PULPING AND BLEACHING OF MELIA DUBIA CLONE K10: A SHORT ROTATION PULP WOOD CLONE TO IMPROVE ENVIRONMENTAL AND ECONOMICAL PERFORMANCE

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INTRODUCTION

➢ World paper and paper board production was 404 million tons per annum

➢ Asia is the highest contributor to the world (182 million tons) followed by Europe (106 million tons and north America (85 million tons) annually.

➢ Asia paper and paper contribution was 45% , Europe was 27% and North America was 21% (Jain et al. 2015)

➢ China is the largest contributor to the world paper and paper board producer accounts for one fourth of the 404 million tons.

➢ India paper and paper board production is 14.99 million tons, accounts for only 3.70% of the words production.

➢ Rs. 50,000 crores annual turnover and contribute Rs. 4500 crores to the national exchequer.

➢ There are 813 pulp and paper mills with an installed capacity of 22.15 million tons.
India paper industry is one of the world's fastest growing industries.

Only 600 mills are in operation produce around 14.99 million tons against 19.27 million tons.

The consumption stands at about 16.73 million tons per annum result in per capita consumption of 13.2 kg (Jain et al. 2015).

The demand is set to rise from 16.73 million tons to 20.0 million tons by 2020 due to:

- Growth in education sector of all state government
- Increased corporate activity and lifestyle change
- Press publications
- Packaging's
- Growing affluence population
RAW MATERIAL

➢ The wood based paper mills contributes 31%, agro based was 22% and recycled 47%

➢ Forest deficient countries like India and China is forced to use the non woody fibrous raw materials for paper making

➢ India non wood raw materials such as bamboo, cereal straws, bagasse, etc., contribute about 22.0% of the total raw material furnish during 2011.

➢ This agro residue has decreased gradually due to several issues including environmental concern which forced many of the agro mill switch over to recycle fiber.

➢ The per capita forest area in the country is 0.08 ha as compared to the world average of 0.64 ha.

➢ Need to find new short rotational alternative wood for paper making
➢ The supply of wood pulp will be increased more than 300% over the current supply through popularity of *Eucalyptus* among farmers.

➢ The demand and supply estimates is expected to increase at faster growth rate than production and will exist gap between demand and supply.

➢ Supply potential of forest products is to be enhanced by the use of improved seeds, genetically superior planting material, technological interventions and short rotation.

➢ Indian imports of wood began to rise, increasing from $630 million in 2003 to $2.7 billion in 2013.
India is under tremendous pressure to meet the growing demand for wood and wood products, such as pulp and paper.

The current production of raw materials for pulp and paper is 2.76 million tons, against the demand of 5.04 million tons, a shortfall of 45%.

The projected demand by 2020 is 13.2 million tons, which is still more staggering (Palsaniya et al., 2009).

Inadequate raw materials and stringent forest policies have forced the wood based industries to become self-reliant in terms of acquiring their own raw materials.

At present, these farms integrate the production of Eucalyptus and Casuarina as major sources of raw materials for pulp and paper.

Melia dubia has emerged as a suitable raw material, because of its increased pulp recovery and exceptional strength.
EXPERIMENTAL

➢ Two species of Mdubia wood species were selected for this study.

➢ Wood meals bulk and basic density of K10 (2 & 3 yrs) were determined.

➢ Wood meals chemical properties were determined as standard testing procedure.

➢ The chips were pulped (alkali charge 16 % and 17% as Na₂O, bath ratio 1:2.8, cooking temperature: 165°C, time: 60 minutes, H factor: 800) in a Laboratory bomb digester.

➢ Oxygen delignification was carried out laboratory rotating digester at 95°C with 45 minutes reaction time of 1.0% Caustic addition and 12.0 kg Oxygen addition.

➢ The oxygen delignified pulps were bleached in the laboratory to achieve a brightness of 90% ISO using following bleaching sequence D₀E₁D₁.
## PHYSICAL AND CHEMICAL PROPERTIES MELIA DUBIA K10 CLONE

