Pulping Study of Young Trees : Eucalyptus Citriodora and E. Sieberiana

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Two young trees 1 year old and 2½ year old each of Eucalyptus citriodora and E. sieberiana for pulping characteristics were studied. Both species 1 year old pulped well by cold alkali as well as sulphate process. The yield of sulphate pulp was of the order of 50% and handsheets had a breaking length of 6200 m. in both the cases. Neutral sulphite semichemical pulp using 10% total chemicals of 2½ year old E. citriodora and E. sieberiana gave a pulp recovery of 85% and 84% with a breaking length of the handsheets 8000 m. and 7750 m. respectively. Sulphate pulps of 2½ years old E. citriodora and E. sieberiana were prepared from different positions of the trees under the pulping conditions mentioned in Table 5. A recovery of unbleached pulps ranging between 54.0% to 56.0% for E. citriodora and 45.6% to 47.0% E. sieberiana was obtained. The breaking length was 5500m.-6000 m. and 5500 m. to 7400 m. for E. citriodora and E. sieberiana respectively. The data indicates that the young trees of two species can produce a suitable pulp for paper.

Introduction

Fast growing Eucalyptus plantations are being raised to meet the raw material deficit of expanding pulp and paper industry. Number of Eucalyptus species have been evaluated for pulping. Forest Products Division (CSIRO) Australia has reported that the pulp from the young *E. sieberiana* had high strength propeties as compared to young trees of other Eucalyptus species *viz. E. maculata, E. cypellocarpa* and *E. muelleriana.*

In our earlier paper we have reported the results of our investigation on the prehydrolysis sulphate pulp from *Eucalyptus citriodora,* cultivated for essential oil. The stems of this plant having 1 – 1½ cm. diameter, were taken for pulping. The yields of the pulps and the alpha cellulose of the bleached pulp were comparable to those obtained from 5 year old *E. citriodora* tree. Continuing the work on Eucalyptus species the present study deals with the pulping potentials of two of the Eucalyptus species viz. *E. sieberiana* and *E. citriodora* introduced in the Regional Research Laboratory, Jammu.

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Two young trees of each species, 1 year old and 2½ year old were cut. Pulping characteristics by different methods were studied and hand sheets of the pulps were evaluated for strength properties.

Chemical examination

The two materials were chemically examined according to the methods of TAPPI. The results of the analysis recorded in table 1, show that alpha cellulose is as high as in any other mature hardwood and extractives are fairly low.

Pulp preparation

Sulphate pulp and cold alkali pulp from 1 year old plants of *E. citriodora* and *E. sieberiana* were prepared under the conditions given in Table 3. The cold alkali treated chips were

Table 1.

Chemical Composition of 2½ year old Trees.

	E. sieberiana	*E. citriodora*
1. Ether extractives	0.91 percent	0.59 percent
2. Alcohol benzene extractives (1:2 by vol.)	0.85	0.58
3. Hot water extractives	4.96	7.92
4. Pentosans	20.70	23.68
5. Lignin*	24.75	22.0
6. Holocellulose*	75.68	88.0
7. Alphacellulose*	48.81	46.3

*Calculated on extractive free basis.

passed through the Sprout Waldron Laboratory refiner using Plate No. 17804. and a gap of 0.005".

Similarly sulphate pulp and neutral sulphite semichemical (NSSC) pulps were prepared from 2½ year old trees of *E. citriodora* and *E. sieberiana.*

Samples of the wood were also taken from different parts i. e. bottom, middle and top position of the trees for sulphate pulping. Sulphate pulping was done by the usual method reported in our earlier communication under the conditions given in the Table 3 & 5. For N.S.S.C. pulping, woodchips of representative sample of the tree was taken and pulped in a vertical autoclave using 10% total chemical, keeping the ratio of Na_2SO_3 and Na_2CO_3 4:1. The digestion was done at a temperature of 160°C for a period of 3 hours. The cooked chips after washing with water were passed through Sprout Waldron refiner using a clearance gap of 0.005".

The pulps were beaten, and the freeness was determined. Handsheets of the pulps were made by the standard procedure for strength evaluation of the paper.

Results and discussion

Girth height and density of the young trees of *E. citriodora* and *E. sieberiana* are mentioned in the table 2. From the date of weight and height of the trees it can be seen that *E. citriodora* 2½ years has 23.5 kg. more woody portion than *E. sieberiana.* Variation of girth with height can also be seen in the table. Cold alkali pulping of 1 year old tree of *E. citriodora* and *E. sieberiana* under the conditions given in table 3 gave pulp yields of 80–84%.

