Physical, Mechanical, and Thermal Properties of Heat-Treated Poplar and Beech Wood

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Air-dried density, weight loss (WL), impact bending strength (IBS), Shore-D hardness, and thermal conductivity values were determined for heat-treated poplar (*Populus nigra* L.) and beech (*Fagus orientalis* Lipsky) wood and compared with those for untreated samples. The test samples were heat-treated at 140, 160, 180, and 200 °C for 2 h. The results showed that density decreased and WL increased with increasing temperature for all temperatures. Additionally, during the heat treatment, the IBS increased in beech wood samples at 140 °C, but at higher temperatures, these values gradually decreased in both wood species. The highest decline in IBS values, found at a temperature of 200 °C, was 66.5% for beech and 55.7% for poplar. The Shore-D hardness of both wood species increased after heat treatment and regarding beech wood, the hardness increasing rate at temperature at 140 °C, 160 °C, 180 °C and 200 °C, 8.94%, 14.19%, 8.27% and 11.7%, respectively according to control samples. Regarding poplar wood, hardness increasing rates were 6.20% at 140 °C, 4.41% at 160°C, 5.88% at 180°C and 5.31% at 200°C according to control samples. The thermal conductivity of poplar and beech wood samples decreased after heat treatment, except for samples heat treated at 160 °C.

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INTRODUCTION

Although the use of wood in the construction industry dates to ancient times, it is still an important building material that is widely used in interior design and exterior decoration applications today (Uzun *et al.* 2016; Uzun and Sarıkahya 2021; Yeşil *et al.* 2021). Additionally, wood is a commonly used material in traditional buildings (Saka and Kahraman 2020; Bacak and Yaldız 2023). However, some undesirable properties, such as easy combustibility, dimensional instability due to atmospheric changes, and degradability by insects, termites, wood-destroying fungi, and marine borers, limit their application in the building and construction industry. A lot of effort is being made by experts and researchers to eliminate the disadvantages of wood material and to use it efficiently (Augustina *et al.* 2023). Different strategies have been developed to change the properties of wood material. Wood modification systems can enhance wood properties by restricting dimensional change, improving strength, and reducing susceptibility to decay (Crupi *et al.* 2023). Heat treatment is one of the modification methods widely used by researchers, as it has been successfully used to improve the properties of wood materials (Hill 2006). Heat treatment of wood is an effective method to improve the dimensional stability and durability against biodegradation, but the mechanical properties are decreased at the same time. Due to deterioration in mechanical properties, the use of heat-treated wood as load-bearing structural material should be restricted (Welzbacher *et al.* 2011; Nhacila *et al.* 2020). Welzbacher *et al.* (2008) densified Norway spruce (*Picea abies* Karst.) by the OHT-process and concluded that compression-set recovery of densified and oil-heat treated spruce was almost completely eliminated by an OHT at temperatures above 200 °C. Wood heat treatment has increased significantly in the last few years and is still growing as an industrial process to improve some wood properties (Esteves and Pereira 2009). In addition, heat-treated wood material has an increasing trend use in interior and exterior applications such as flooring, siding, claddings, decking, interior of saunas, wall paneling, windows, doors, and garden furniture (Jirouš-Rajković and Miklečić 2019).

