Effect of Eucalyptus globulus wood density on papermaking potential

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ABSTRACT: It is well documented that the characteristics of raw materials determine the papermaking potential of the pulp. The variability of the wood used by the pulp mills is extremely wide. We report on the behavior of three *Eucalyptus globulus* wood chip samples with basic densities of 0.467, 0.537, and 0.600 g/cm^3, in kraft cooking and papermaking. The pulp yield range of 49%–58.7% was attributed to the different wood chemical composition, in particular to the lignin content and relative proportion of cellulose and hemicelluloses. The morphological characteristics of the pulp fibers were also markedly different. The average fiber length is 0.71, 0.80, and 0.85 mm, respectively for the *E. globulus* of low, intermediate, and high wood basic density. The pulp fibers from the lowest density wood exhibit very high wet fiber flexibility, while those from the highest density wood exhibit rigid behavior. Using this structural property as reference, the corresponding papers are stronger, but exhibit lower light scattering coefficients than those from the lowest density wood.

Application: Understanding the morphological characteristics of the *E. globulus* wood fibers in tree selection and genetic improvement programs, in addition to the wood density and pulp yield, can help papermakers to avoid negative impact on light scattering coefficient and refining energy consumption.

Bleached *Eucalyptus globulus* kraft pulp has a strong market position for the production of printing and writing papers due to its strength, bulk, opacity, and smoothness [1, 2]. This performance is mainly due to the morphological characteristics of the pulp fibers, in particular its high Runkel ratio (twice the fiber wall thickness divided by the lumen diameter) and the relatively low pulp fiber width. The low fiber length also leads to a very high number of fibers per gram, which confers good formation to the papers [3]. The number of fibers per gram, the high specific surface area, and the relatively high pulp fiber rigidity lead to papers with high bulk and opacity. The paper exhibits good strength properties, at the expense of a relatively high-energy consumption in beating [2].

Although the general performance of *E. globulus* grown in Portugal for printing and writing paper production is very good, it is of technical and scientific interest to evaluate the influence of the morphological variability of *E. globulus* fibers on their performance in the papermaking process and on the final paper properties. It is well known that both the pulping processes and the raw material affect pulp fiber properties. However, for a given pulping process, raw material is the main factor determining pulp fiber properties [2–4].

It is also well documented that there is considerable fiber morphology variability within trees, between trees within a stand, and between trees from different stands [5, 6] because of genetic variability, soil-related and climatic conditions, and cambium age. This variability has been exploited in genetic improvement programs for different species and also for *E. globulus* [7, 8]. The main objective has been to increase pulp production per cubic meter of wood, which is associated with the increase of wood basic density and pulp yield. However, optimization efforts should also consider fiber characteristics such as fiber wall thickness, fiber width, and fiber length. Several papers were published recently concerning the relationships between wood basic density and fiber and pulp characteristics [5, 9]. Most of the work in this area analyzed dozens of wood samples and estimated their papermaking potential based on the unrefined or gently refined pulps. This is a good strategy for correlation assessment but it does not consider the impact of beating on paper properties.

We selected three *E. globulus* wood samples representative of two clone stands and current industrial raw material, with markedly different wood basic densities, to evaluate the variability of *E. globulus* pulp fiber characteristics and their influence on papermaking potential. The pulp fibers have similar fiber width but markedly different fiber wall thickness, which enabled us to investigate its influence on beating response.

EXPERIMENTAL

Table I shows the provenance, climate conditions, mean age, and basic density of the two wood samples coming from two clone stands grown in Portugal. The third sample was an industrial chip sample from a Portuguese pulp mill, with a basic density of 0.537 g/cm^3. The samples were previously screened to remove over-thickness chips (>8 mm) and fines. We determined the cross-section dimensions of the vegetal cells in the wood samples by image analysis using the Qwin 500 system from Leica Microsystems® (Wetzlar, Germany). For each wood sample, four resin-embedded representative samples were prepared and polished to observe in a reflection microscope. Five images from each preparation were recorded with a magnification of 50X, accounting for 20 images per wood sample. About 20 fibers were measured (fiber wall thickness and fiber

	Site	Rainfall, mm/yr	Altitude, m	Mean temperature, °C	Age, year	Tree	Basic density, g/cm³
E. globulus–LD	Odemira (37°36′N; 8° 39′W)	635	70	15.0	7	Clone	0.467
E. globulus– ID	Pulp mill	-	-	-	10	Industrial	0.537
E. globulus–HD	Mortágua (40° 24′N; 8° 09′W)	1255	250	14.9	11	Clone	0.600

I. Location of the sites and characteristics of the raw materials: low density (LD), intermediate density (ID), high density (HD).

width in tangential direction) in each image, providing nearly 400 measurements for each property and each sample. We also evaluated the percentage of vessel area.