Table 2

Variation of Girth with Height of 2½ year old Tree

2½ year old tree	*E. citriodora*	*E. sieberiana*	Position from base metres	*E. citriodora* AV. girth cm	*F sieberiana* AV. grith cm
			Base — 1.5	42.5	42.5
Total Height metres	10	7.6	1.5 — 3.0	32.5	32.5
Total weight kg.	0.67	43.5	3.0 — 4.5	32.5	22.5
Density Air dry	0.74	0.78	4.5 — 6.0	25.0	17.5
Density oven dry	—	—	6.0 — 7.5	20.0	10.0
			7.5—10.0	12.5	—

Table–3

Conditions of Pulping and Properties of Hand Sheets of 1 year old Trees.

Sulphate Pulp		**Cold Alkali Pulp**	
Total chemicals % (NaOh & Na_2S ratio 3:1)	= 20	Totai Chemicals % (NaOh)	= 16
Solid liquor ratio	= 1:6	Solid liquor ratio	= 1:5
Maximum digestion temp. °C	= 160	Temperature	= Ambient
Time at maximum temperature hours	= 4	Time hours	= 4

	E. sieberiana		*E. citriodora*	
	Sulphate Pulp	Cold Alkali Pulp	Sulphate Pulp	Cold Alkali Pulp.
1. Pulp yield%	50	86	50	80
2. Freeness, before beating °SR	25	13	—	18
3. Freeness after 15 minutes beating °SR	35	31	50	47
4. Breaking length meters	6200	1610	6200	2890
5. Stretch%	2.4	0.5	1.75	2.0
6. Burst factor	33.2	6.6	27	6.5
7. Folding (double fold)	75	2	75	2
8. Tear factor	70	—	50	—
9. Brightness G.E. Units.	23	46	—	—

Breaking length, stretch and brightness of *E citriodora* is higher than *E. sieberiana*. *E. citriodora, E. sieberiana* 1 year old plant pulped well by sulphate process using 20% total chemicals at 160°C for 4 hours. The yield of unbleached pulp was 50% and breaking length of the handsheets was as high as 6200m. (Table 3) in both the cases. Tear factor of *E. sieberiana* is 75 against 50 of *E. citriodora*. Results of N.S.S.C. pulping are given in Table 4. As can be seen in the table the pulp yield of two species *E citriodora* and *E. sieberiana* without screening are 85.5% and 84.0% respectively. After 20 minutes beating the Schopper Riegler freenees is more for *E. citriodora* than *E. sieberiana*. Sprout Waldron refining and washing on 60 mesh screen, *E. sieberiana* gave a pulp recovery 76.0% against *E. citriodora* 71.0% probably due to the presence of more fines in *E. citriodora*. Handsheets of *E. citriodora* and *E. sieberiana* after 15 minutes beating recorded a breaking length of 8000 m. and 7750 m. and burst factor 25 and 23 respectively.

Table 4

Neutral Sulphite Semichemical Pulping of 2½ year Old Trees and Properties of Hand Sheets

1. Total chemical % (Na_2SO_3 : Na_2CO_3 = 4:1) = 10
2. Solid liquor ratio = 1:6
3. Time at maximum temp hours. = 3
4. Maximum digestion temp. °C = 160

	E. citrodora	*E. sieberiana*
1. Yield of unbleached pulp %	85.5	84.0
2. Brightness G. E. Units.	28.0	37.0
3. Yield after Sprout Waldron refining and screening %	71.0	76.0
4. Freeness after refining °SR	18	15
5. Freeness after beating 15 min °SR	25	35
6. Breaking length metres	8000	7750
7. Stretch %	2.5	2.6
8. Folding Endurance	32.0	24.0
9. Burst Factor	25.0	23.0

Pulping characteristics by sulphate process of these two species taken from different portions of the two trees 2½ years old under the conditions of pulping are recorded in Table 5. The pulp yields of *E. citriodora* was of the order of top > bottom > middle portion (56%,55% and 54.0 %), and that of *E sieberiana* (47.0%, 46.0 % and 45.6 %.) Middle portion > bottom > top. The breaking length of the handsheets after 20 minutes beating for *E. citriodora* was 6000 m. top portion, 5500 m. middle and bottom portions. While that of *E. Siberiana* middle 7400 m; top 6200 m. and bottom 5500 m. The whole data of young trees of these two species indicate that suitable pulp can be produced from young trees of Eucalyptus for paper.

Table 5

Sulphate Pulping of 2½ year old trees and Properties of Hand Sheets.

