

Influence of citric acid on the properties of medium-density particleboard produced with tannin-formaldehyde adhesive

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Tannins are natural phenolic compounds widely found in the bark of all hardwoods and conifers. Citric acid (CA), on the other hand, is a weak organic acid found in most fruits, and can be applied as a natural adhesive in particleboard panels (PB) and as a treatment for lignocellulosic materials. Considering this, the study aimed to evaluate the influence of CA on particleboard bonded with tannin-formaldehyde. The addition of CA to tannin-formaldehyde formulations did not produce the expected effects on the properties of the pine particleboard. This behavior can be attributed to the unfavorable interaction between CA and the phenolic compounds in tannin, compromising the formation of strong, cohesive bonds.

ID	Formulation
TN0	15% tannin + 10% formaldehyde
TN2	15% tannin + 10% formaldehyde + 2% CA
TN4	15% tannin + 10% formaldehyde + 4% CA

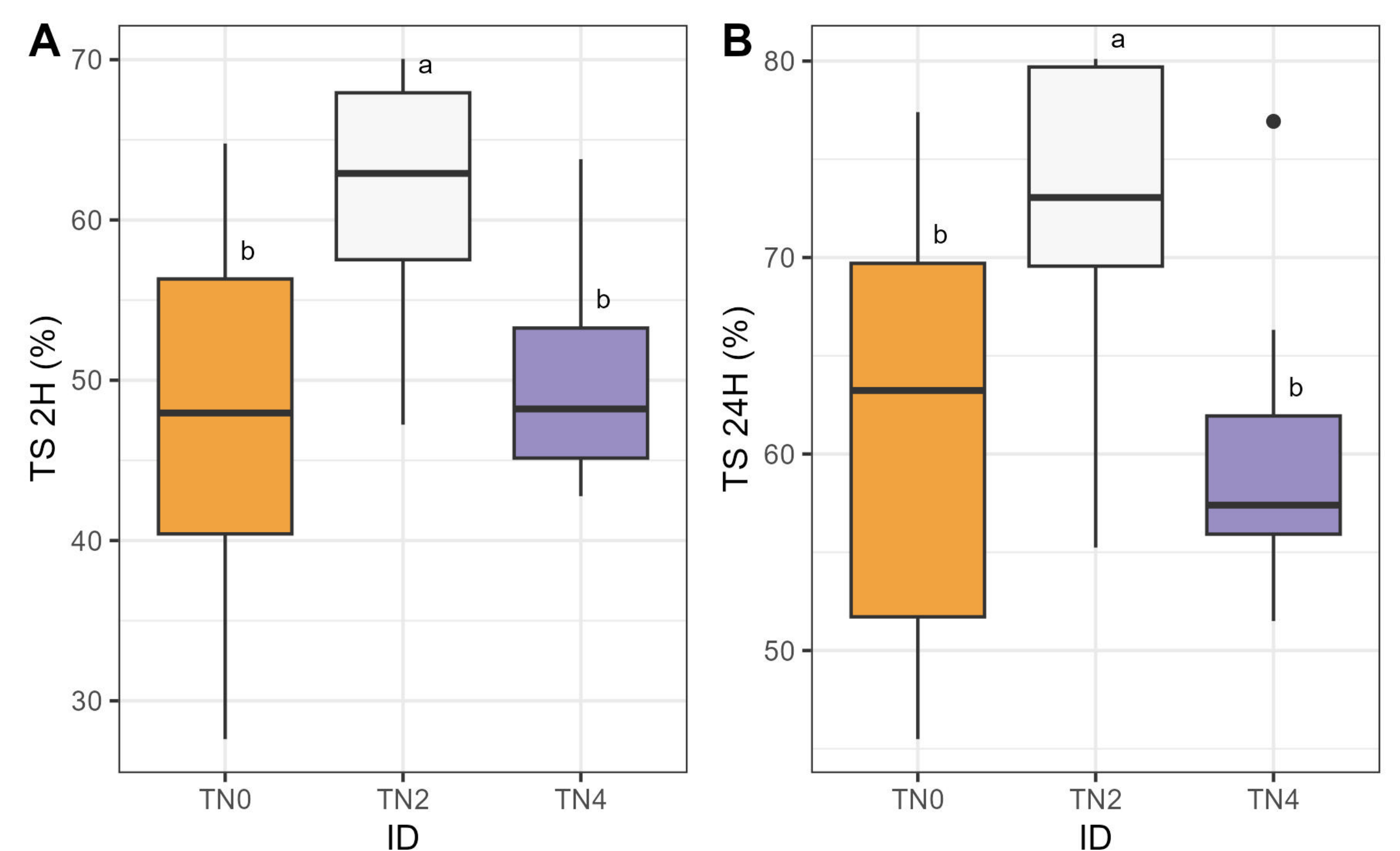
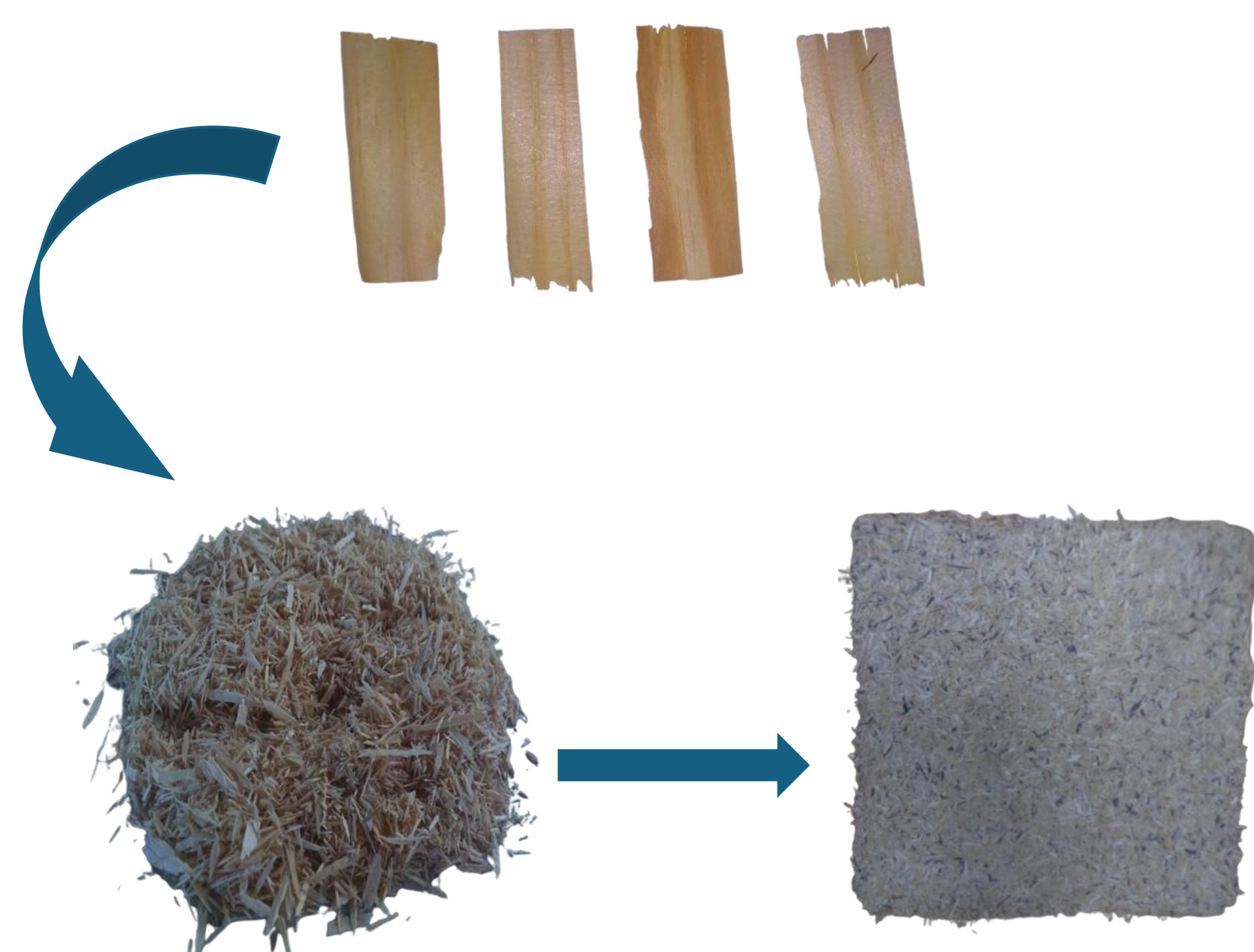


Figure 1. Thickness swelling after 2h (A) and 24h (B) of immersion in water. Means followed by the same letter are not statistically different according to Tukey's test ($n = 12$, $\alpha = 0.05$, $p \leq 0.0001$).

