INVESTIGATING STORAGE TIME TO MINIMIZE END-SPLITTING IN *EUCALYPTUS NITENS* LOGS

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Abstract. The selection of *Eucalyptus nitens* (H. Deane & Maiden) logs for higher value-added products is complex, due to the presence of radial and longitudinal splits as a result of growth stress, which reduces their utilization in solid products. The objective of this research was to determine the limited time for the utilization of the logs to increase their use in higher value-added products. Forty trees with two 4 m logs were used. The radius (r_t), radial, and end-splitting along the log (R_{long}) were measured on days 0 and 1 in the forest and later on days 7, 14, 21, and 28, at the Universidad del Bío-Bío, where they remained under sprinkler irrigation and covered with polyethylene plastic. The relative splitting index (SI) was determined as ($R_{\max}/r_t$) per log. The results showed that there were significant differences in the maximum end-splitting indicator ($R_{\max}$) with log height and storage time. The SI indicator showed significant differences with storage time, being a better fit than $R_{\max}$. The linear model that showed the relationship between the external openings of the splits and the longitudinal split had a coefficient of determination (r^2) of 0.77.

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In conclusion the use of *Eucalyptus nitens* wood is conditioned by the initial quality of logs that enter the mechanical transformation process, storage time of fewer than 7 d, use the second log and have a diameter greater than or equal to 40 cm, with radial splits at the ends less than 75% (SI $= \leq 75^{*}r_t$ %) of the radius and consider an oversize of at least 20 cm at each end of the log.

Keywords: Radial splitting, longitudinal splitting, log height, growth stresses.

INTRODUCTION

The interest in using fast-growing species in the wood industry has allowed foresters to position the different species of *Eucalyptus*, as alternative raw materials for the primary conversion industry, mainly due to their high capacity to adapt to different forest sites (Cardoso et al 2005; Lima 2005; Gonçalves et al 2006; França 2014; Rozas et al 2021a, 2021b). The main use of fast-grown *Eucalyptus* species is for pulp and paper production (Balasso et al 2022). In Chile, *Eucalyptus nitens* (H. Deane & Maiden) has become the third most important forestry species, showing great adaptation in the central-southern of the country, with a growth rate of 35 m^3/ha yr and diameters of over 40 cm at 14 yr of tree, making it suitable for both, sawmill, panel industries and construction industry (Biechele et al 2008; Balasso et al 2022).

However, the genus *Eucalyptus* has high growth stresses, which limits the potential for obtaining production of higher value-added products (Gonçalves et al 2006; Souza 2006; Trugilho et al 2006; Lima et al 2007; Trugilho et al 2007; Biechele et al 2008; Monteiro et al 2010; Valencia et al 2011; Trevisan et al 2013; Cunha et al 2015; Rozas 2015; Vega et al 2016; Rozas et al 2021a, 2021b). Growth stresses take the form of end-splitting after harvest and warping during mechanical processing, drying, and use when construction, reducing the yield and quality of wood products (Matos et al 2003; Rozas 2015; Vega et al 2016; Schmidt et al 2019).

Therefore, research efforts have focused on reducing the factors that cause end-splitting. For this, measurement methods have been developed, such as the splitting index (SI) used by Malan (2008), Hernández et al (2014), and Trevisan et al (2014); and the classification protocol, developed by the CSIR and used by Verryn and Turner (2000), Washusen et al (2009), Valencia et al (2011), and Dunn et al (2014). These methods have allowed researchers to investigate the relationship between end-splitting and tree properties, such as the correlation between Diameter Breast Height (DBH) and tree height (Lima et al 2000; Trevisan et al 2014).

Regarding storage time, studies have focused on *Eucalyptus grandis* and *Eucalyptus dunnii*, reporting the presence of end-splitting from the third day after harvest (Malan 1979). Hillis and Brown (1978) found that end-splitting was visible before 7 d, and Oliveira et al (1999) after 7 d. Bariska (1990) reported end-splitting for 5 d and Schacht et al (1998) for 4 d. These authors agree that the utilization of logs for industrial use requires defining a maximum storage time before end-splitting prevents the profitability of obtaining solid wood.

Investigations on the relationship between storage time and end-splitting are limited. Dunn et al (2014), Vega et al (2016), and Balasso et al (2022), investigated the end-splitting behavior of *Eucalyptus nitens* logs but did not define a time limit for log utilization. The absence of technological knowledge impedes decision-making regarding the selection and utilization of *Eucalyptus nitens* logs (Balasso et al 2022). Currently, the previous studies have been isolated and discontinued over time, remaining in the stage of semi-industrial experimental tests. Unfortunately, there have been no concrete industrial-scale production models operating in the Chilean market for the utilization of this valuable resource. Hence, this study contributes to the understanding of the species for its subsequent mechanical processing.

Therefore, the aim of this research was to determine the storage time limit of the utilization of *Eucalyptus nitens* logs of 13 yr of age and an average DBH of 44 cm, through the development of log end-splitting, which allows increasing its use in products of higher added value.

MATERIALS AND METHODS

Precedence of Raw Material

The forest plantation belonged to Agrícola y Forestal Natalhue Ltda., located in the Huenuye Norte estate, Lanco-Panguipulli sector (39°29′78″ South and 78°41′34″ West), Valdivia province of Chile. According to the Köppen classification, this province has a Cfsb-type climate (oceanic climate with short summer drought and Mediterranean influence), with annual precipitation of 2.351 mm/yr, high RH (average 75%), and mean temperatures between 4°C and 9°C (Regional Climatology 2001).

The silvicultural regime consisted of a plantation with an initial density of 1666 trees/ha, with thinning at 6 yr (700 trees/ha), 8 yr (400 trees/ha), and 10 yr (200 trees/ha). Three pruning was also carried out: the first at 2.5 yr (2.5 m in height), the second at 3.5 yr (between 5 and 6 m in height), and the last at 5 yr (9 m in height).

