**Supplementary data**

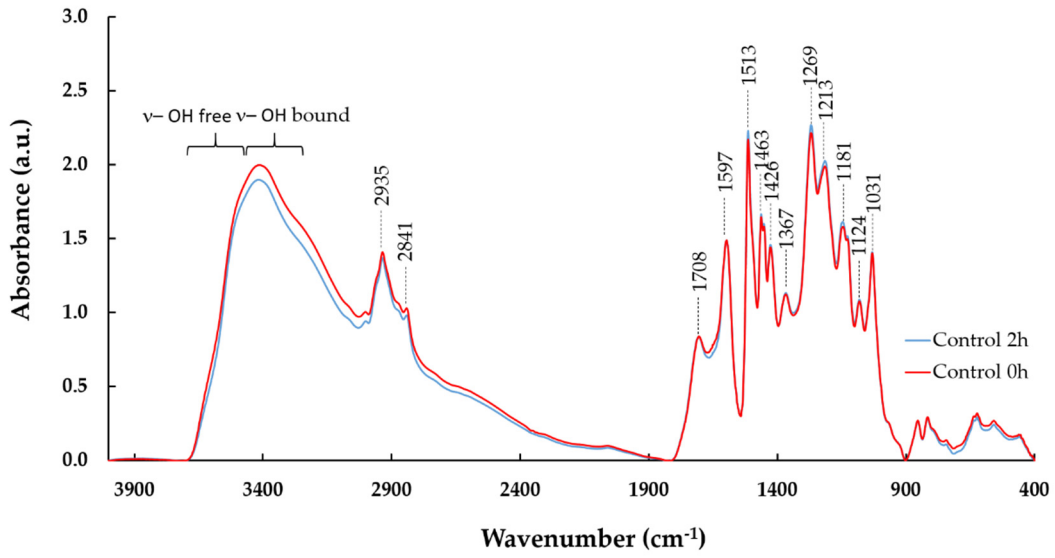



Figure S1: FTIR spectra of control kraft lignin incubated in buffer at pH 5.0 without HBT, for 0 and 2 hours.

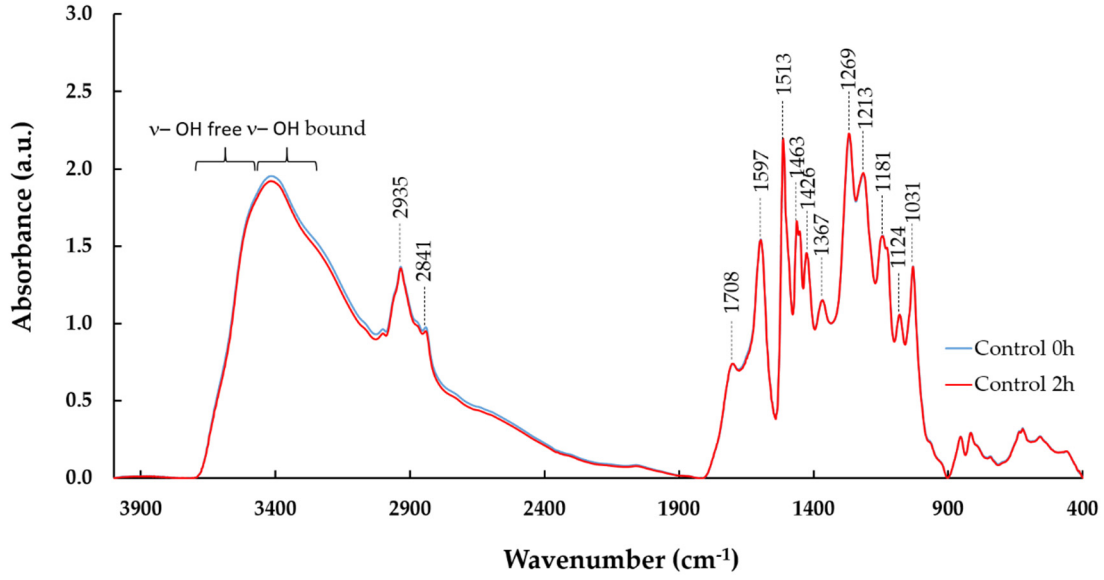



Figure S2: FTIR spectra of control kraft lignin incubated in buffer at pH 6.0 without HBT, for 0 and 2 hours.

