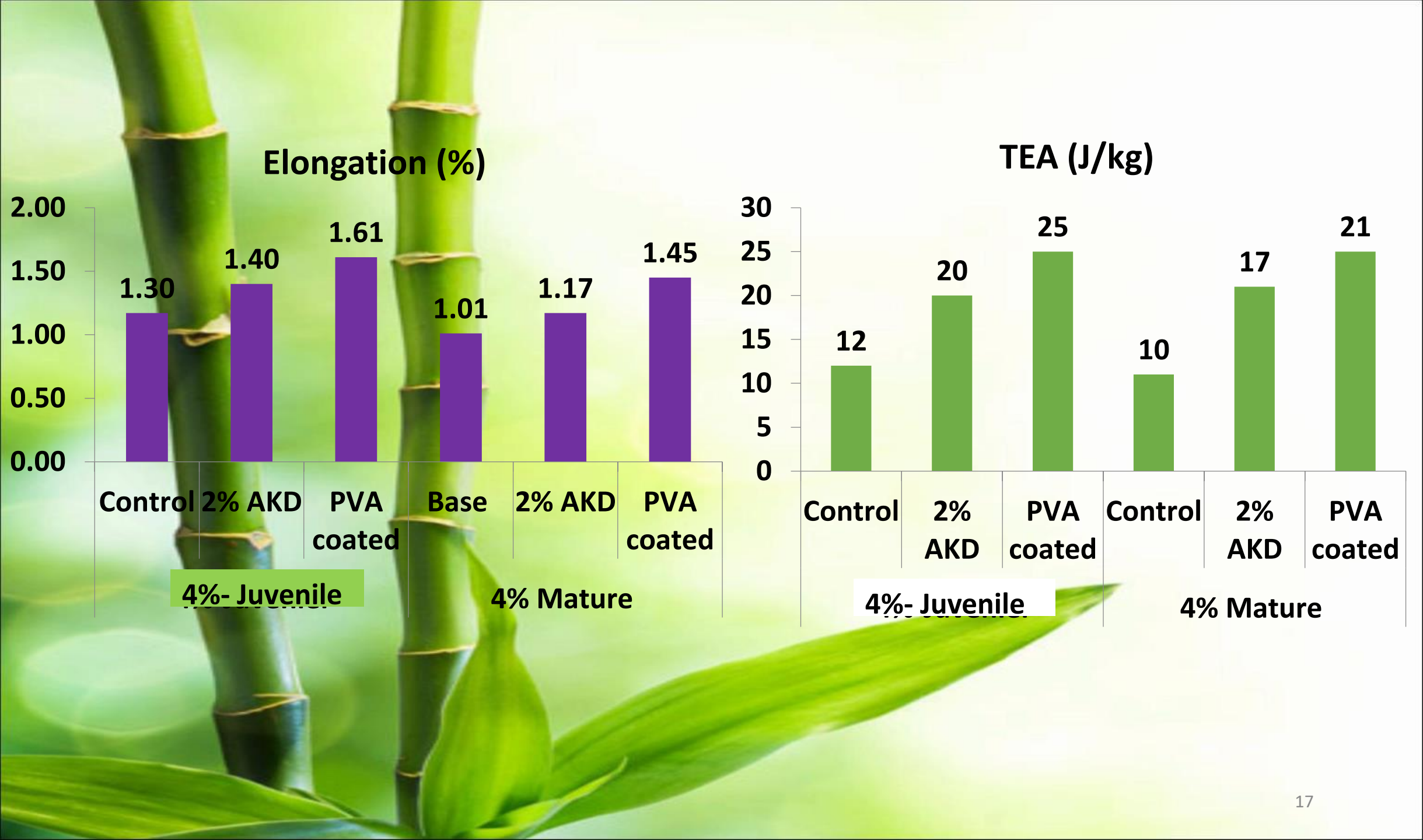
Mechanical Strength Properties of Juvenile and Matured Bamboo after Sizing and Coating

Breaking Length (km)