Selection of Raw Material

Forty 13-yr-old *Eucalyptus nitens* trees with an average DBH of 44 (cm) were selected. After harvest, the total height of each tree was measured from the base to the top, using a 60 m tape measure with an accuracy of 0.002 m. The trees were cut from the DBH (1.3 m) to 5.3 m and from this height to 9.3 m. In this way, 40 logs were obtained corresponding to the 1.3-5.3 m section (Log A) and 40 logs for the 5.3-9.3 m section (Log B). In addition, 5 cm samples were cut from the end of logs to determine the basic density (Instituto Nacional de Normalización NCh176/2, 1986) and MC (Instituto Nacional de Normalización 176/1, 2019) (see Fig 1).

Table 1. MC and basic density measures in selected logs.

Height	Side logs	N	MC average (SD; CoV)	Basic density (SD; CoV)
1.3-5.3	I	40	148.2 (13.1; 8.8)	477 (34; 7.1)
	II		143.2 (13.2; 9.2)	433 (27; 6.3)
5.5-9.3	III	40	143.5 (13.2; 9.2)	421 (26; 6.3)
	IV		136.1 (16.1; 11.8)	434 (32; 7.3)

N, number of measurements; CoV, coefficient of variation (%).

In addition, Table 1 shows the average values of basic density and MC measurements by the *Eucalyptus nitens* log for this study.

Measurement of End-splitting

The log-end-splitting was evaluated on days 0 and 1 in the forest and later on days 7, 14, 21, and 28, at the Universidad del Bío-Bío, where they remained under sprinkler irrigation and covered with polyethylene plastic. All stages corresponding to the selection, harvesting, measurement, and transport of *Eucalyptus nitens* trees are summarized in Fig 2.

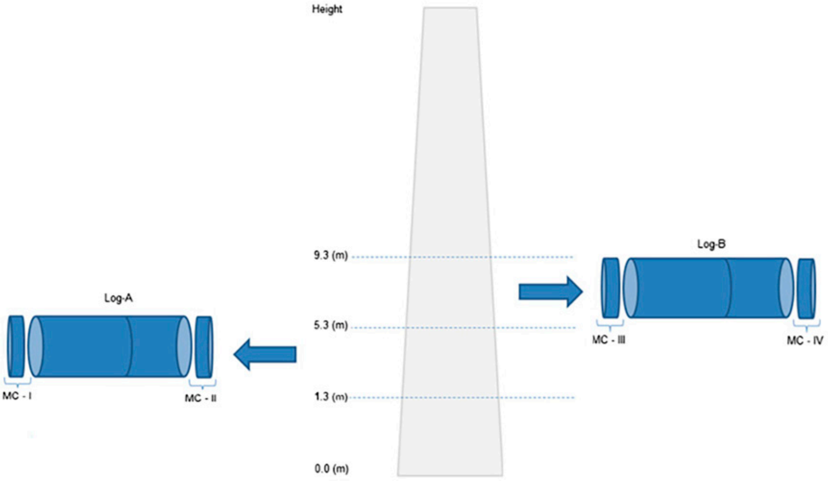


Figure 1. Sampling for basic density and MC and logs identification in *Eucalyptus nitens* logs.

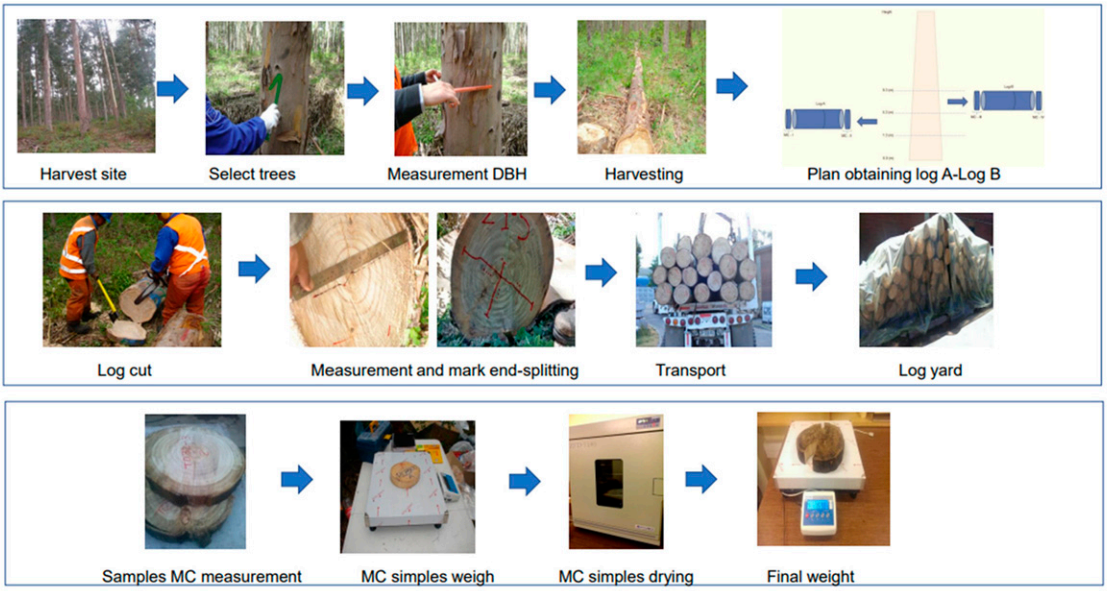


Figure 2. Stages were carried out in this investigation. DBH, Diameter Breast Height.