The wood basic density was determined according to TAPPI 258 om-94 [Basic density and moisture content of pulpwood]. Representative materials were ground and samples prepared for lignin and extractives contents determination according to TAPPI 222 om-88 and TAPPI 204 om-88 [Acid-insoluble lignin in wood and pulp; Solvent extractives of wood and pulp] (successively with dichloromethane, ethanol, and water), respectively.

The wood chips underwent a conventional kraft cooking process under the following reaction conditions: effective alkali charge, variable; sulfidity index, 30%; liquor:wood ratio, 4:1; time to temperature, 90 min; time at temperature (160°C), variable. Experiments were carried out with 1000 g o.d. of wood in a forced circulation digester. The cooked chips were disintegrated, washed, and screened on an L&W screen with 0.3 mm slot width. The accepted material was collected on a 200-mesh screen. The screened and total yields were gravimetrically determined. Kappa number and pulp viscosity were evaluated according to the ISO 302 [Pulps - Determination of kappa number] and ISO 5351/1 standard methods [Cellulose in dilute solutions - Determination of limiting viscosity number - Part 1: Method in cupri-ethylene-diamine (CED) solution]. The brown stock was bleached according to the $D_0E_1D_1E_2D_2$ sequence, using a kappa factor of 0.2 in the D_0 stage and the same charges and reaction conditions in the remaining stages.

The neutral sugar composition of the woods and pulps were determined after acid hydrolysis by gas chromatography analysis, according to published procedures [10, 11]. The morphological properties of pulp fibers were determined automatically by image analysis of a diluted suspension (20 mg/L) in a flow chamber in Morfi® (TECHPAP, Grenoble, France). The pulps were beaten in a PFI mill at 500, 2500, and 4500 revolutions under a refining intensity of 3.33 N/mm. Wet fiber flexibility (WFF) was determined according to the Steadman and Luner procedure [12], using CyberFlex® (CyberMetrics, Roswell, Georgia, USA) equipment in a fine free suspension.

In summary, a very thin and oriented fiber network was formed on a wire of a very small head-box and transferred to a glass slide with wires under controlled pressure conditions [12]. The same equipment and procedure, this time using glass slides without wires, were used to measure the relative bonded area (RBA) of the wet fibers. The water retention value (WRV) was determined according to the Silvy et al. procedure [13], for the suspension with and without fines. Fines were removed in the Bauer-McNett apparatus, using a 100-mesh screen. We prepared paper hand sheets according to Scan-C 26:76 and tested their structural, mechanical, and optical properties.

	Wood basic density (g/cm³)		
	0.467 (LD)	0.537 (ID)	0.600 (HD)
Effective alkali charge (%, as NaOH)	18.7	18.7	17.9
Sulfidity (%)	30	30	30
Liquid/wood ratio	4:1	4:1	4:1
Time to temperature (min)	90	90	90
Time at temperature (160°C) (min)	60	58	45
Pulp yield (%, on wood)	49.0	52.4	58.7
Rejects (%, on wood)	0.2	3.0	0.9
Kappa number	15.3	16.2	14.0
Viscosity, $cm^3.g^{-1}$ unbleached pulps	942	1053	1274
Viscosity, $cm^3.g^{-1}$ bleached pulps	855	982	945

II. Cooking conditions and results.

RESULTS AND DISCUSSION

Cooking

The wood basic density values obtained for *E. globulus* samples were within the usual range reported for this species [7]. The cooking conditions required by the three samples to produce kraft pulp with kappa number in the range of 14–16 were significantly different (**Table II**). In particular, the wood sample with the highest basic density required the mildest reaction conditions and led to a pulp yield nearly 10 points higher than that exhibited by the wood sample with the lowest wood basic density. These differences cannot be attributed to the casual losses of fine elements, such as vessels, in pulp collection after cooking because a 200-mesh screen was used and the vessel dimensions and its content in the woods were not so different (data not shown). According to our previous experience the standard deviation of the pulp yield is close to unity. The pulp yield variability is in good agreement

	Lignin content (%)	Extract			Total extractives
		Dichloromethane	Ethanol	Water	
E. globulus–LD	21.5 (±1.0)	0.35	0.34	1.91	2.6 (±0.5)
E. globulus–ID	20.0 (±0.9)	1.58	1.78	1.37	4.7 (±0.6)
E. globulus– HD	18.0 (±1.2)	0.17	1.12	1.45	2.8 (±0.2)

III. Lignin and extractives contents.

	Glucose	Xylose	Galactose	Mannose	Arabinose
E. globulus–LD wood	65.7	30.2	1.9	1.3	0.8
E. globulus–HD wood	67.2	28.5	1.8	1.8	0.6
E. globulus–LD pulp	76.8	22.6	0.2	0.2	0.1
E. globulus–HD pulp	77.6	21.6	0.4	0.2	0.2

IV. Neutral sugar composition of E. globulus–HD and E. globulus–LD woods and bleached pulps (molar proportions, %).

with reported data [7, 14].

