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# Microwave drying of *Melia dubia* and its effect on mechanical properties

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## INTRODUCTION & AIM

There is an increasing interest in the advancement of technologies for expediting the drying process of wood. The prevailing trend leans towards developing technologies that are rapid, energy-efficient, and result in fewer drying defects. In this context, microwave drying proves advantageous (Balboni et al., 2018). Consequently, there has been a quest for innovative wood drying techniques. Microwave (MW) treatment has long been recognized as an efficient technique for enhancing the permeability of refractory wood species which will help in the easy movement of water in wood (Torgovnikov & Vinden, 2010). When microwaves interact with moist materials, water's dielectric properties absorb the microwave energy, converting it into heat within the material. This rapid heating accelerates the evaporation rate during the drying process. The unique heating mechanism of microwave drying could lead to quicker drying of the wood strands (Du et al., 2005). In other study, He et al., (2017), dried the *Eucalyptus urophylla* with microwave pre-treatment and found that drying rate was significantly accelerated, thus, reducing the total drying time. In a similar study, by Balboni et al. (2018), on *Eucalyptus macrorhyncha,* similar outcomes were observed, including a reduction in strength properties with higher MW intensity. In our study, we sought to understand the behavior and changes in mechanical properties under microwave drying, as well as identify the underlying factors responsible for these changes in wood characteristics.

## METHOD

**Material:** Small clear specimens of *Melia dubia* with dimensions 25 mm × 45 mm × 300 mm (hxbxl) were obtained from local market.

**Microwave Treatment:** The MW treatment was conducted using the MW with a frequency of 2.45 GHz and have the maximum power output of 900 W.

Table 1: Different microwave treatments for *Melia dubia*

| Treatment | MW power | Exposure time | Idle time |
|---|---|---|---|
| T1 | 540 W | 30 Seconds | 2 minutes |
| T2 | 540 W | 30 Seconds | 5 minutes |
| T3 | 540 W | 1 minute | 2 minutes |
| T4 | 540 W | 1 minute | 5 minutes |

**Drying Rate:** The drying rate for each treatment indicates the volume of water removed per specific time duration, as determined by following equation:

$$\text{Drying Rate (gm/minute)} = \frac{\textit{Amount of moisture removed}}{\textit{Total drying time}}$$

**Mechanical Properties:** Static Bending (Modulus of Elasticity and Modulus of Rupture and Compression Parallel to Grain (Maximum Compressive Strength) of *M. dubia* was evaluated as per Indian standard, IS: 1708; 1986, on Universal Testing Machine.

**Light Microscopy:** Wood microstructures were analyzed using light microscopy. The wood sections were examined under the Nikon polarizing microscope (Eclipse Ci-POL) connected with imaging software.

## RESULTS & DISCUSSION

The rate of moisture loss in wood varies across different stages, above the Fibre Saturation Point (FSP) and below the FSP (Table2). Despite achieving a superior drying rate in T1, T3, and T4, these treatments exhibited defects such as checks, splits, and warping. In contrast, T2, which had a lower drying rate, produced samples without defects. Thus, the samples from T2 were selected for evaluating the mechanical properties and anatomical changes (Figure 2). MW dried wood showed reduction in Modulus of Elasticity (MOE), Modulus of Rupture (MOR)) and Maximum Compressive Strength (MCS) (Figure 1).

Table 2: Moisture loss (g/min) above FSP and below FSP for all treatments

| Drying time (g/min) | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Above FSP | 0.79 | 0.4 | 1.39 | 0.77 |
| Below FSP | 0.68 | 0.29 | 0.67 | 0.39 |
| Overall | 0.74 | 0.35 | 1.11 | 0.59 |