Each end-splitting observed at the ends of the logs was measured by length and by log radius (r_t), using a 0.001 m precision tape measure. In addition, the opening (Ab) of the end-splitting that covered the entire radius and end-splitting along the log splits (R_{long}) along the log was measured, using a 0.01 mm precision tape measure. With these data, the SI was determined as the ratio between R_{max}/r_t and classified into five groups as shown in Table 2.

Statistical Analysis

A descriptive analysis was performed for R_{max} indicator and SI, where the mean, SD, SEM, coefficient of variation, confidence interval with 95% confidence, and maximum (max) and minimum (min) values were determined. Statistical tests included correlation tests (Pearson's test), analysis of variance (ANOVA) at a significance level of 5% (*p*-value: 0.05), and comparison of means with the Tukey test (*p*-value: 0.05). All these analyses were performed with Minitab 17 software (Minitab 2014, State College, PA) and Microsoft Office 2019 (Redmond, WA).

RESULTS AND DISCUSSION

Variation of R_{max} Indicator with Log Height and Measurement Time

Table 3 shows the descriptive statistics for the maximum end-splitting indicator (R_{max}) evaluated for the two types of logs between 0 and 28 d: Log A (1.3-5.3 m) and Log B (5.3-9.3 m). The end-splitting increased with storage time and decreased

Table 2. Ranges and descriptions for the SI indicator.

Classification	Range	Description
A	$SI < 35\%$	Maximum end-splitting is less than 35% of log radius
B	$35\% \leq SI < 50\%$	Maximum end-splitting is between 35% and 50% of radius
C	$50\% \leq SI < 75\%$	Maximum end-splitting is between 50% and 75% of log radius
D	$75\% \leq SI < 100\%$	Maximum end-splitting is between 75% and 100% of log radius
E	$SI = 100\%$	Maximum end-splitting is equal to log radius

SI, splitting index.

Table 3. Descriptive statistics for the maximum end-splitting indicator $R_{\max}$ (cm) in selected *Eucalyptus nitens* logs.

t_m	Log	h	N	Mean	SD	SE	CV	Min	Max
0	A	I	40	12.8	3.8	0.6	29.3	6.0	22.0
		II	40	12.6	3.5	0.5	27.5	1.0	18.0
	B	III	40	12.0	3.3	0.5	27.2	6.0	19.0
		IV	40	11.0	2.8	0.4	25.1	6.0	17.0
1	A	I	40	14.7	3.5	0.6	24.0	7.0	23.0
		II	40	14.7	3.5	0.4	23.8	1.0	20.0
	B	III	40	14.3	2.8	0.5	19.8	8.0	21.0
		IV	40	12.8	2.1	0.3	16.6	8.0	18.0
7	A	I	40	17.3	2.7	0.4	15.5	10.0	23.0
		II	40	16.0	2.7	0.4	16.7	7.0	21.0
	B	III	40	15.8	2.7	0.4	16.9	11.0	22.0
		IV	40	14.0	2.3	0.4	16.3	8.0	18.0
14	A	I	40	17.9	2.7	0.4	15.3	10.0	23.0
		II	40	16.7	2.7	0.4	16.1	7.0	21.0
	B	III	40	16.5	2.6	0.4	15.8	12.0	24.0
		IV	40	14.5	2.1	0.3	14.2	9.0	18.0
21	A	I	40	18.3	2.8	0.4	15.1	10.0	25.0
		II	40	17.2	2.6	0.4	15.3	8.0	22.0
	B	III	40	17.1	2.3	0.4	13.6	12.0	24.0
		IV	40	15.0	2.0	0.3	13.4	9.0	18.0
28	A	I	40	18.8	2.9	0.5	15.4	10.0	27.0
		II	40	17.5	2.6	0.4	14.6	9.0	24.0
	B	III	40	17.4	2.1	0.3	12.2	12.0	24.0
		IV	40	15.3	2.1	0.3	13.5	11.0	19.0

t_m, measuring time (d); h, log height (m); N, number of observations; mean, average $R_{\max}$ value (cm); SD, standard deviation of $R_{\max}$ (cm); A, log height between I = 1.3 m y and II = 5.3 m; B, log height between III = 5.3 m and IV = 9.3 m; SE, standard error of the mean for $R_{\max}$ (cm); CV, coefficient of variation for $R_{\max}$ (%); Max, maximum value of $R_{\max}$ (cm); Min, minimum value of $R_{\max}$ (cm).

with height of the tree. In addition, the end-splitting of all heights increased on average by 20% (1 d), 35% (7 d), and 47% (28 d) over time. These results are consistent with those reported by Balasso et al (2022) in their study on *Eucalyptus nitens* logs.

Scanavaca and Garcia (2003) observed that end-splitting in *Eucalyptus urophylla* logs increased by 88% between harvest and 7 d, which was higher than the rate found in the current research. Our results indicate, that sawmill and peeling utilization of *Eucalyptus nitens* logs should be before 7 d, to avoid the propagation of $R_{\max}$ indicator, and in turn reduce the yield of sawn wood and veneer. Similarly, decreases in the $R_{\max}$ indicator with increasing height indicate that selection by height also allows an increase in wood yield, with Log B (5.3-9.3 m) being the one that allowed the lowest amount end-splitting.