The very high pulp yield exhibited by high-density (HD) *E. globulus* can be attributed to both the low lignin content (**Table III**) and the high relative content of cellulose in the carbohydrate fraction of this wood (**Table IV**). Considering that the large majority of the carbohydrates in wood and particularly in pulps are glucose and xylose, it seems acceptable to assign the glucose to cellulose and xylose to xylan. The other wood samples exhibit lower pulp yields than *E. globulus*–HD, as a consequence of the wood chemical composition and the required cooking conditions.

Bleaching

No differences were detected regarding pulp bleachability, and the yield losses were close to 3% for the three pulps. The analysis of the chemical composition of the bleached pulps in terms of sugar proportion shows that the HD pulp exhibited about 1% higher cellulose content than the low-density (LD) pulp. We observed the same order of magnitude for the corresponding wood samples. The higher retention of cellulose and xylan in the HD pulp, in comparison with the LD pulp, was in accordance with the milder reaction conditions required by the HD wood (see Table II; the residual alkali is close to 4 g/L, for all cooks). On the other hand, *E. globulus*–LD pulp exhibited the lowest pulp viscosity before and after bleaching. Considering the dominant contribution of cellulose for the viscosity values, 1% less in cellulose content cannot justify the differences observed in pulp viscosity and they can tentatively be attributed to the higher cooking time and the lower tree age.

WOOD AND FIBER PROPERTIES

Table V shows the biometric characteristics of the fibers for the three unbeaten pulps. The following conclusions can be drawn:

1. *E. globulus*–HD pulp, produced from the wood of the highest density, exhibits fibers with an average length of 0.85 mm, which is 20% higher than that exhibited by the pulp with the lowest pulp yield, coming from the wood with the lowest basic density (0.467 g/cm^3) and the tree stand of the lowest age;
2. *E. globulus*–HD pulp fibers are only slightly wider than those of *E. globulus*–LD, but exhibit a fiber coarseness, which is close to 40% higher; and
3. The pulp fibers produced from the industrial chip sample exhibit intermediate morphological characteristics.

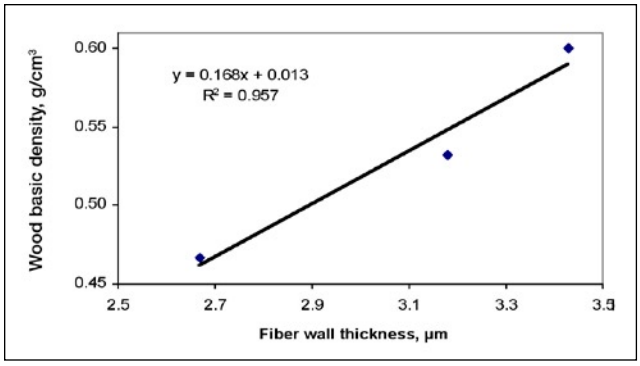
The fiber length and coarseness correlate linearly with the wood basic density. The coarseness differences between the HD and LD pulps cannot be only at-

	Fiber width (µm)	Length, length-weighted (mm)	Coarseness (mg/m)	Fibers/gram x 10^{-6}
LD (0.467 g/cm^3)	18.3 (±0.1)	0.711 (±0.003)	0.051 (±0.001)	31.9 (±0.6)
ID (0.537 g/cm^3)	18.6 (±0.1)	0.805 (±0.005)	0.061 (±0.001)	23.6 (±0.5)
HD (0.600 g/cm^3)	19.3 (±0.1)	0.853 (±0.005)	0.072 (±0.003)	19.2 (±0.8)

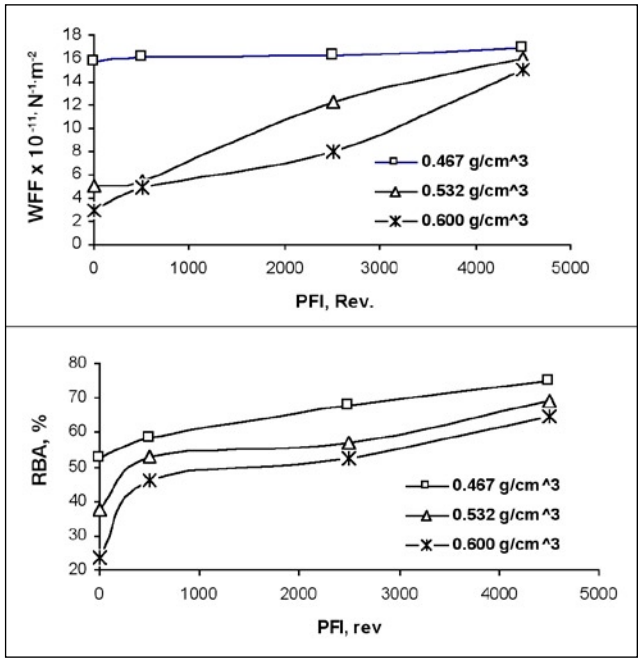
V. Fiber characteristics of unbeaten pulps (mean ± standard deviation).