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Unit</th>
<th>2 years</th>
<th>3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bulk density</td>
<td>kg/m³</td>
<td>192</td>
<td>208</td>
</tr>
<tr>
<td>2</td>
<td>Basic Density</td>
<td>kg/m³</td>
<td>481</td>
<td>467</td>
</tr>
<tr>
<td>3</td>
<td>Ash</td>
<td>%</td>
<td>0.72</td>
<td>0.64</td>
</tr>
<tr>
<td>4</td>
<td>Hot water solubility</td>
<td>%</td>
<td>2.64</td>
<td>2.72</td>
</tr>
<tr>
<td>5</td>
<td>1% NaOH solubility</td>
<td>%</td>
<td>12.0</td>
<td>12.8</td>
</tr>
<tr>
<td>6</td>
<td>Alcohol: Benzene solubility</td>
<td>%</td>
<td>1.12</td>
<td>1.20</td>
</tr>
<tr>
<td>7</td>
<td>Lignin</td>
<td>%</td>
<td>19.3</td>
<td>20.7</td>
</tr>
<tr>
<td>8</td>
<td>Pentosan (ash corrected)</td>
<td>%</td>
<td>13.2</td>
<td>13.8</td>
</tr>
<tr>
<td>9</td>
<td>Holocellulose (ash corrected)</td>
<td>%</td>
<td>74.2</td>
<td>75.6</td>
</tr>
</tbody>
</table>
## UNBLEACHED MELIA DUBIA K10 CLONE PULP PROPERTIES

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particular</th>
<th>2 years</th>
<th>3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White liquor addition,%</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>Screened pulp yield,%</td>
<td>54.63</td>
<td>53.66</td>
</tr>
<tr>
<td>3</td>
<td>Reject, %</td>
<td>0.99</td>
<td>0.69</td>
</tr>
<tr>
<td>4</td>
<td>Kappa number</td>
<td>27.3</td>
<td>25.7</td>
</tr>
<tr>
<td>5</td>
<td>Pulp brightness, %ISO</td>
<td>33.1</td>
<td>33.7</td>
</tr>
</tbody>
</table>
BLEACHING CONDITIONS

➢ D₀ Stage: Then freshly collected 1.2%ClO₂ was added into 10% consistency pulp and mixed well and put the pulp contained polythene bags in a preheated water bath at 75°C for 90 minutes with intermittent mixing of the pulps.

➢ Ep stage: The 10% consistency with 1.0 % NaOH addition was chosen to a terminal pH of 10.2-10.5. Then 1.0 % Hydrogen peroxide was added and noted the pulp mixture pH.

➢ D1 stage: The 10% consistency with 0.8 % ClO₂ addition was chosen to yield a terminal pH above 5.0.

➢ Pulp characterization: At all stages brightness, kappa number and strength properties of the pulps were carried out as per TAPPI standard methods.

➢ Bleach filtrate analysis: At all stages, the filtrate were collected and tested for Color, Total Dissolved solids (TDS) inorganic and Chemical Oxygen Demand (COD) as per standard testing methods.
16% & 17% TAA (K10 / 2 & 3 yrs) UNBLEACHED

PULP PROPERTIES

<table>
<thead>
<tr>
<th>Tensile Index</th>
<th>Tear Index</th>
<th>Burst Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.2</td>
<td>7.9</td>
<td>2.5</td>
</tr>
<tr>
<td>52.6</td>
<td>8.0</td>
<td>2.8</td>
</tr>
<tr>
<td>49.5</td>
<td>7.6</td>
<td>2.5</td>
</tr>
<tr>
<td>50.1</td>
<td>7.7</td>
<td>2.8</td>
</tr>
</tbody>
</table>

K10 2YRS/16%  K10 3YRS/16%  K10 3YRS/17%  K10 3YRS/17%

- **Tensile Index**
- **Tear Index**
- **Burst Index**

Legend:
- **Green** - Tensile Index
- **Red** - Tear Index
- **Blue** - Burst Index
M. DUBIA (K10/ 2 yrs) 16% TAA PULP BLEACHING PROPERTIES

Graph showing pH, Brightness, ISO, and Kappa number over different stages (ODL, Do, Ep, D1) with values indicating trends and changes.
M DUBIA (K10/2yrs) 17%TAA PULP BLEACHING PROPERTIES

- pH
- Brightness,ISO
- Kappa number

Graph showing the properties of M Dubia pulp with different pH levels and their effects on brightness, ISO, and Kappa number.
M DUBIA (K10/ 3 yrs)16%TAA PULP BLEACHING PROPERTIES
M DUBIA (K10/ 3 yrs) 17% TAA PULP BLEACHING PROPERTIES
16% & 17% TAA (K10/2 yrs) UNBLEACHED AND BLEACHED PULP STRENGTH PROPERTIES
16% & 17% TAA (K10 /3 yrs) UNBLEACHED PULP AND BLEACHED PULP STRENGTH PROPERTIES
16% & 17% TAA K10 (2yrs)
BLEACH FILTRATE CHARACTERISTICS

- Colour Pt. Co.,
- Total dissolved solids mg/l
- Total COD mg/l
- Chlorides as Cl mg/l
BLEACHED FILTRATE CHARACTERISTICS

- Colour Pt. Co.,
- Total dissolved solids mg/l
- Total COD mg/l
- Chlorides as Cl mg/l
RESULTS

➢ The 481 kg /m3 basic density and 192 kg /m3 bulk density were observed in two year old species whereas the 467 kg /m3 basic density and 208 kg /m3 bulk density was recorded in three year old species.