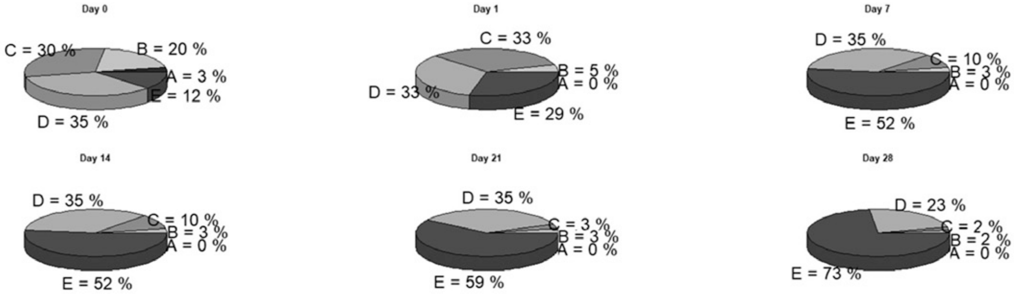
In this sense, Hambisa et al (2023) mentioned that the magnitude of the recovery rate of sawnwood was reduced by several factors, such as end-splitting. The above shows the importance of log classification, mainly for the peeling and sliced processes, where log-end-splitting increases drastically, reducing the use of raw material. For the sawmilling process, this effect is lower, but it is also difficult to industrialize.

Variation of SI with Height and Time of Measurement

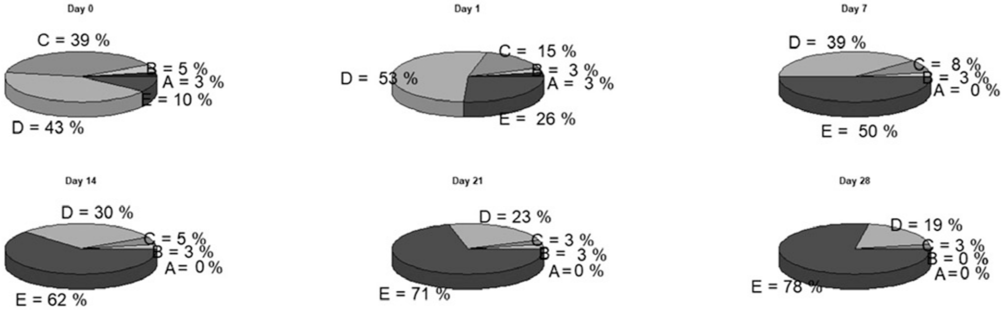
In Fig 1, the distribution of SI with height and storage time can be observed. For example, the Grade E at 1.3 m, increased from 12% (0 d) to 29% (1 d), to 53% (7 d), and 73% (28 d), a trend that was also observed for the other heights. Similarly, there were no significant variations in Grade D logs for the four heights ovens the first 7 d of evaluation. Grade C logs show a reduction from 7 d. The Grade A and Grade B logs were of low proportion and tended to be zero from 1 d onwards.

Figure 3 shows the increase in SI for the different grades with storage time. Thirty-seven percent of grade D logs declined to Grade E after 1 day and 64% were Grade E after 7 d. This increase was maintained until day 28 (Fig 2). This percentage decreases a lower of end-splitting after harvest, with the lowest level being 35% of the radius.

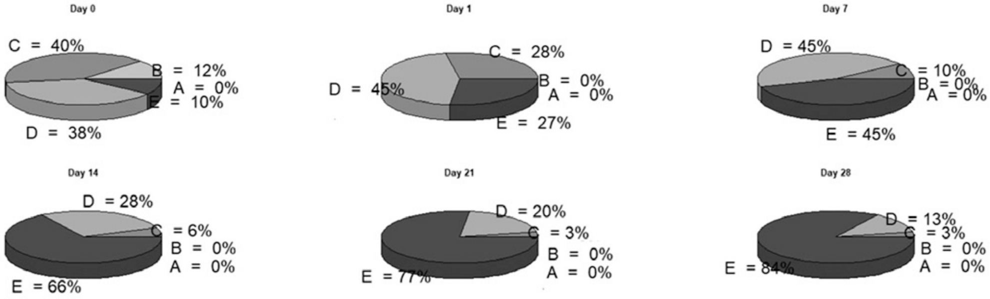
The results indicate that utilization time for logs of *Eucalyptus nitens* is limited. In this context, França (2014) and Balasso et al (2022) attributed this to the high growth stresses, which explain the presence of end-splitting as soon as the logs are harvested. Given these results, it is recommended to use *Eucalyptus nitens* logs within 0 to 7 d, provided that adequate transport and storage conditions are ensured during this period. Another strategy would be to oversize the logs before industrial use, cutting the end-log to eliminate



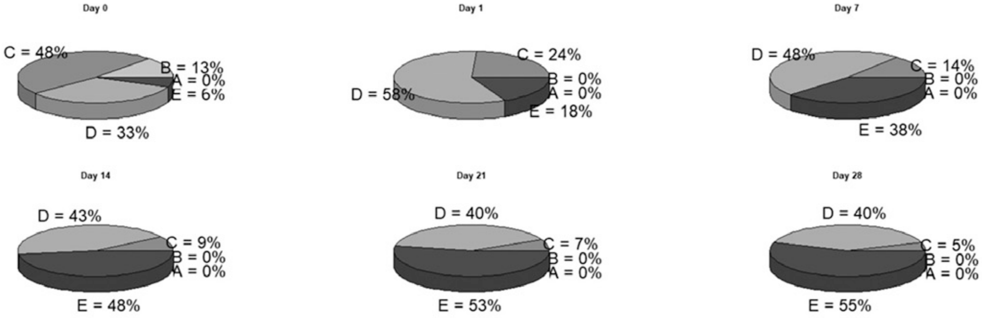
(a) Log A (1.3 m)



(b) Log A (5.3 m)



(c) Log B (5.3 m)



(d) Log B (9.3 m)

Figure 3. Splitting index for different heights in *Eucalyptus nitens*: Log A, (a) 1.3 m and (b) 5.3 m; and Log B, (c) 5.3 m and (d) 9.3 m.

end-splitting and thus optimize their final use. This will reduce the SI before mechanical processing and thus increase the recovery of sawn timber and veneer. This becomes relevant for *Eucalyptus nitens*, as it is prone to a large amount of end-splitting after harvest (Washusen et al 2009). In this context, Vega et al (2016) and Rozas et al (2021a, 2021b); observed significant differences in *Eucalyptus nitens* and significant end-splitting at different time intervals. Similar behavior was observed by other researchers, França (2014) reported severe end-splitting from 7 d, Hillis and Brown (1978) reported it on 6 d, and Bariska (1990) on 5 d. However, Lima et al (2002) reported that end-splitting reached its maximum between harvest and 3 d.