	LD (0.467 g/cm^3)		ID (0.537 g/cm^3)		HD (0.600 g/cm^3)	
	Fiber wall thickness (µm)	Fiber width (tangential) (µm)	Fiber wall thickness (µm)	Fiber width (tangential) (µm)	Fiber wall thickness (µm)	Fiber width (tangential) (µm)
Mean	2.67	12.13	3.18	13.16	3.43	12.32
SD	0.56	2.08	0.62	1.83	0.58	1.51
Maximum	3.11	14.63	4.12	16.67	4.47	14.90
Minimum	1.81	9.72	2.14	9.40	2.18	9.73

VI. Wood fiber characteristics (SD = standard deviation).



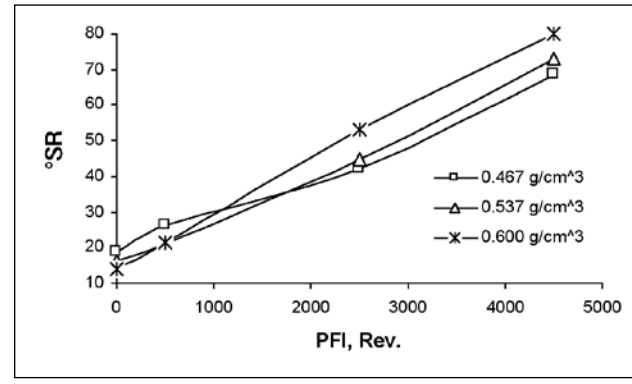
1. Correlation between wood basic density and fiber wall thickness.



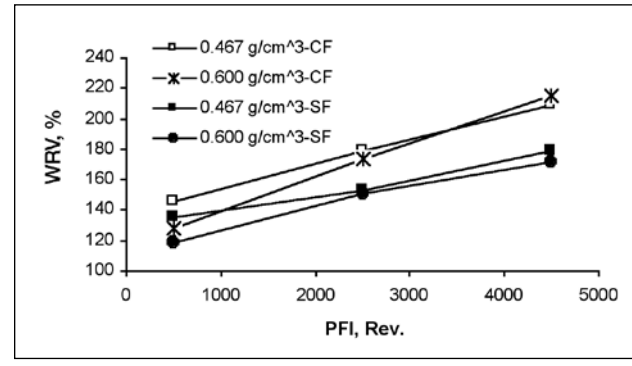
2. Evolution of wet fiber flexibility (WFF, top) and relative bonded area (RBA, bottom) with beating, for the three samples of E. globulus (standard deviation (σ): WFF = 1; RBA=0.9)

tributed to the differences in pulp yield, which reaches 20%. The morphological characteristics of the wood cells should also be considered. In fact, the microscopic analysis of the cross-section of the wood fibers (**Table VI**) revealed that *E. globulus*–HD has a mean fiber wall thickness of 3.4 µm, while *E. globulus*–LD has only 2.7 µm; on the contrary, the average fiber width (tangential) is close for the three samples. Therefore, the objective of producing pulps with markedly different morphological properties was attained. Table VI also illustrates the wide range of variation for both the fiber wall thickness and the fiber width. Moreover, a good correlation between the wood basic density and the fiber wall thickness was observed (**Fig. 1**), as expected and previously reported [9].

The wet fiber flexibility (WFF) measurements highlight the considerable differences between the three bleached pulp fibers and also reveal the effects of beating and fiber morphology on the fiber flexibility development (**Fig. 2 top**). The



3. Evolution of the Schopper Riegler degree (°SR,σ=0.5) with beating, for the three E. globulus pulps.

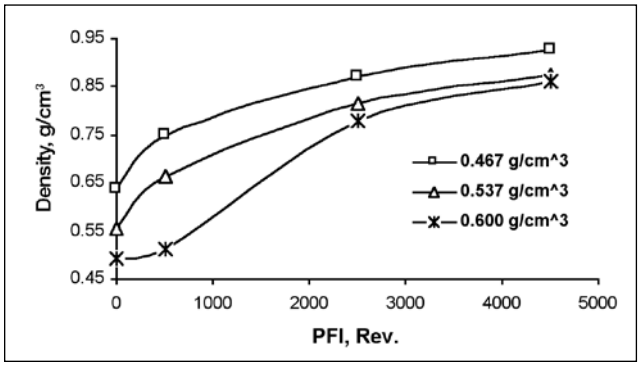


4. Evolution of WRV (σ=3) with (CF) and without (SF) fines with beating, for the LD (0.467 g/cm³) and HD (0.600 g/cm³) E. globulus pulps.