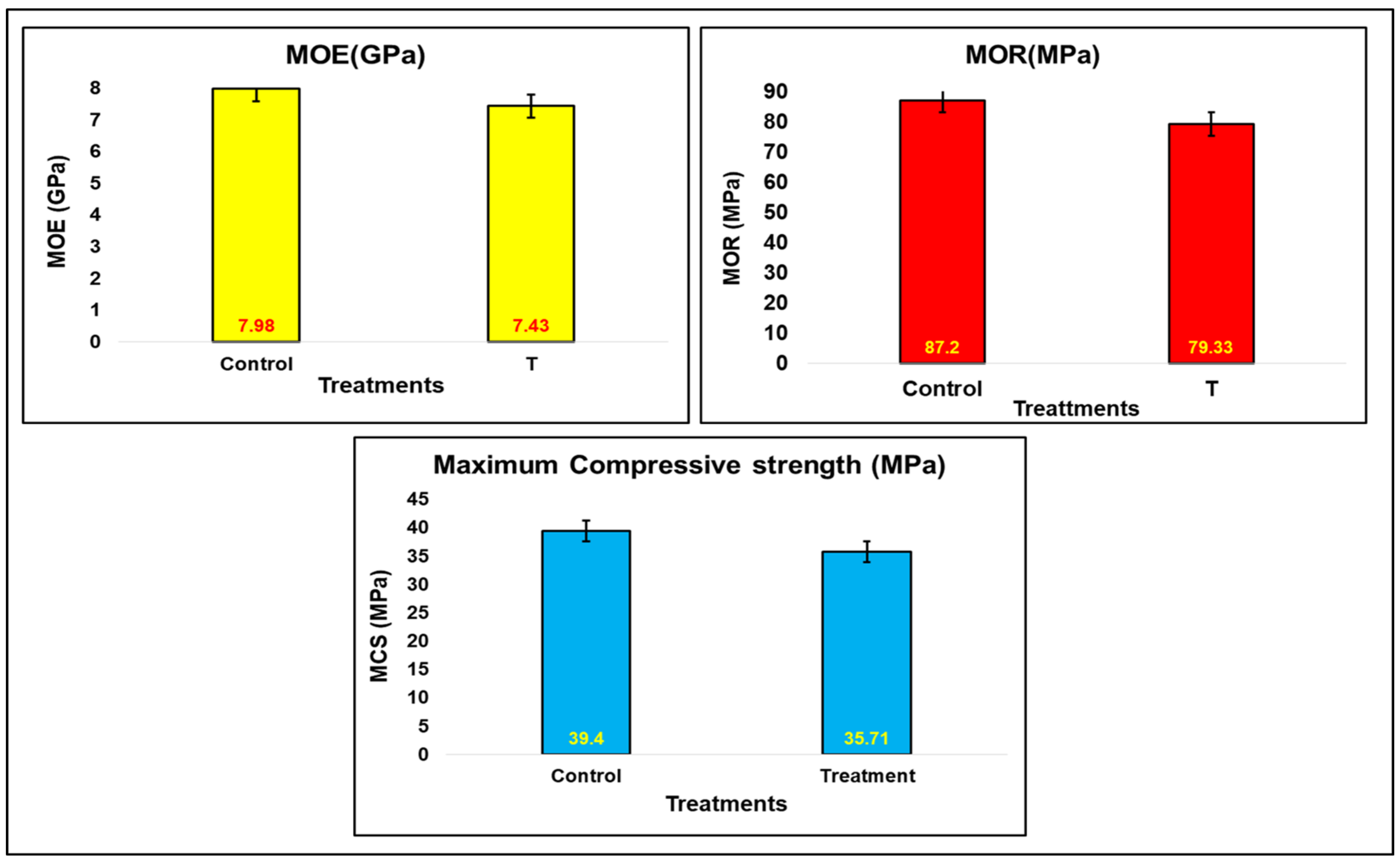


Figure 1: Figure shows the reduction in Mechanical properties. MW dried wood exhibited a reduction of 7±3%, 10±2% and 9±2% in MOE, MOR and MCS respectively.

