Alterations of the Anatomical Structure of Eucalypt Wood Chips in Three Refining Conditions for MDF Panels Production

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ABSTRACT

The utilization of eucalypt wood in production of MDF panels is recent in Brazil and is necessary to understand the effect of the industrial process in the wood anatomical structure. The refining stage of eucalypt wood chips is one of the most important and it affects directly the technological properties of MDF panels. With this aim, three differentiated refining conditions of *Eucalyptus grandis* wood chips were applied in MDF line production, varying the (i) heating time (ii) digestion and refining pressures and (iii) specific energy consumption and evaluated the wood cell components. The results showed that the increase of the refining intensity of the eucalypt wood chips reduced the mean length of the fiber and increased the percentage of broken fibers; the vessels and parenchyma cells also decreased in the wood pulp confirmed by the SEM analysis. However, there is no significant difference of fiber wall thickness within the wood refining treatments. The increase of the wood chips refining conditions also promoted a characteristic darkening of the wood pulp cellular elements. Pulps with clearer coloration composed with higher frequency of fiber bunches, vessels and parenchyma cells retained in sieves mesh 20 of Bauer McNett were obtained by the application of lighter refining variables. The alterations of the wood cell elements of eucalypt chips due to the refining treatments were related with the stages of the operational process and MDF board quality.

Keywords: Wood anatomy, *Eucalyptus grandis*, refining, chip, fiberboard, MDF panel.

INTRODUCTION

The use of *Eucalyptus spp* wood for production of MDF panels (Medium Density Fiberboard) is recent in Brazil and may have certain advantages in relationship to *Pinus spp* wood, as a minor cycle of plantations rotation and possibility to use logs with bark (Belini, 2007).

Analysis with *Pinus spp* wood have shown that coloration and morphological characteristics of MDF panels are due to the conditions of wood chip refining (Myers, 1983; Rodarmel, 1995; Groom et al., 2004) and the increase in specific energy consumption influences the fiber length (Rodarmel, 1995). As shown by Riedl & Park (2006), there are few studies about the influence of the fibers in the performance of the panel compared to the studies related to the paper properties.

Therefore, the present study aimed to characterize the anatomical components of *Eucalyptus grandis* wood after three different refining conditions for MDF panel production.

MATERIAL AND METHODS

E. grandis trees with 6,9 years-old were cut and the wood transformed in chips in industrial chipper. The eucalypt wood chips were submitted to the three refining conditions with different heating time, digestion and refining pressures and specific energy (Table 1).

Table 1 – Refining variables of E. grandis wood chips to MDF panel production

Wood chips refining treatments	Heating Time (min)	Digester Pressures (bar)	Refiner Pressure (bar)	Specific Energy Consumption (kwh/t)
A	3,0	7,0	7,2	90
B	4,0	8,0	8,2	100
C	5,0	9,0	9,2	110

The samples of eucalypt pulpwood were collected in mat former of the MDF panels, in industrial scale, in the production flow, after gluing, drying and classification stages of the refined material. In laboratory the morphological classification of the wood cellular components was led in five sieves of the equipment Bauer McNett model 203C (TAPPI, 1975). For each sieve, samples of cellular components were collected for optical (Johansen, 1940) and SEM (Kitajima & Leite, 1999) microscopic examination. Also the dimensions of the cellular elements (length, width, wall thickness, diameter) were determined (IAWA Committee, 1989). For the statistical analyses it was used SAS (SAS Institute Inc, 1997) being considered delineate as entirely random**.**

RESULTS AND DISCUSSION

The values of cellular elements retention for each sieve represent the differences in the fiber mean length: in the refining condition A (less intense) the retention was of 46,6% in the sieve 20 mesh (larger mesh aperture), with statistical difference in comparison with the more intense refining treatments (B and C). The results indicate a smaller intensity of fiber wall rupture and formation of fiber bunches, differently of the verified in the condition C (Table 2).

Table 2 – Percent of fiber retention in Bauer McNett sieve analysis.