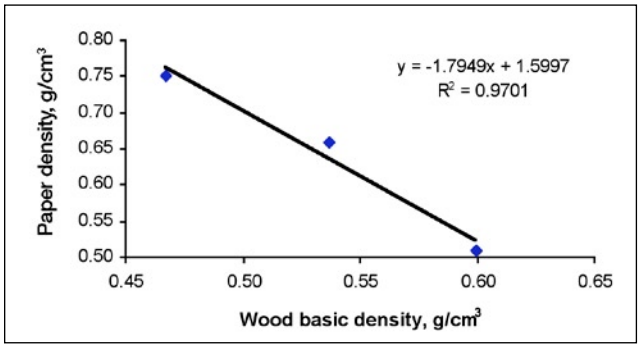
pulp fibers coming from the wood sample with the lowest basic density (LD–0.467 g/cm³) are, even without beating, very flexible, while those coming from the wood samples with the highest basic density (HD–0.600 g/cm³) exhibit very low values of flexibility without beating. This unit operation has a tremendous positive impact on WFF. However, even for the highest beating level (4500 revolutions in PFI mill), the fibers from *E. globulus*–HD are more rigid than *E. globulus*–LD pulp fibers. Figure 2 bottom represents the relative bonded area, measured in individual wet fibers put on a slide, representing the ratio between the area effectively in contact with the slide and the projected area of the fiber. The differences between the pulp fibers are very large at the beginning and decrease with beating, but significant differences remain even at 4500 revolutions in the PFI mill.

PAPERMAKING POTENTIAL

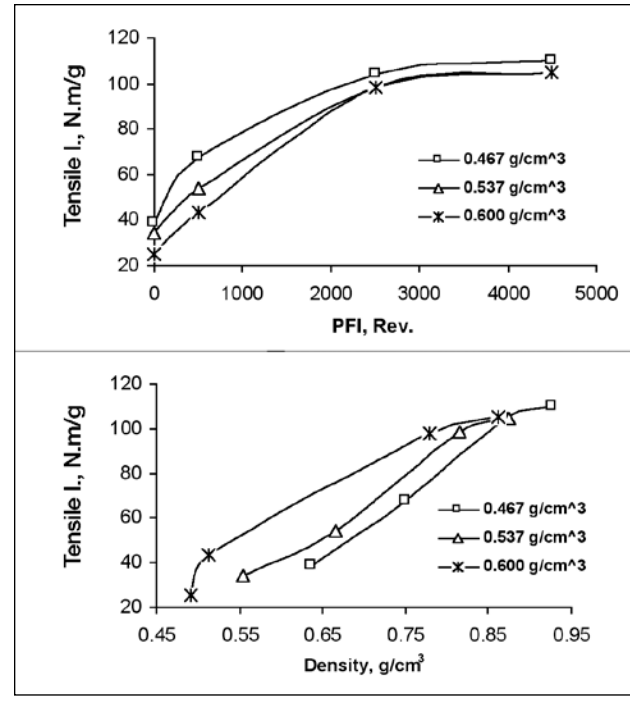
Figure 3 plots the mean value evolution of drainability resistance for the three pulps. For unbeaten pulps, the fibers from *E. globulus*–HD (0.600 g/cm³) exhibit the lowest drainability resistance, while *E. globulus*–LD (0.467 g/cm³) pulp shows the highest value. These results are expected considering the morphological properties of the fibers. The three pulps exhibit fibers with similar width, but the very low fiber wall thickness of *E. globulus*–LD pulp fibers leads to a very high specific surface area (m²/g of pulp) and, consequently, high drainage resistance. The contrary occurs for *E. globulus*–HD fibers, which are coarse but exhibit the highest rate of drainage resistance development. The microscope observation of the pulp suspensions, under dark



5. Evolution of paper density (σ=0.01) with beating, for the three E. globulus pulps.



6. Correlation between paper density and wood basic density.



7. Evolution of tensile index (s=5) as a function of PFI revolutions (top) and paper density (bottom).

field, showed that *E. globulus*–HD pulp fibers develop higher external fibrillation than *E. globulus*–LD.

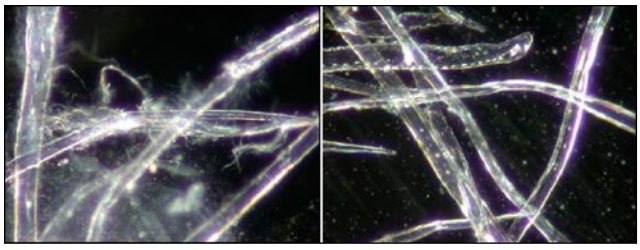
The different beating development is also revealed in the water retention value (WRV) of the pulp suspension with fines (**Fig. 4**). The WRV for the pulp suspension without fines revealed that *E. globulus*–HD pulp fibers show, in general, slightly lower water retention than *E. globulus*–LD pulp, throughout the refining period (Fig. 4), despite their higher external fibrillation. Conjugation of previous results suggests lower swelling and higher external fibrillation aptitude of *E. globulus*–HD pulp. Seth [15], working with softwood pulps with very different coarseness, reported significantly higher external fibrillation for the coarse fibers at 6000 PFI revolutions. The influence of fines on WRV measurements is also remarkable for both pulps (Fig. 4).