Cunha et al (2015) emphasized that moisture loss in the log accelerated the end-splitting process, due to moisture gradients that produce compressive and tensile stresses in the log. Breaks that propagate in the form of end-splitting develop as the stresses exceed the mechanical strength of the wood.

For this reason, de Fégely (2004) recommended not cutting to commercial length after harvesting but doing it before industrial use of the log and in multiple lengths (Dunn et al 2014), to reduce the magnitude of the end-splitting. Furthermore, SI was suggested as a better estimator than the R_{max} indicator since the former showed greater precision in assessing the splitting behavior.

Effect of Storage Time and Log Height on R_{max} Indicator

The ANOVA and comparison of means (Tukey's test) for storage time and height on R_{max}, showed that there were significant differences between storage time (p-value: <0.001) and height (p-value: <0.001) (Table 4). The exception was the measurement immediately after harvesting (0 d), where there were no significant differences (p-value: 0.071). However, there were no significant differences between measurements from 7 to 28 d for all heights evaluated.

Similarly, no significant differences were detected between heights at 0 d (p-value: 0.071), but significant differences were detected between log heights for day 1 (p-value: 0.002), day 7 (p-value: <0.001), day 14 (p-value: <0.001), day 21 (p-value: <0.001), and day 28 (p-value: <0.001). Specifically, from 1 d the R_{max} at 9.3 m was significantly lower than the rest of the heights evaluated.

Similar results were also found by Lima et al (2000) and Trevisan et al (2013), who reported that log height affects the magnitude of end-splitting. Similarly, Malan (1984) observed an increase in

Table 4. ANOVA and Tukey tests for the maximum end-splitting indicator R_{max} (cm).

	Log A		Log B			
t_m (d)	I	II	III	IV	Statistics	
0	12.8 aA	12.6 aA	12.0 aA	11.0 aA	F: 2.4	p-value: 0.071
1	14.7 aA	14.7 aB	14.3 abB	12.8 bB	F: 3.4	p-value: 0.002*
7	17.3 aB	16.0 aBC	15.8 aBC	14.0 bBC	F: 10.6	p-value: <0.001*
14	17.9 aB	16.7 aC	16.5 aC	14.5 bC	F: 12.2	p-value: <0.001*
21	18.3 aB	17.2 aC	17.1 aC	15.0 bC	F: 13.2	p-value: <0.001*
28	18.8 aB	17.5 abC	17.4 bC	15.3 cC	F: 14.3	p-value: <0.001*
Statistics	F: 23.7	F: 15.8	F: 23.8	F: 21.1	—	
	p-value: <0.001*	p-value: <0.001*	p-value: <0.001*	p-value: <0.001*	—	

*Significant at 5% significance, using the F-test.

t_m, measuring time (d); Log A, log height between I = 1.3 m y and II = 5.3 m; Log B, Log height between III = 5.3 m and IV = 9.3 m; F, F-test result; p-value, probability.

Different uppercase letters denote statistically significant differences (5% significance level) when applying the HSD Tukey test, for the same height and different measurement times (same column).

Different lowercase letters denote statistically significant differences (5% significance level) when applying the HSD Tukey test, for the same measurement time at different heights (same row).

end-splitting in *Eucalyptus grandis* from the base up to 4.3 m and then a decrease with height. Similar results were obtained by Trevisan et al (2014) in *Eucalyptus grandis* logs, which had their maximum end-splitting at 30% of the total height of the tree, after which the end-splitting height decreased. In this research, the reduction of $R_{\max}$ indicator with height was only observed on day 0. Thereafter, storage time determined the magnitude of the end-splitting, indicating the logs should be used in less than 7 d (Figure 4).

Model to Estimate the End-splitting along the Log (R_{long})

Figure 5 shows the relationship between the end-splitting along the log and the external opening of end-splitting, showing a high concentration of data in the first third of the line and a high frequency of end-splitting along the log of 210 mm, which were related to an opening between 1.0 and 3.5 mm. Pearson tests showed a high positive correlation, close to 88% (p-value: <0001), and a coefficient of determination (r^2) of 0.77. The statistical model explaining this behavior can be seen in Eq 1.

$$R_{\text{long}} = 46,225 \times A_{\text{ext}} + 60,467 \qquad (1)$$

where R_{long} is the propagation of end-splitting along the log in (mm) and A_{ext} is the external end-splitting opening in (mm).

The linear regression model to determine the magnitude of propagation of end-splitting, which can be used to estimate the loss from topping in grade E logs, is shown in Table 5.