Wood refining treatments	Sieve aperture (mesh)				
	20	**35**	**65**	**150**	**> 150**
A	46,6 a (0,8) (1,7)	13,6 b (0,5) (4,0)	18,3 c (1,0) (5,5)	11,2 b (0,8) (6,9)	10,3 b (1,4) (13,2)
B	24,9 b (0,8) (3,3)	24,2 a (0,47) (1,9)	27,6 b (0,5) (2,0)	12,1 b (0,9) (7,8)	11,3 ab (1,7) (15,3)
C	21,0 c (0,4) (1,7)	21,0 c (0,5) (2,4)	31,1 a (0,4) (1,3)	14,7 a (0,2) (1,7)	12,3 a (0,5) (4,3)

Note: Mean values are followed by standard deviation and variation coefficient; different letters in the same column differ to each other at the level of 5% of significance (Tukey test).

The visual aspect of the cellular components of eucalypt wood in the refining treatment A indicated roughness morphology and clear coloration, while in the condition C the cellular components presented fine morphology and darker coloration, as mentioned by Groom et al. (2004).

The vessel and parenchyma cells frequency showed statistical differences between the refining conditions A and C, being verified higher number of these cells in the lighter treatment (A).

Significant differences were observed for the fiber length and wall thickness in the sieves classification of 20 and 35 mesh and for the fiber diameter in the sieve 65 mesh (Table 3). In the condition of higher refining intensity (C) the fiber wall thickness was lightness higher, although the fiber length was smaller, indicating the transversal cell wall rupture. The fibers mean length values of the *E. grandis* were of 600-1320 µm as indicated by Tomazello Filho (1985 a,b) and Andrade et al. (1994).

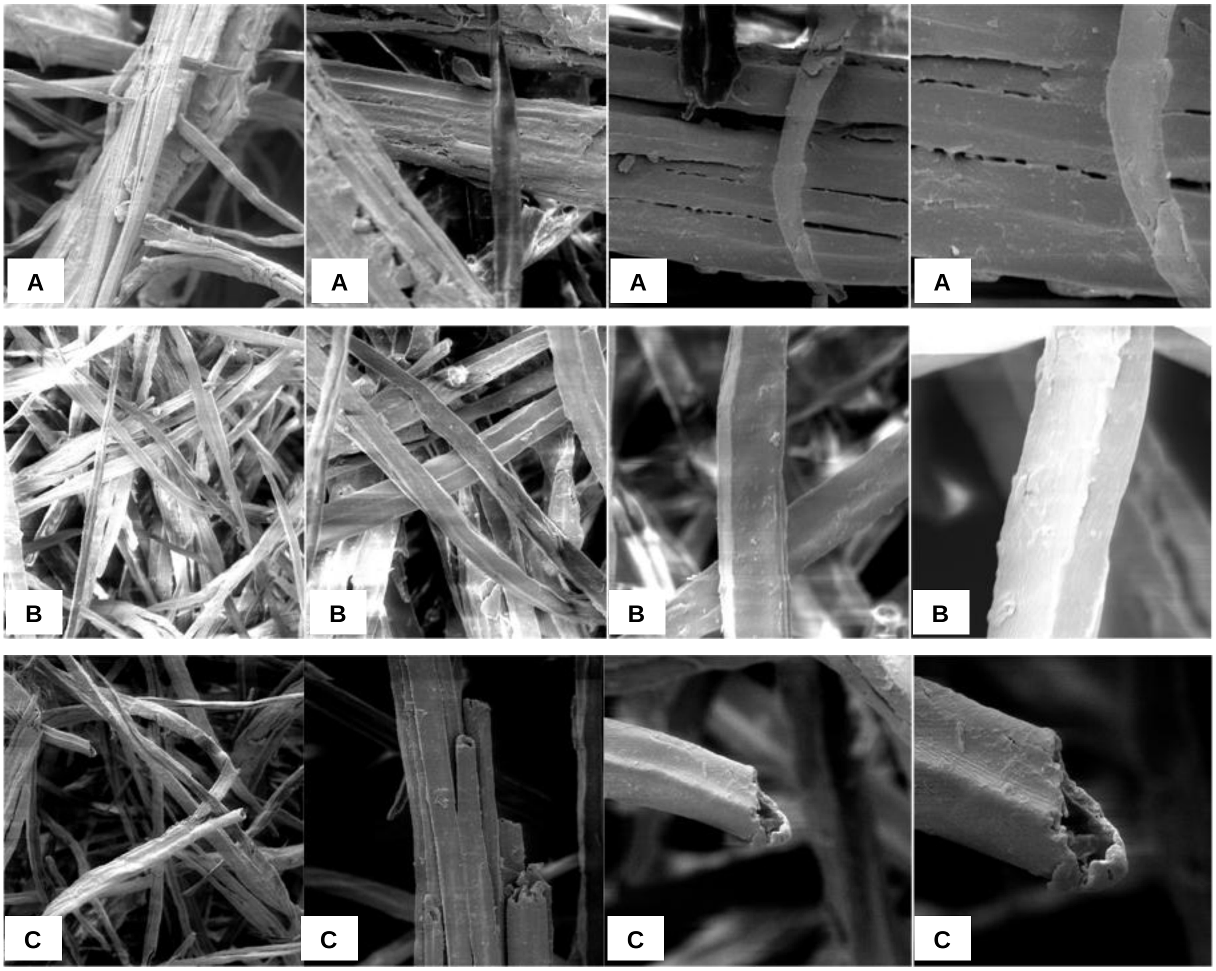
Table 3 – Fiber length, width, lumen diameter and wall thickness of E. grandis wood after different refining conditions