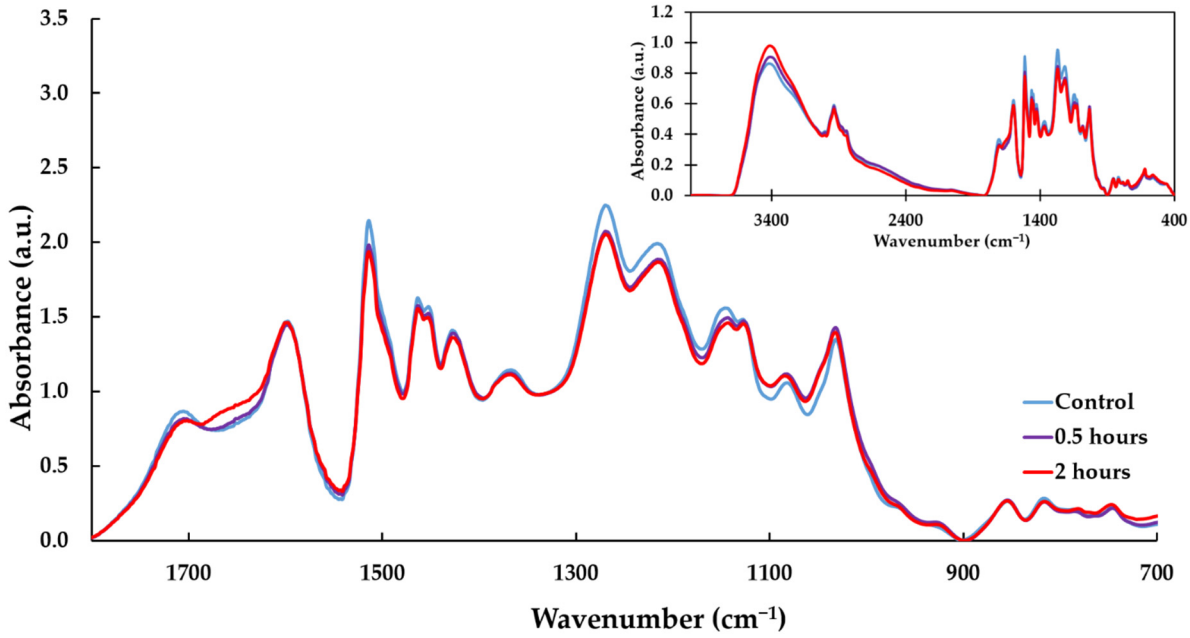
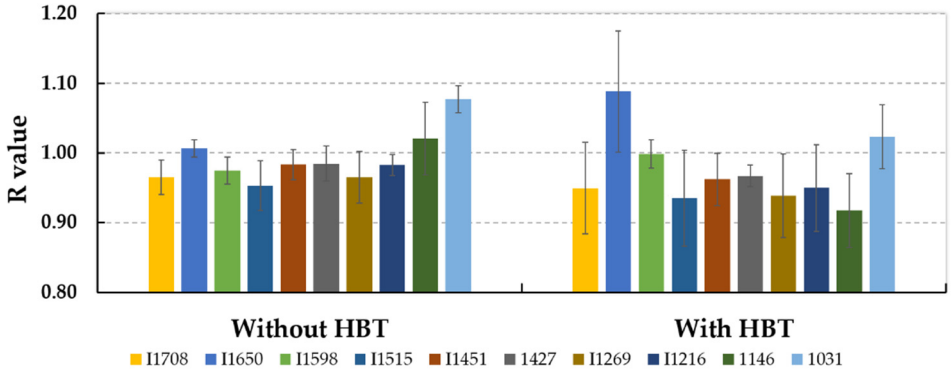



Figure S3: FTIR spectra of kraft lignin treated by *Pci*Lac with HBT (2%) for 0, 0.5 and 2 hours. Insert: full range. The vertical lines indicate the main bands of lignin detailed in Table 2.