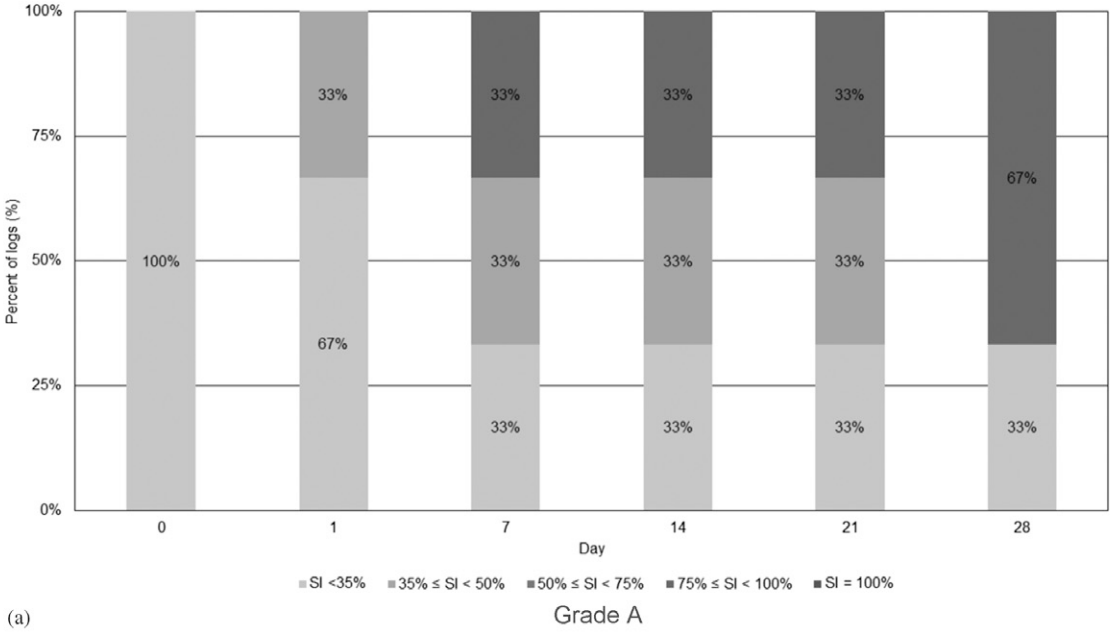
The model to predict the end-splitting along the log (R_{long}) supported the premise that grade E logs determine the magnitude of log blunting. Specifically, the model indicated that the loss due to blunting at one or both ends should average 7.6 cm on 0 d and 11.1 cm on 1 d. The elimination of end-splitting along the log into 7 d requires trimming 31.3 cm. On 14 d, the blunting should be 36.8 cm, and on 21 and 28 d it is 43.0 and 46.7 cm, respectively. These results corroborate that eliminating the end-splitting along the log implies increasing the length of blunting over time.

Dunn et al (2014) applied blunting between 29.0 and 54.0 cm on *Eucalyptus nitens* logs which were 2.6 m long, which resulted in the elimination of longitudinal end-splitting in some grade E logs. To the above, it should be considered that in mechanical processing and drying of wood, this defect tends to increase along the length of the log. In this respect, the application of blunting in grade E logs may increase utilization. However, this decision will depend on other factors such as the cost of the raw material and the final quality of the products.

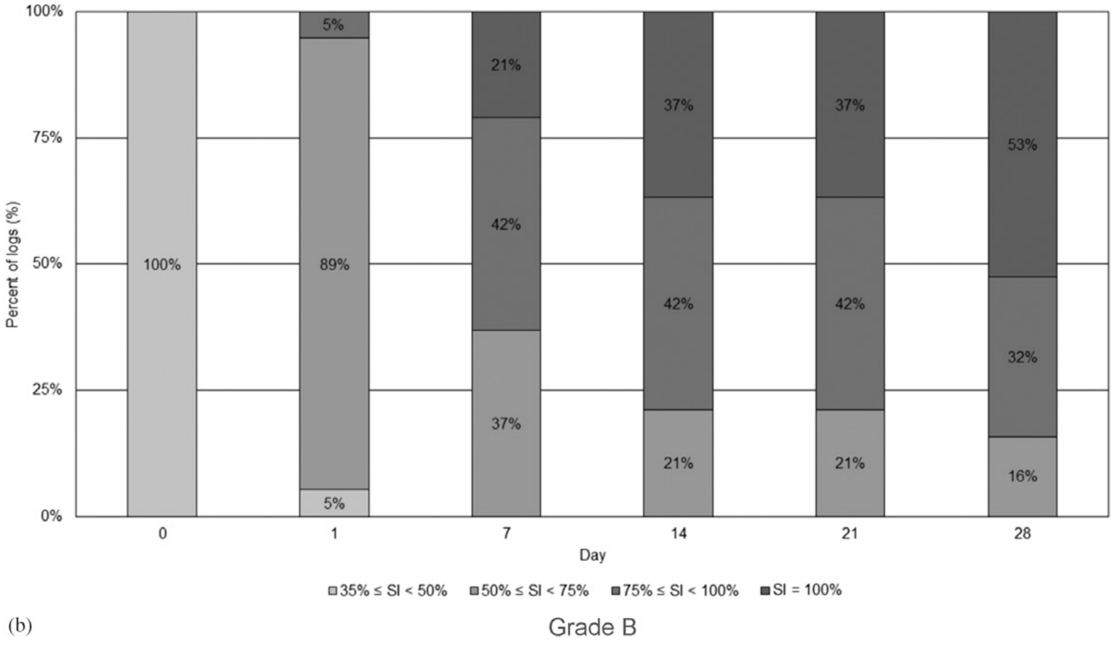
Variation of SI with the Properties of the Tree

Table 6 shows the Pearson correlation and the ANOVA for the behavior of SI with the tree characteristics, noting that only the measurement time was directly correlated with the SI (p-value: <0.001). In contrast, DBH, log diameter, total tree height, and log position did not show a significant correlation with this index. The ANOVA indicated that only the measurement time was significant (p-value: <0.001).