Wood is mainly composed of cellulose, hemicellulose, lignin, and extractive substances, which are chemical compounds in varying degrees depending on the species. As a result of heat treatment, the wood undergoes significant changes in its chemical composition. The physical and mechanical properties of wood material are significantly affected by changes in these compounds (Korkut and Budakcı 2010). There are some heat treatment parameters (such as exposure period, temperature, heating medium, wood moisture content, and atmospheric pressure) influencing the properties of wood, and these parameters interact with each other (Korkut and Hiziroglu 2009). A better knowledge of the properties of heat-treated wood material, which is increasingly used in interior and exterior decoration applications, will contribute to its efficient use in buildings. For this purpose, besides impact bending strength (IBS), hardness and thermal conductivity are also important properties. Impact bending strength is the ability of wood to absorb energy through impact bending and generally represents the material's durability (Gaff *et al.* 2019). Hardness is an important wood property for several applications, which is closely related to density and is one of the most important indicators of wood material strength (Esteves *et al.* 2021; Oral 2023). Thermal efficacy is a parameter that measures the thermal property of materials and is often denoted as k, which is defined as the heat transfer rate through a unit thickness of the material per unit area per unit temperature difference and influenced by density, porosity, moisture content, and mean temperature difference of material (Kol and Gündüz Vaydoğan 2023). Wehsener *et al.* (2023) studied combination of delignification and densification to enhance bending strength and ASE of poplar (*Populus nigra* L.) wood. The delignification procedure was done at 100, 130, or 150 °C for 7 h and then samples were compressed at 100, 130, or 160 °C for 4, 20, or 24 h. Test results showed that bending strength increases up to 450 MPa compared to the densified reference of 250 MPa and the untreated poplar of 65 MPa.

Kol and Gündüz Vaydoğan (2023) investigated thermal conductivity values of the heat-treated beech (*Fagus orientalis* Lipsky) and pine (*Pinus sylvestris* L.) wood. They reported that the thermal conductivity values of the heat-treated woods decreased as the heat- treatment temperature increased. In addition, Pelit *et al.* (2017) studied the effects of densification and heat treatment on the thermal conductivity of fir (*Abies bornmulleriana* Mattf.) wood and reported a significant decrease in all specimens depending on the increase in treatment temperature.

Although there are differences in the hardness values of wood materials, some researchers have reported that the hardness values decrease, depending on heat treatment conditions (Ulker *et al.* 2018; Esteves *et al.* 2021). On the other hand, Shi *et al.* (2007) reported an increase or decrease in the hardness of heat-treated spruce (*Picea* spp.), pine

(*Pinus* spp.), fir (*Abies* spp.), aspen (*Populus* spp.), and birch (*Betula* spp.), depending on the species, test directions, and treatment conditions.

Exposure of wood to heat treatment makes it more fragile and rigid, so its mechanical strength decreases (Korkut and Bektas 2008). Concerning the impact bending strength, Korkut and Hiziroglu (2009) studied the effect of heat treatment on impact bending strength and found that increasing treatment temperature and duration decreased impact bending strength. In another study, Kaygın *et al.* (2009) studied the effect of heat treatment on some mechanical properties, including the impact bending strength of Paulownia (*Paulownia elongata*) wood, and reported that the highest IBD decrease was 87.0% at 200 °C for 7 h. Although heat treatment is known as an effective wood modification method, the use of heat-treated wood material in indoor and outdoor applications is increasing (Kol and Gündüz Vaydoğan 2023). Thermal conductivity, hardness, and impact bending strength are important properties of construction materials. The mechanical properties of heat-treated wood material have been examined in detail in the literature.

However, studies on thermal conductivity, hardness, and impact bending strength are relatively limited. Also, the properties analyzed in this study have been examined separately in the literature in different wood species and under different heat treatment conditions.

This study aimed to determine the effect of thermal modification at different temperatures (140, 160, 180, and 200 °C) on the thermal conductivity, hardness, and impact bending strength of poplar (*Populus nigra* L.) and beech (*Fagus orientalis* Lipsky) wood species.

EXPERIMENTAL

Poplar (*Populus nigra* L.) and beech (*Fagus orientalis* Lipsky) wood species were randomly obtained from a local sawmill in Simav, Kütahya, Türkiye. Poplar and beech woods are widely used in the woodworking and furniture industry, and they are among the materials that are increasing in popularity in interior and exterior decoration applications. For this reason, they were preferred as experimental material in the study. The samples with the dimensions of 25 mm × 120 mm × 450 mm (tangential x radial x longitudinal) were prepared from the sapwood region of kiln-dried lumbers. The test samples were prepared according to the ISO 3129 (2019) standard from regular woods, without rot and knots, and the samples were randomly chosen from first-class timbers, without color differences or density variations.