➢ Ash content recorded for two year old sample was 0.72% and in three year old sample was 0.64% which implies that ash content decreases with the increase in the age of the *M. dubia* wood.

➢ 1% NaOH solubility, which measure low molecular weight carbohydrates, lower in two year old was 12.0% compared to three year old sample was 12.8%.

➢ The holocellulose of content of two and three year old *M. dubia* K10 was found to be 74.2% & 75.6%.

➢ Low lignin content was reported in two year old was 19.3% compared to three year old *M. dubia* species was 20.7% which show that lignin content increase while age of tree increase.
The unbleached pulp yield was 54.63 & 55.36% and its reject content was 0.99% & 0.66% for 16% TAA. Whereas the yield was 53.66 & 54.85 % and its reject content was 0.69 & 0.55% for 17% TAA respectively.

The screened pulp kappa number was 27.3 & 22.5 for 16% TAA and 25.7 & 21.6 for 17% TAA pulp.

Two year old *M. dubia* K10 pulp tensile, tear and burst index was 52.2 Nmg-1 7.86 mNm² g-1 & 2.52 KPa m² g-1 for 16% TAA and 52.6 Nmg-1, 8.02 mNm² g-1 and 2.82 KPam² g-1 for 17% TAA.

Three year old *M. dubia* K10 pulp tensile, tear and burst index was 49.5 Nm g-1, 7.61 mNm² g-1 & 2.45 KPa m² g-1 for 16% TAA and 50.1 Nmg-1, 7.66 mN m² g-1 and 2.77 KPam² g-1 for 17% TAA.

*M. dubia* K10 pulp delignification efficiency in the D₀ stage, expressed as kappa number reduction was 69.3 & 56.2 % for 16% TAA, as compared with 68.9 % & 64.2 % for 17% TAA.
Extraction stage kappa reduction was 43.5% & 39.0% for two years old pulp whereas 49.1% & 51.2% for three year old 16% & 17%TAA pulp.

The extraction stage brightness was 81.2 %& 80.3 %ISO for two years old and 85.6% & 86.8%ISO for three old *M. dubia* K10 clone.

This Final chlorine dioxide (D1) stage kappa reduction was 55.0% & 54.8% for two years old whereas 60.7% & 58.1% for three year old at 16% & 17% TAA charge respectively.

The D1 stage brightness was 88.3% & 88.2%ISO for two years old and 90.2% & 91.3 %ISO for three old *M. dubia* K10 clone at 16% & 17% TAA charge.

Colour was 4300 & 4000 Pt.co.unit, Total Dissolved Solids was 3502 & 3790 mg/l and COD was 1992 & 1713 mg/l for 2 years old whereas colour was 5700 & 5250 Pt.co.unit, Total Dissolved Solids was 3786 & 3912 mg/l and COD was 2412 & 2669 mg/l for 3 years old clone.
CONCLUSIONS

➢ In present study pulping, bleaching and its filtrate indicates that *M. dubia* K10 clone of two and three years old is the most suitable species to manufacture paper making.

➢ This is achieved by terminating cook at slightly higher kappa and bleaching without using any acid or alkali in chlorine dioxide bleaching at optimum temperature with OD$_0$EpD$_1$ sequence.

➢ The pulp yield, bleachability and bleach filtrate characteristics were superior when compared to the regular hardwood ECF plant pulps.

➢ The great economical and environmental benefit derived from the significant pulp yield even for two years old species makes *M. dubia* K10 species is a best short rotation pulp wood suitable for pulp and paper industry.
ACKNOWLEDGEMENT

Authors are thankful to Tamilnadu Newsprint and Papers Limited (TNPL), Kagithapuram, karur, for giving permission to submit this paper in the IPPTA AGM Conference, March 2017.
DISCUSSION FOR IMPROVEMENT OF MELIA DUBIA K10 SPECIES PULPING AND BLEACHING
THANKING YOU