Figure 5 reveals that *E. globulus*–HD pulp exhibits paper density values markedly lower than the other two pulps for all the beating range, but the differences between the pulps are significantly attenuated with beating. This observation is explained by the markedly different evolution with beating of wet fiber flexibility and relative bonded area (Fig. 2) of the different pulp fibers. On the other hand, even at 4500 PFI revolutions, where drainage resistance of *E. globulus*–HD pulp is significantly higher than the other corresponding suspensions, the paper density remains significantly lower than *E. globulus*–LD pulp, which is a very important consequence of fiber morphology. Furthermore, around 500 and 2500 PFI revolutions were required, respectively, for *E. globulus*–LD and *E. globulus*–HD to reach a paper density of 0.75 g/cm^3. The differences are markedly reduced when the reference is tensile strength (**Fig. 7 top**), but remain significant throughout the range of this property.

The paper density has a strong influence on paper performance and its value, as well as those for other properties, measured for unbeaten or gentle beaten pulps, has been used as an indicator of papermaking potential of the wood samples. Moreover, these values can also be correlated with wood properties or some fiber properties. **Figure 6** shows the very good negative correlation between the paper density at 500 PFI revolutions and the wood basic density. Similar correlations were also observed between paper density and fiber wall thickness or fiber coarseness. However, the diverse responses of the different fibers in beating should also be considered in order to have a more realistic picture of the papermaking potential of the wood samples.

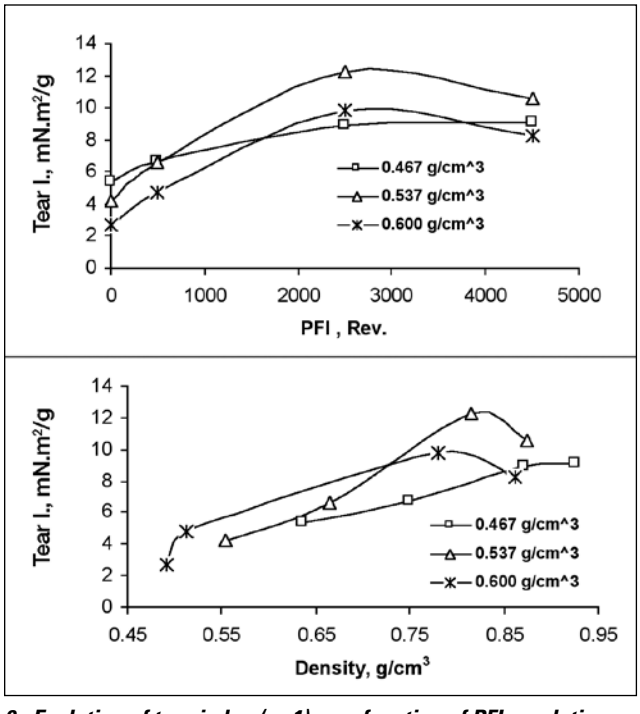
As expected from the paper density data (and corresponding paper porosity), *E. globulus*–HD exhibits higher air permeability than the other pulp samples, at a given beating energy. Paper smoothness is markedly higher for *E. globulus*–LD pulp, at a given refining level, but there are no significant differences when the comparison is made at a given paper density.

Regarding mechanical properties, *E. globulus*–LD pulp exhibits higher tensile (Fig. 7 top) and burst strengths than *E. globulus*–HD, at a given PFI revolutions, in accordance with its higher paper density. Considering again the tensile values at 500 PFI revolutions, a negative correlation between this property and the wood basic density, fiber wall thickness or coarseness was observed. However, the beating has an important impact on tensile strength and the differences between the pulps decrease with beating, particularly for *E globulus*-ID, as Fig. 7 (top) shows. Furthermore, the representation of

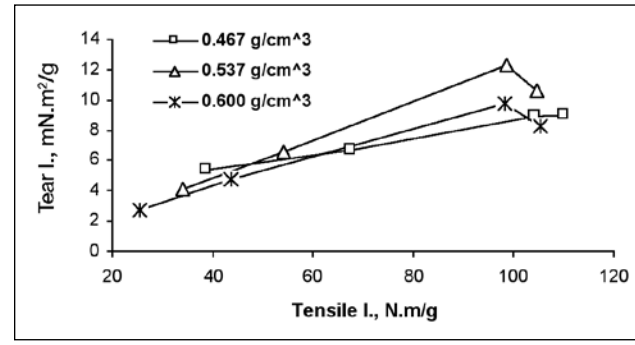


8. Photomicrographs (magnification 50x) of the HD pulp beaten at 2500 revolutions (left) and LD pulp beaten at 500 revolutions (right), to achieve a paper density close to 0.77 g/cm³.