The first group was used as a reference (control) and did not undergo heat treatment. Heat treatments were carried out at four temperatures, namely 140, 160, 180, and 200 °C for 2 h in a laboratory-type (Nüve FN 120) heating chamber controlled at an accuracy of ± 1 °C under atmospheric pressure. Temperatures were measured and controlled from the digital display of the heat treatment oven. Temperatures over 140 or 150 °C alter the physical and chemical properties of wood permanently, and therefore for the test samples were heat treated at 140, 160, 180, or 200 °C in this study. After heat treatment, treated and control samples were conditioned in a climate device (Nüve ID 501) with a relative humidity of 65 ± 5% and a temperature of 20 ± 2 °C for 4 weeks before testing.

After heat treatment, test samples were prepared from the boards according to the relevant standards. The density of treated and control samples was determined by the ISO

13061-2 (2014) standard. The sample size was 30 mm × 20 mm × 20 mm (longitudinal × radial × tangential). Ten replicates were used for each treatment condition of temperature. The air-dry density values of test samples were calculated according to Eq. 1,

$$D_{12} = \frac{W_{12}}{V_{12}} \text{ (g/cm}^3\text{)} \tag{1}$$

where D_{12} is the air-dried density (g/cm^3), W_{12} is absolute the air-dried weight (g), and V_{12} is absolute the air-dried volume (cm^3).

Weight loss (WL) (%) of test samples were calculated according to Eq. 2,

$$\text{WL} = \frac{(W_{ut} - W_t)\ x\ 100}{W_{ut}} \tag{2}$$

where W_{ut} is the absolute dry weight of the sample before the heat treatment (g), and W_t is the absolute dry weight of the sample after the heat-treatment (g). Ten replicates were tested for every treatment level.

Impact bending strength (IBS) was determined with five test specimens with the dimensions of 20 mm × 20 mm × 300 mm (radial direction, tangential direction, and axial direction-the longitudinal direction (L) is parallel to the fiber grain) according to the ISO 3348 (1975) standard and according to Eq. 3,

$$\text{IBS} = \frac{Q}{bxh}\ (kj/m^2) \tag{3}$$

where IBS is impacting bending strength (kj/m^2), Q is absorbing energy (kj), b is width of the test specimen (mm), and h is thickness of the test specimen (mm). Twenty-five replicates were tested for every treatment level. The IBS test device is shown Fig. 1.

Fig. 1. IBS test device used in test measurements

Fig. 2. Shore-D hardness device used in test measurements

The Shore-D hardness measurements of all control and heat-treated samples were done according to the ISO 868 (1985) standard. Test samples with dimensions of 20 mm × 50 mm × 100 mm were used. A Shore-D hardness device (Tronic-Model PD801) (Fig. 2) was used for measurements. All hardness tests were carried out on the tangential surface of test samples. Twenty-five replicates were tested for every treatment level.

Thermal conductivity measurements of control and treated samples were determined according to the ISO 8302 (1991) standard in a thermal conductivity measurement device (Linseis HFM 300). The properties of the thermal conductivity testing device are given in Fig. 3. Test samples were assembled from control and heat-treated boards and finally cut to dimensions of 20 mm × 300 mm × 300 mm. The temperatures of the hot plate and cold plate were 20 and 15 °C, respectively. Three samples were prepared for each measurement and tested for every treatment level. Thermal conductivity measurements were carried out after the test samples were kept at 20 ± 2 °C and 65 % ± 5 relative humidity for 3 weeks.

Fig. 3. Thermal conductivity device used in test measurements

Statistical Analyses

The MSTAT-C software package (Michigan State University, USA) was used for the statistical analysis of the data. Analysis of variance (ANOVA) was performed to determine whether there were any significant differences among the experimental groups. If the factor effects were significant with a margin of error of $P \leq 0.05$, comparisons were carried out using the Duncan test.