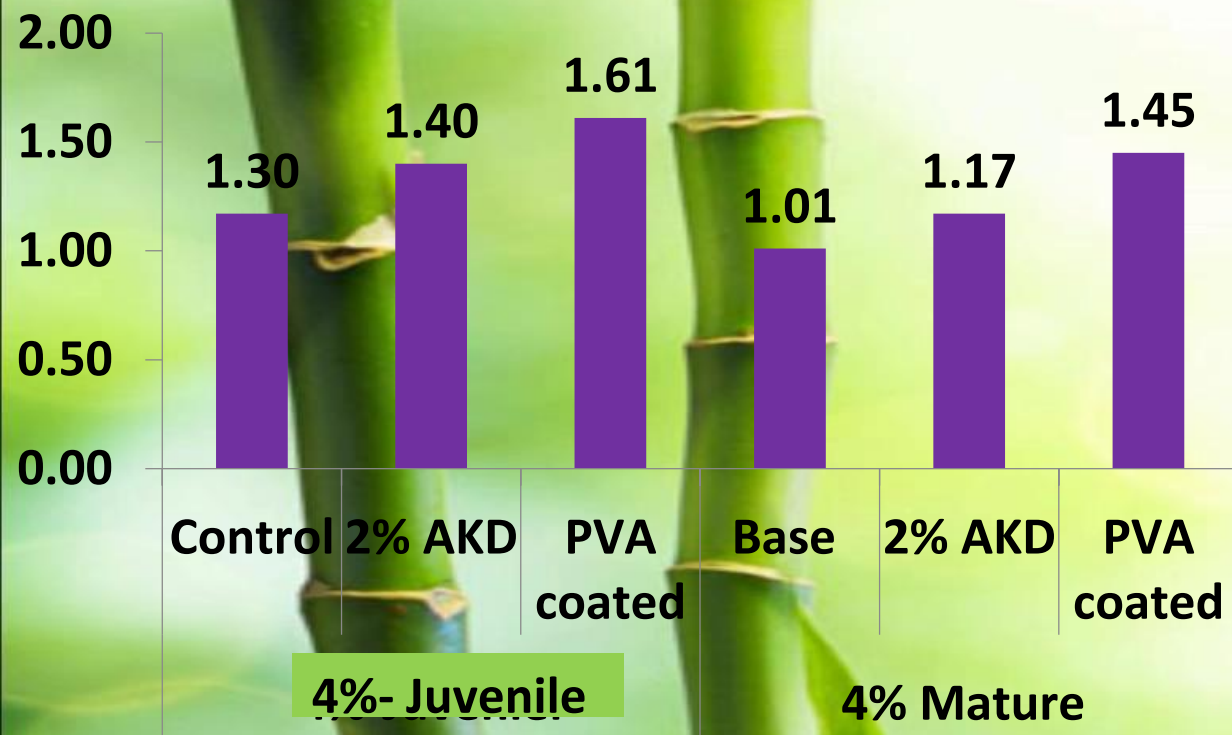


Burst Factor

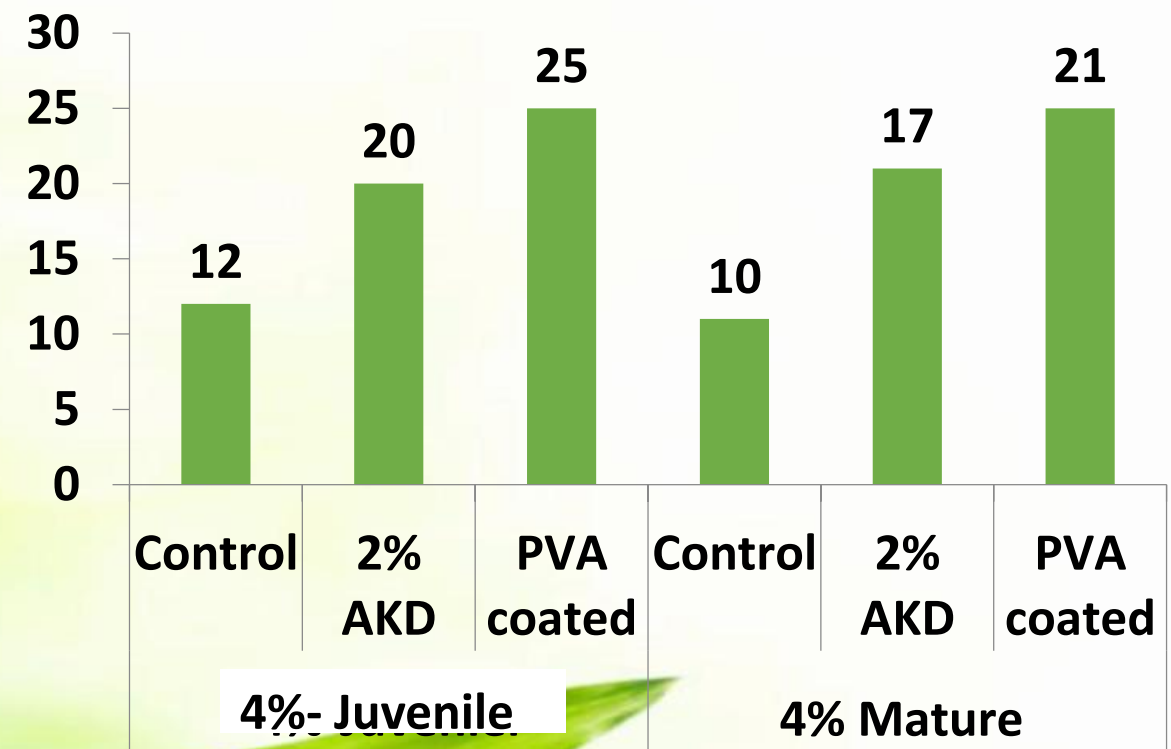




Elongation (%)