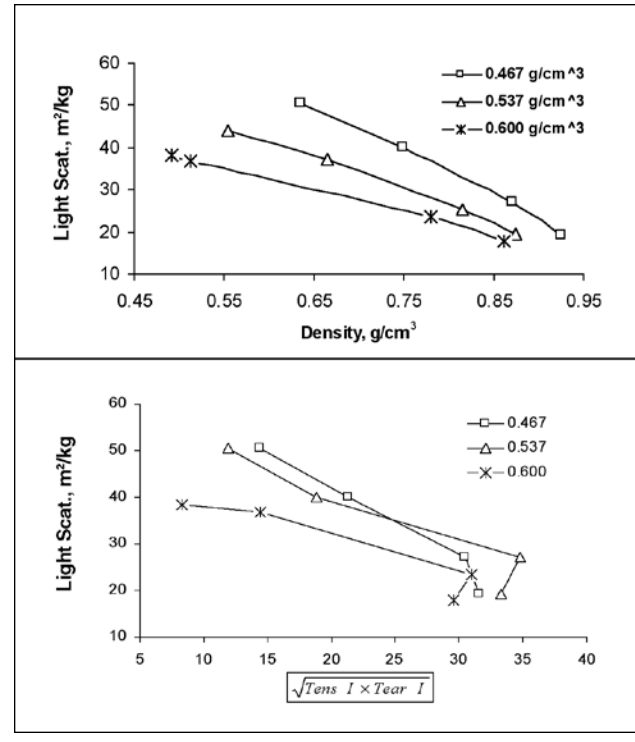
tensile strength as a function of paper density reveals that *E. globulus*–HD pulp can produce stronger papers than the other pulps. These results are mainly a natural consequence of the higher inter-fiber bonding developed by *E. globulus*–HD and *E. globulus*–ID pulp fibers compared with *E. globulus*–LD pulp fibers, at a given paper density. **Figure 8** represents the photomicrographs of the pulp fibers (*E. globulus*–HD and *E. globulus*–LD) corresponding to the papers with similar densities (≈ 0.77 g/cm³). The much higher external fibrillation on *E. globulus*–HD pulp fibers is evident. However, the better performance of *E. globulus*–HD is achieved at the expense of higher energy consumption in beating. For the pulps under evaluation, the fiber length and zero-span tensile strength have only minor effects on the relationship between tensile and paper density. The bonding between the fibers should control the paper strength at this level. The zero-span tensile strength data show the slightly superior performance of *E. globulus*–HD compared with *E. globulus*–LD in the dry tests (195 vs. 187 N.m/g, at 500 PFI revolutions); the difference reaches 10%



9. Evolution of tear index (σ=1) as a function of PFI revolutions (top) and paper density (bottom).



10. Evolution of tear index as a function of tensile index.

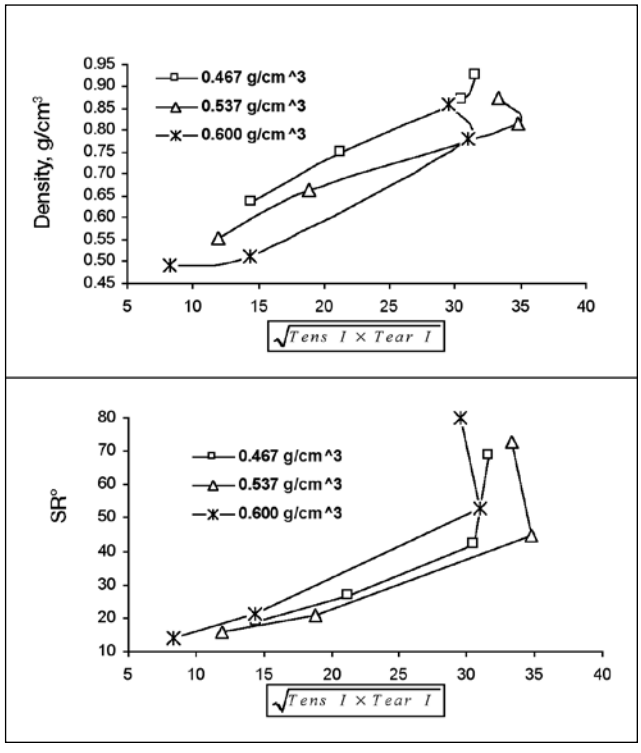


11. Light scattering coefficient (σ=0.7) vs. paper density (top) and mechanical strength (bottom).

when the comparison is based on the corresponding wet tests (170 vs. 152 N.m/g, at 500 PFI revolutions). At least three characteristics [16, 17] could be cited to explain the superiority of *E. globulus*–HD pulp: lower fibril angle; lesser weak points in the fiber wall, such as kinks and nodes; and higher pulp viscosity, which is the most obvious (Table II).