Fiber dimensions (µm)	Refining conditions	Sieve aperture (mesh)			
		20	**35**	**65**	**150**
Length	**A**	1065 a (30,3) (2,8)	1037 a (47,0) (4,5)	1006 a (9,3) (0,9)	893 a (8,2) (0,9)
	B	920 b (1,5) (0,2)	956 b (16,1) (1,7)	996 a (6,32) (0,6)	868 a (9,7) (1,1)
	C	915 b (15,1) (1,7)	945 b (27,6) (2,9)	962 a (30,3) (3,2)	852 a (24,7) (2,9)
Width	**A**	21,0 a (0,4) (1,6)	21,1 a (0,4) (1,7)	21,7 a (0,4) (1,6)	20,6 a (0,2) (0,9)
	B	20,5 a (0,9) (4,5)	20,6 a (0,7) (3,6)	21,6 a (0,6) (2,9)	21,0 a (0,3) (1,6)
	C	21,2 a (0,1) (0,5)	21,0 a (0,2) (0,9)	21,3 a (0,8) (3,7)	21,1 a (0,4) (1,9)
Lumen diameter	**A**	11,2 a (0,7) (5,8)	11,5 a (0,7) (5,9)	12,2 ab (0,1) (1,2)	11,7 a (0,3) (2,3)
	B	11,6 a (1,0) (9,0)	11,6 a (1,1) (9,1)	12,6 a (0,6) (4,5)	12,4 a (0,3) (2,1)
	C	11,0 a (0,7) (5,8)	11,2 a (0,6) (5,1)	11,7 a (0,6) (5,3)	11,8 a (0,5) (4,1)
Wall thickness	**A**	4,9 cb (0,2) (4,7)	4,8 cb (0,3) (5,7)	4,8 ab (0,2) (4,5)	4,5 a (0,1) (3,1)
	B	4,5 c (0,1) (2,0)	4,5 c (0,4) (7,7)	4,5 a (0,1) (1,3)	4,4 a (0,1) (1,0)
	C	5,1a (0,3) (5,7)	4,9 a (0,4) (7,4)	4,8 a (0,1) (2,9)	4,7 a (0,1) (0,8)

Note: Mean values are followed by standard deviation and variation coefficient; different letters in the same column differ to each other at the level of 5% of significance (Tukey test).

The wood cell components in SEM reveals in the refining condition A the presence of fiber bunches; in B the unbroken fibers and dissociated in the medium lamella; in C the higher frequency of broken fibers (Figure 1) (Belini, 2007).

Figure 1 – Cellular components of E. grandis wood after three different refining conditions (A, B, C) in SEM (200, 500, 1000 and 2000x, respectively).



CONCLUSIONS

To *Eucalyptus grandis* wood chips the treatment of less intense refining (condition A) showed larger retention of fibers in the sieves of larger opening (mesh 20 and 35) due to the presence of fiber bunches, vessels and parenchyma cells, confirmed by the SEM.

The increase of the refining intensity of the wood chips (condition C) reduced the mean fiber length, with larger retentions in the sieves of smaller opening, with darkening of the cellular components.

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