A




B

Two way ANOVA

| | Indice | I1708 | I1650 | I1598 | I1514 | I1451 | I1427 | I1269 | I1216 | I1146 | I1031 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Laccase** | F | 5.2 | 0.9 | 2.2 | 13.4 | 5.3 | 1.7 | 11.5 | 8.9 | 5.1 | 12.9 |
| | P | 0.012 | 0.436 | 0.129 | 0.001 | 0.011 | 0.201 | 0.001 | 0.001 | 0.013 | 0.001 |
| **HBT** | F | 0.4 | 0.1 | 2.0 | 0.9 | 2.5 | 0.6 | 0.4 | 0.01 | 0.4 | 0.05 |
| | P | 0.555 | 0.754 | 0.165 | 0.344 | 0.125 | 0.450 | 0.511 | 0.933 | 0.539 | 0.825 |
| **Laccase X HBT** | F | 0.3 | 1.2 | 1.4 | 1.5 | 4.5 | 1.9 | 2.3 | 2.0 | 1.1 | 2.6 |
| | P | 0.765 | 0.304 | 0.273 | 0.236 | 0.021 | 0.163 | 0.121 | 0.151 | 0.359 | 0.091 |

: $p < 0.001$
: $p < 0.05$

Figure S4: (A) R values of 10 FTIR bands identified from loading profiles. R is the intensity ratio of each FTIR band between kraft lignin treated by *Pci*Lac (130 U/g for 2 hours) with and without HBT (2%) and the respective control. (B) Results of two-way ANOVA on 10 bands identified from loading profiles. Laccase activated lignins at pH 4.5 with 0, 13 and 130 U/g of *Pci*Lac, with and without HBT for 0, 0.5 and 2 hours. Differences vs. control were significant at F statistic > 1 and P<0.001 (red) or P<0.05 (pink).

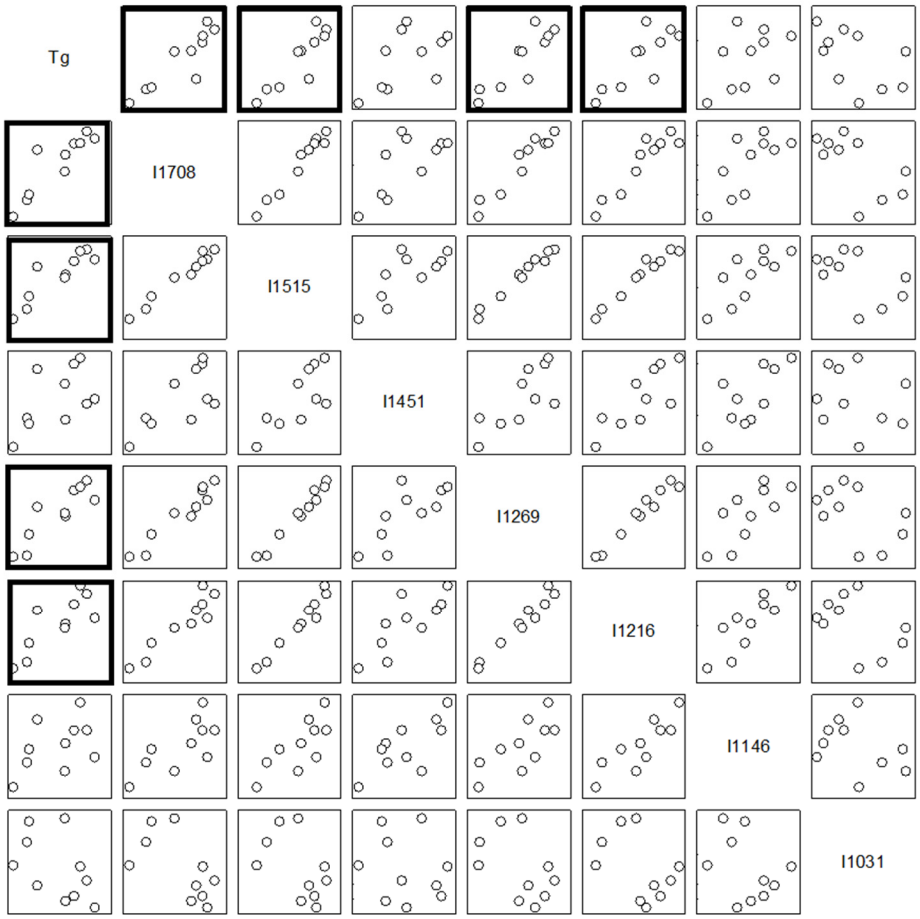



Figure S5: Scatter plot of Tg and the 7 significant FTIR bands (I1708, I1515, I1451, I1269, I1216, I1146, I1031) from figure 5c. Highlighted squares were the pair of variables with a positive correlation coefficient $R > 0.87$ and P values below 0.001, except Tg & I1216 with $R = 0.806$ and $P = 0.005$.