The relationships between tree characteristics and splitting were also observed by García (1995), Lima et al (2002), Scanavaca and Garcia (2003), and França (2014), in different *Eucalyptus* species. These authors confirmed the abrupt increase in end-splitting with storage time but also observed that splits tended to stabilize over time. This behavior was verified in our investigation. In this sense, Japarudin et al (2021) noted that proper silvicultural practices and an appropriate postprocessing strategy can optimize the quality and quantity of veneer and sawn board. For Espey et al (2021), economic losses due to end-splitting occur at all stages of further processing. This author reported values for *Eucalyptus grandis* and *Eucalyptus globulus* that estimated splitting losses at 6-10% of lumber production. In addition, the assessment of veneer recovery from several different eucalypts in Australia has been downgraded to D-grade quality due to veneer splitting.

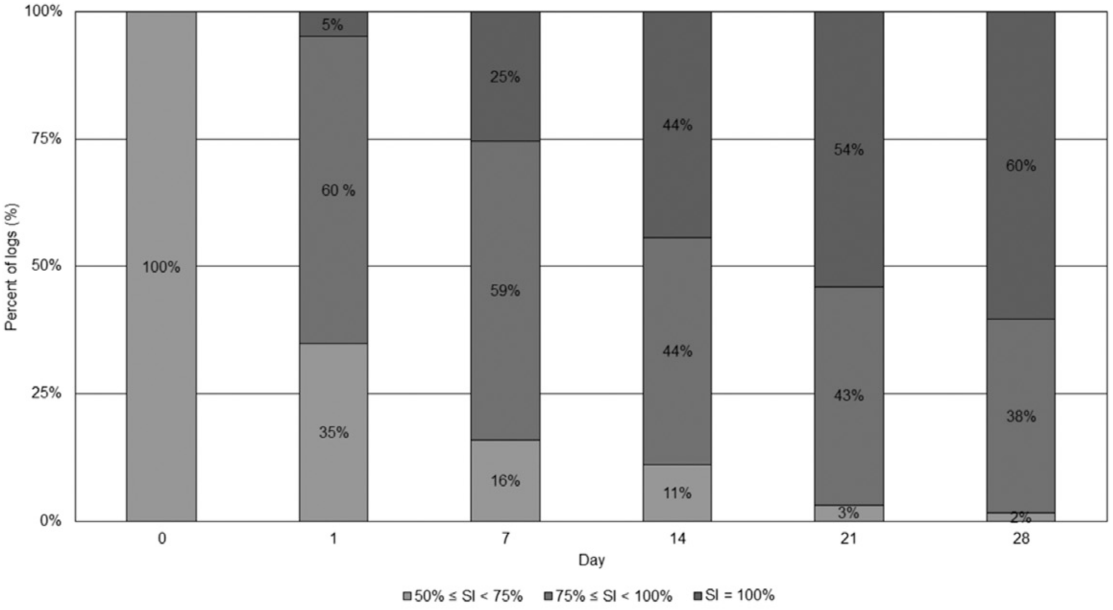


(a)

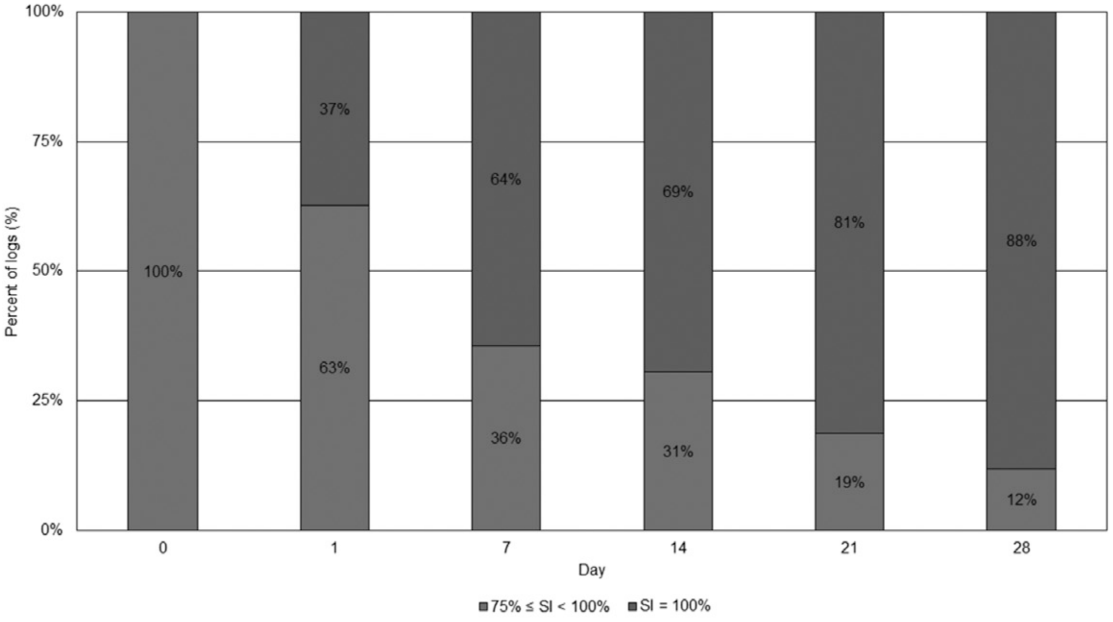


(b)

Figure 4. Splitting index (SI) increases with storage time for (a) SI < 35%, (b) 35% ≤ SI < 50%, (c) 50% ≤ SI < 75%, and (d) 75% ≤ SI < 100%.



(c) Grade C



(d) Grade D

Figure 4. (*Continued*).