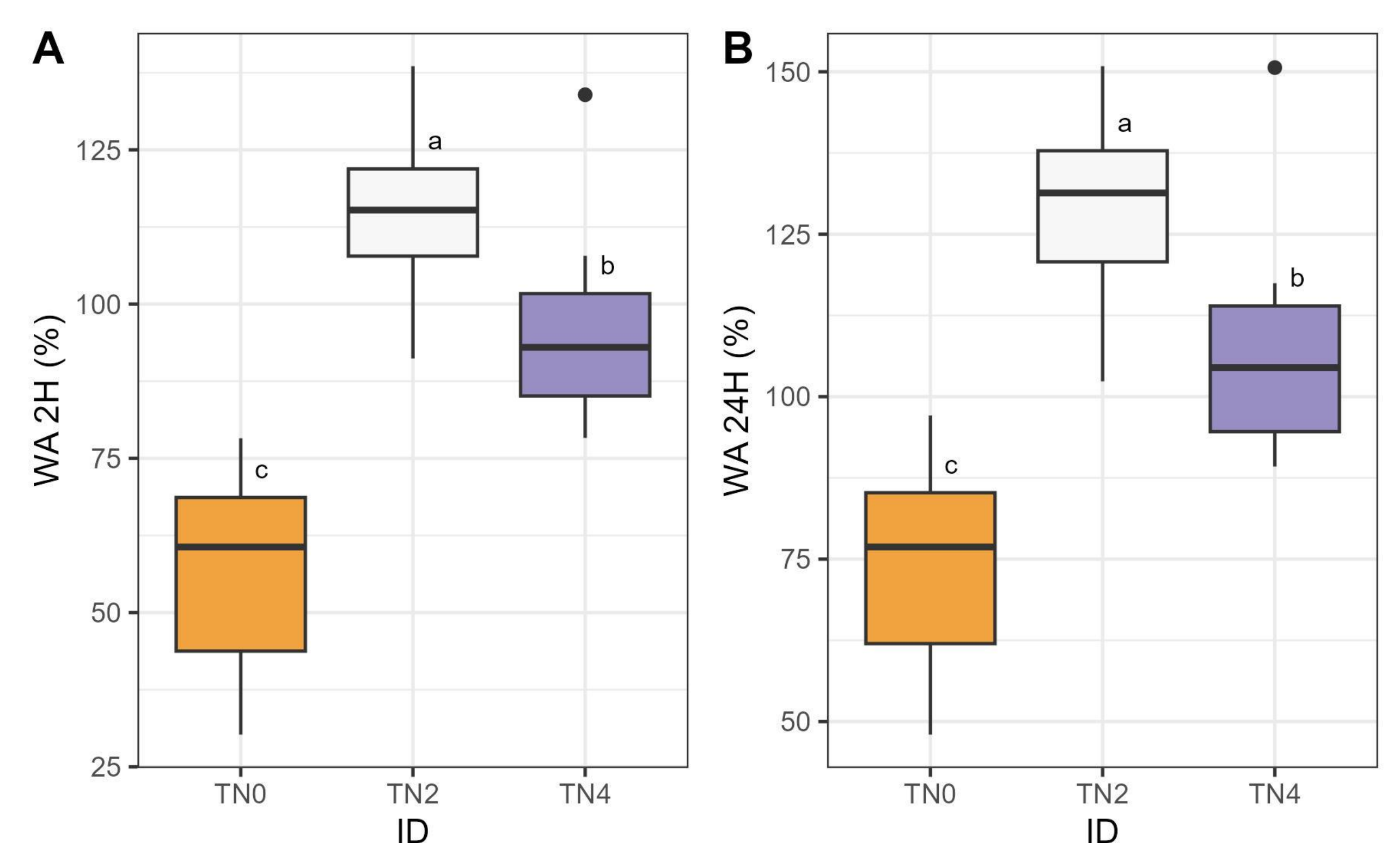


Figure 2. Water absorption after 2h (A) and 24h (B) of immersion in water. Means followed by the same letter are not statistically different according to Tukey's test ($n = 12$, $\alpha = 0.05$, $p \leq 0.0001$).

Table 1. Properties of medium-density particleboard produced with tannin-formaldehyde adhesive. Means followed by the same letter are not statistically different according to Tukey's test ($\alpha = 0.05$).

ID	Density [g/m ³]	MOE [N/mm ²]	MOR [N/mm ²]	IB [N/mm ²]
TN0	0,891 ^a (3,82)	2950,75 ^a (3,82)	24,56 ^a (3,82)	0,456 ^a (0,05)
TN2	0,678 ^b (5,01)	1215,69 ^b (3,82)	12,10 ^b (3,82)	0,232 ^b (0,04)
TN4	0,715 ^b (3,78)	1545,95 ^b (3,82)	14,53 ^b (3,82)	0,267 ^b (0,04)
<i>p-value</i>	≤ 0.0001	≤ 0.0001	≤ 0.0001	≤ 0.0001