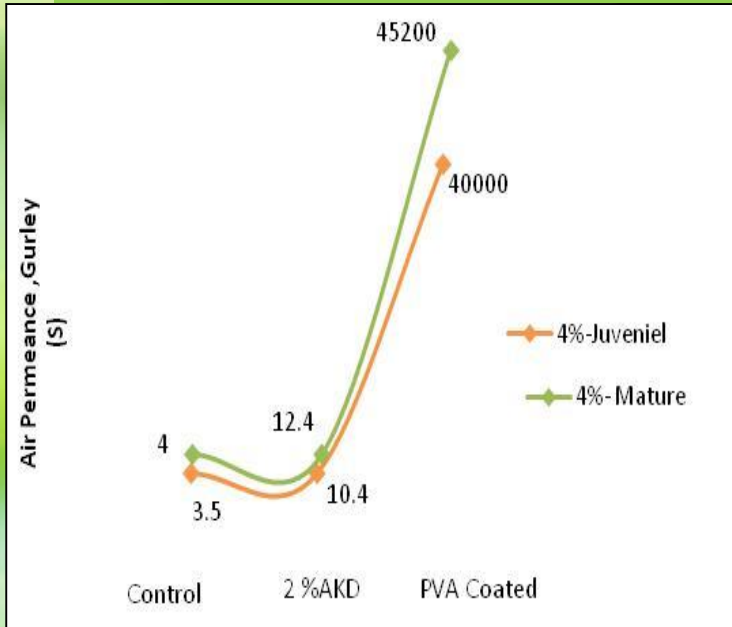


TEA (J/kg)



Barrier Property of Bamboo Pulp Hand Sheets

Air Permeance, Gurley (Sec)



Water Absorbency

	Cobb60 g/m ²	
	4 %- Juvenile	4 %- Mature
Control	245±2	270±2
2% AKD	21±2	25±2
PVA coated	20±1	24±1

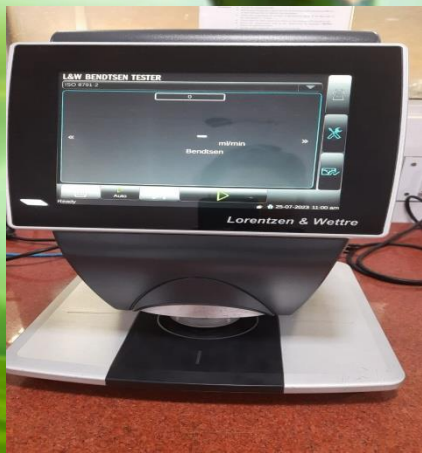
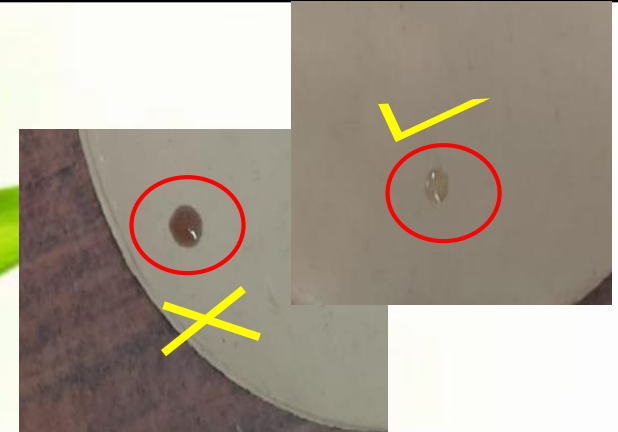
Grease /Oil resistance

	KIT Value	
	4 %- Juvenile	4 %- Mature
Control	0	0
2% AKD	4	5
PVA coated	12	12

Control

2% AKD

PVA coated



Comparison of Bamboo CTMP Pulp v/s. Market Pulp

Physical strength Properties	Bamboo CTMP Pulp	Market Pulp
Tear Index mn m ² /g	10.3	9.4
Burst Factor	25.5	24.6
Cobb 60 (Water Absorbance)	21-25	350-400
KIT value (Grease Proof)	12 (Yes)	3 (No)
Air Permeance (sec)	40,000-45,200	218
Cost/ton pulp	~27,265/- (27.26/ kg)	~60,000/- (60/ kg)

Conclusion

- **The Presentation focus on utilization of Juvenile Bamboo for food packaging applications in place of single use plastic .**
- **Morphology of bamboo indicates that juvenile bamboo is more suitable for CTMP pulping as compared to mature bamboo.**
- **Coating of PVA on CTMP Pulp make it more suitable for packaging of liquid food materials.**
- **Robust mechanical properties related to food packaging have achieved after sizing and coating.**
- **The prepared packaging material have high air, water and oil resistant properties which supports packaging of even liquid food items too.**
- **The prepared CTMP bamboo pulp is a potential substitute the market pulp available for production of molded crockery.**
- **The production cost of CTMP pulp comes around Rs. 28 /kg as compared to the market pulp i.e. ~Rs. 60 /kg . It is economical beneficial and help in better return on investment.**

Possible Applications of Bamboo CTMP Pulp



**THANK
YOU!**