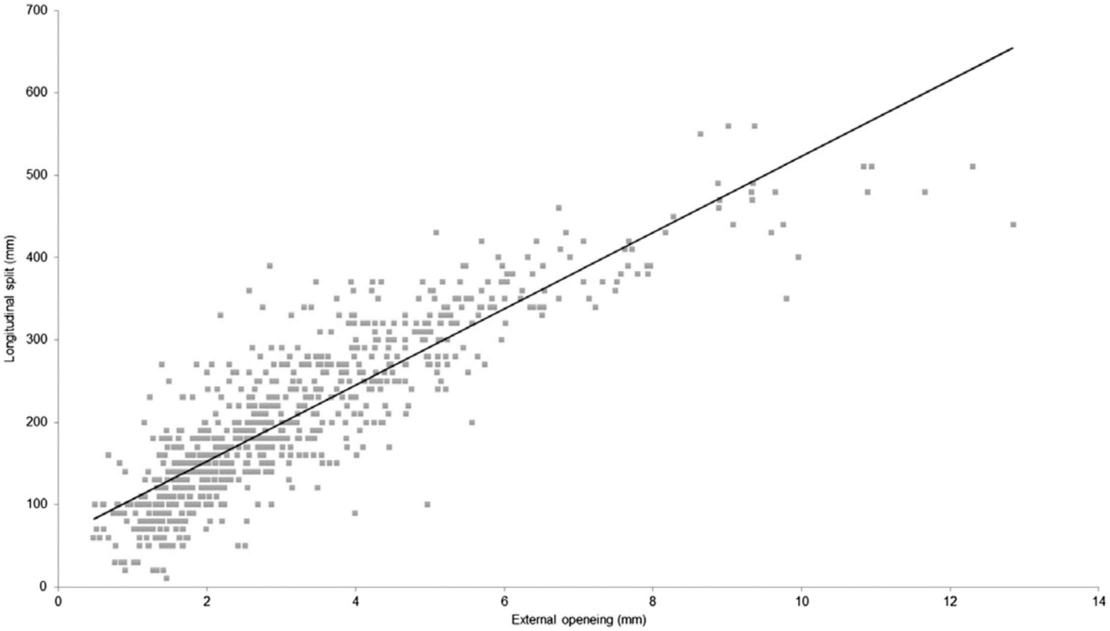


Figure 5. Longitudinal splitting (mm) and external opening (mm) in *Eucalyptus nitens* logs.

Scanavaca and Garcia (2003) and Lima et al (2004) observed a significant relationship between end-splitting and log height in different species of *Eucalyptus*. Monteoliva and Hernández et al (2014) also observed a direct relationship between the DBH measured in logs of *Eucalyptus grandis* and *Eucalyptus dunnii* and end-splitting. Chafe (1981) found a direct relationship between end-splitting and total height in *Eucalyptus regnans*, while Scanavaca and Garcia (2003), Lima et al (2004), de Fégely (2004), Lima (2005), Hernández et al (2014), and -Valencia et al (2011) observed a significant inverse relationship between end-splitting and log diameter in different *Eucalyptus* species, which they attributed to a smaller surface area over which growth stresses may be redistributed during release.

Table 5. Percentage of E-grade logs, end-splitting along the log (R_{long}), and estimated topping loss in *Eucalyptus nitens* logs.

Measurement (d)	Log	% E grade logs	A_{ext} (mm)	R_{long} (mm)	Loss due to blunting (cm)
0	A	17.5	0.491	75.91	7.6
	B	15.0	0.492	75.98	7.6
1	A	45.0	1.044	109.35	10.9
	B	35.0	1.089	112.07	11.2
7	A	65.0	4.372	310.58	31.1
	B	60.0	4.437	314.51	31.5
14	A	72.5	5.411	373.41	37.3
	B	75.0	5.224	362.11	36.2
21	A	82.5	6.354	430.43	43.1
	B	85.0	6.322	428.50	42.9
28	A	87.5	7.095	475.23	47.5
	B	87.5	6.832	459.36	45.9

Log A, log height between I = 1.3 m y and II= 5.3 m; Log B, log height between III = 5.3 m and IV = 9.3 m.

Table 6. Correlation and variance analysis for SI in *Eucalyptus nitens* logs.

Variable	Statistical	t_m	A_{Log}	D_T	DBH	A_{total}
IR	PC	0.639	−0.054	−0.016	−0.071	0.010
	p-value	<0.001[a]	0.239	0.727	0.121	0.831
	F	331.5	2.43	0.19	2.08	0.33
	p-value	<0.001[b]	0.120	0.666	0.150	0.564

[a] Significant correlation, with a significance level of 5%.

[b] Significant at a significance level of 5%, using the *F*-test.

SI, splitting index; IR, maximum split (%); PC, Pearson correlation test result; *F*, *F*-test result; *P*-value, probability; t_M, measuring time (d); A_{Log}, end of the log where R_{max} was measured (m); D_T, log diameter (cm); DAP, diameter at chest height (1.3 m); A_{total}, total tree height (m).

Despite the contradictory results and the lack of consensus, the research provides important prior knowledge about the effects of each variable on increased log end-splitting. According to the literature, growth stresses are responsible for the splits. Therefore, the results obtained will improve the understanding of factors that promote the end-splitting of *Eucalyptus nitens* logs improving forestry and mechanical transformation operations by providing information to improve decision-making for efficient use of this species.

CONCLUSIONS

Industrial use of *Eucalyptus nitens* wood is highly dependent on the initial quality of the log entering the subsequent process either sawing or peeling. In both instances the storage time should not exceed 7 d, it is recommended to use the second log with a diameter greater than or equal to 40 cm, with end-splitting less than 75% of the radius of the log (SI = $\leq 75{*}r_t$ %). A minimum oversize of 20 cm at each end of the log, and the criterion of multiple-lengths, should be adhered to.

When evaluating the behavior of end-splitting, the SI would be a more precise estimator than the R_{max}.

The linear regression model can predict the required length of blunting to prevent longitudinal end-splitting. It is recommended to oversize each end of the log by at least 20 cm and consider the criterion of multiple lengths when performing this procedure.

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