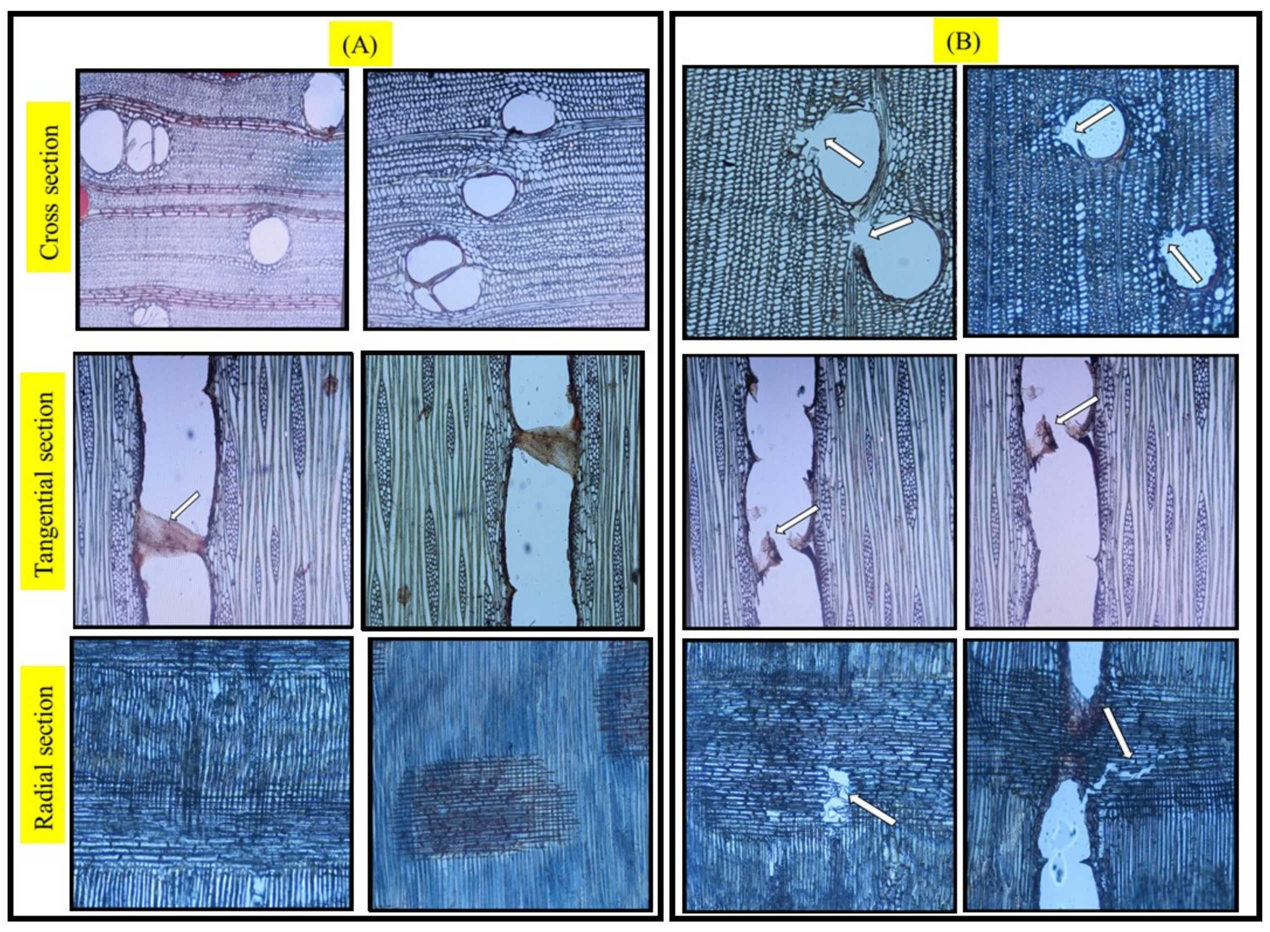


Figure.2: Light microscopy images of *M. dubia*: (A) control samples; (B) MW dried samples. The damaged perforation plates, vessel cell walls, and fractured ray cells can be seen in MW dried samples.

The decline in mechanical properties may be attributed to these micro-cracks or damage in its microstructures. Zhang and Cai, (2006) and Xia et al., (2013) noted same findings in *Abies lasiocarpa* and *Larix gmelinii* wood.

## CONCLUSION

These findings shows effect of MW exposure on wood properties. While MW drying expedited the removal of moisture, leading to reduced drying times, it concurrently introduced notable changes in the microstructure of wood. These alterations in microstructures results in diminishing mechanical properties, evident from the reductions observed.

## REFERENCES

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