1. Total chemical (NaOH : Na_2S = 3 : 1) % = 20
2. Solid liquor ratio = 1:6
3. Maximum digestion temperature °C = 160
4. Time at maximum temperature hours = 4

Pulp characteristics

Portion of tree	BOTTOM		MIDDLE		TOP	
	E. citriodora	*E. sieberiana*	*E. citriodora*	*E. sieberiana*	*E. citriodoa*	*E. sieberiana*
1. Yield of unbleached pulp %	55.0	46.0	54.0	47.0	56.0	45.6
2. Brightness G.E. Units.	30.0	27.0	29.0	29.0	24.0	25.0
3. Freeness before beattng °SR	13.0	15.0	15.0	13.0	15.0	17.0
4. Freeness after 20 minutes beating °SR	35.0	30.0	32.0	32.0	32.0	30.0
5. Breaking length meters	6000	5500	5500	7400	5500	6200
6. Stretch %	2.9	3.0	2.6	2.9	2.5	2.5
7. Folding endurance	35	4	8	130	13	26
8. Burst factor.	16.7	13.3	16.7	40	16.7	31.6

References

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2. *Anon.* Research Review. 1970-71. Division of Forest Products. C.S.I.R.O. Australia Melborne.
3. *TAPPI.* Standards and suggested Methods.

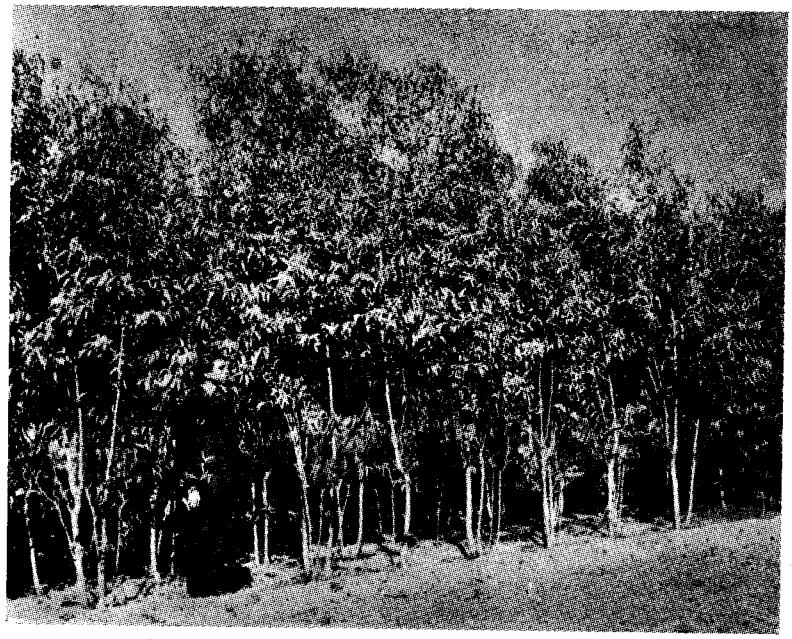

Fig. 1. Six months growth of *Eucalyptus citriodora* after coppicing 1 year old plant.

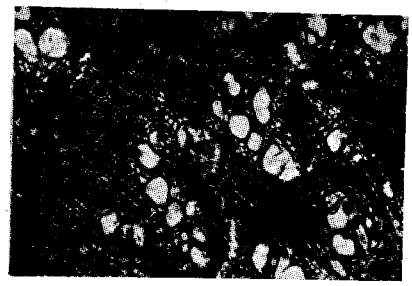

Fig. 4. Photomicrograph of Crossection of *Eucalyptus sieberiana* $2\frac{1}{2}$ year old.

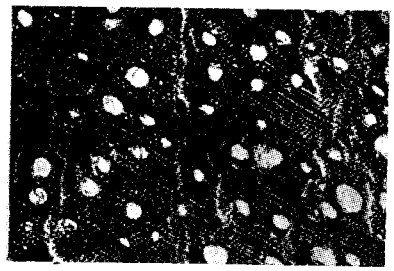

Fig. 5. Photomicrograph of crossection of *Eucalyptus citriodora* $2\frac{1}{2}$ year old.

Fig. 2. *Eucalyptus citriodora* $2\frac{1}{2}$ year old tree.

Fig. 3. *Eucalyptus sieberiana* $2\frac{1}{2}$ year old tree.

Fig. 6. Photomicrograph of *Eucalyptus sieberiana* $2\frac{1}{2}$ year old Cold alkali pulp fibres.

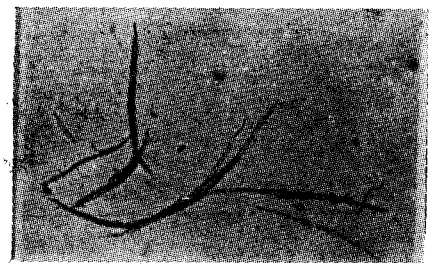

Fig. 7. Photomicrograph of *Eucalyptus citriodora* $2\frac{1}{2}$ year old cold alkali pulp fibres.