Figure 9 illustrates that the pulp coming from the wood with ID exhibits superior performance relative to the other two pulps. Number of fibers per gram, fiber length, intrinsic fiber strength, and inter-fiber bonds seem to be favorably combined in *E. globulus*–ID pulp. Despite the highest values of intrinsic fiber strength and fiber length (Table V) for *E. globulus*–HD pulp fibers, the low number of fibers per gram of pulp leads to relatively low tearing resistance. The superior performance of *E. globulus*–ID is also evident in **Fig. 10**, where tear index is reported as a function of tensile index.

In **Fig. 11**, light scattering coefficient, a very important characteristic for printing and writing papers, is represented as a function of paper density. *E. globulus*–HD pulp exhibits the



12. Paper density (top) and °SR (bottom) vs. mechanical strength.

notably lowest light scattering, in good accordance with the lowest specific surface of these fibers. Even when the geometric average of tensile and tear indexes ($\sqrt{\text{Tensile Index} \times \text{Tear Index}}$) is used for comparison, *E. globulus*–HD compares badly with the other pulps in terms of light scattering. On the contrary, **Fig. 12** (top) shows that *E. globulus*–HD can produce bulkier hand sheets than the other pulps, at given paper strength, which is a positive feature. In accordance with bulk, *E. globulus*–HD pulp exhibits a much higher bending stiffness than *E. globulus*–LD pulp, at paper strength of 20. However, this is achieved at the expense of higher specific energy consumption in refining and probably at higher drainage resistance (Fig.12).

CONCLUSIONS

In accordance with their chemical compositions, the three *E. globulus* wood chip samples exhibit markedly different behaviors in the kraft cooking process, in terms of pulp yield and chemical consumption. The *E. globulus* with the highest wood basic densities, 0.600 g/cm^3, exhibits a much higher pulp yield (58.7%) than the *E. globulus* with the lowest wood basic densities (49%). The three chip samples provided pulp fibers with markedly different morphological characteristics. The fiber wall thickness and the corresponding coarseness are very different while the fiber width is comparable. The experimental data have confirmed that the wet fiber flexibility of the unbeaten pulp fibers is extremely dependent on the fiber wall thickness and have revealed the different sensitivity of the fibers to beating; the WFF of the coarse pulp fibers increase drastically with beating. These fibers require more beating energy and develop higher external fibrillation. Also, the corresponding pulp suspensions drain slower to reach a given paper density although the tensile strength is substantially higher. At a given paper strength, evaluated as $\sqrt{\text{Tensile Index} \times \text{Tear Index}}$, the paper produced from *E. globulus*–HD is bulkier, but the light scattering coefficient is lower and the corresponding pulp suspension drain slower than *E. globulus*–LD. The wood chip sample with intermediate density (0.537 g/cm^3) produced hand sheets that are somewhat denser than *E. globulus*–HD, but the suspension drains better and the paper exhibits very good light scattering coefficient.

The pulping data are favorable to the clone with the wood basic density of 0.600 g/cm^3, but the papermaking results indicate that poor light scattering ability and high energy consumption in refining of these pulp fibers are important drawbacks. **TJ**

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INSIGHTS FROM THE AUTHORS

The high variability of *Eucalyptus globulus* affects digester yield and papermaking potential so there is industrial interest to investigate this topic. We were also interested in the relationships between pulp fiber characteristics and paper structure and properties, which is an area we will continue to investigate.

External fibrillation evaluation, which was carried out by microscopic observation under dark field, was the most difficult aspect of our work. The research showed that wood density variability affects pulp fiber morphology and has an important impact on beating and paper properties.

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Editor's Note



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Get out there!

Spring is finally here (yes, I did see snow falling a mere two days ago here at my suburban Chicago office, but I am dismissing it as an anomaly.) At TAPPI, that means we're all busy working on the exciting events being offered over the next several months. By the time you read this, PaperCon '08 will be over; but if you were there, I'm sure you're still feeling energized by the networking and knowledge that you picked up in Dallas. The latest report from HQ is that at least 900 attendees and 50 exhibitors are already set to make it a truly dynamic event.

There are plenty of other events coming up on the calendar that offer targeted technical programs and outstanding opportunities for peer interaction. TAPPI's 10th Advanced Coating Fundamentals Symposium, June 11-13, features some great post-conference tours and a strong technical program with poster sessions. The International Conference on Nanotechnology for the Forest Products Industry, June 25-27, brings together some of the leading names in the field with five keynote speakers. And TAPPI's 2008 EPE Conference (August 24-27) and the 2008 International Bioenergy & Bioproducts Conference (August 27-29) are scheduled successively in Portland, Oregon – now that's "one-stop shopping" for all your knowledge needs.

There are plenty of events coming up on the calendar that offer targeted technical programs and outstanding opportunities for peer interaction.

So (to borrow a line from a cruise line commercial) this summer, get out there! TAPPI events offer more than a sunburn by the crowded pool.