RESULTS AND DISCUSSION

The factor with the most significant effect is the wood species for the D12 values and the thermal modification temperature for the WL values (Table 1). The wood species, thermal modification temperature, and the interaction between the wood species and thermal modification temperature have a statistically insignificant effect on D_{12} and WL values.

The mean D_{12} and WL values of poplar and beech samples are summarized in Table 2. The density of both heat-treated wood samples was lower compared with control ones for all temperature ranges. This result corresponds with the previous studies that conducted heat treatment on other wood species (Tuncer and Doğu 2018; Yılmaz Aydın and Aydın 2020; Kol and Gündüz Vaydoğan 2023). The density decrease after the heat treatment was statistically significant compared to the initial values. The mean values were significantly different (Table 2).

Table 1. Influence of Factors and Their Interaction on Density and WL According to ANOVA

Properties	Source of variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prop (P)
Density	Factor A	1	1.528	1.528	8018.8396	0.0000
	Factor B	4	0.032	0.008	41.7866	0.0000
	A*B	4	0.006	0.002	8.2818	0.0000
	Error	90	0.017	0.000		
	Total	99	1.583			
WL	Factor A	1	19.360	19.360	880.2666	0.0000
	Factor B	4	327.889	81.972	3227.1445	0.0000
	A*B	4	9.967	2.492	113.2957	0.0000
	Error	90	1.979	0.022		
	Total	99	359.196			

Notes: Factor A: Wood species; Factor B: Thermal modification temperature; A*B = Interaction of wood species and thermal modification temperature; P value is less than 0.05, it is judged as significant.

According to these results, the highest decrease in density values was seen in the heat-treated samples at 200 °C for both wood species. After the heat treatment, the density of samples generally decreases due to the thermal-induced degradation of wood components. After the thermal treatment, the density decreased by 3.4%, 5%, 6.6%, and 7.7% for the poplar samples and decreased by 4.3%, 6.5%, 8.9%, and 11.5% for the beech samples heat-treated at 140, 160, 180, and 200 °C, respectively. Decreasing wood density according to the different heat treatment temperatures occurred due to the degradation of wood components during the treatment process, specifically removing volatile contents (extractives, low molecular weight components) through chemical reactions occurring during the process (Esteves and Pereira 2009).

Table 2. Average Density and WL Values of Poplar and Beech Woods

Wood species	Heat Treatment	D_{12} (g/cm^3)		Weigt Loss (%)	
		Mean	SD	Mean	SD
Poplar	Control	0.378F	0.0218	-	-
	140 °C	0.365G	0.0107	0.64H	0.0596
	160 °C	0.359H	0.0069	1.48F	0.1220
	180 °C	0.353I	0.0159	2.95D	0.1487
	200 °C	0.349J	0.0074	4.16B	0.2423
Beech	Control	0.649A	0.0157	-	-
	140 °C	0.621B	0.0066	1.03G	0.1401
	160 °C	0.607C	0.0177	2.71E	0.1516
	180 °C	0.591D	0.0088	3.93C	0.1904
	200 °C	0.574E	0.0163	5.96A	0.2043

Notes: Means within a column followed by the same capital letter are not significantly different 0.05 significance level using Duncan test. SD is standard deviations. Means are average of ten replications.

Weight loss amounts for poplar and beech wood after heat treatment are shown in Table 2. Weight loss was lowest at 140 °C and increased significantly as the temperature increased for both wood samples. The percentage increase in WL of beech was greater than poplar. Hardwood species generally experience greater weight loss following heat treatment than softwood species (Esteves and Pereira 2009). The WL increase after the heat treatment was statistically significant compared to the initial values. The mean values were significantly different (Table 2). Hill *et al.* (2021) reported that wood species and heat treatment conditions are effective in weight loss after heat treatment. They also noted that hardwoods exhibited higher weight loss than softwoods under identical conditions.

In addition, Srinivas and Pandey (2012) reported that maximum weight loss occurred after heat treatment at 240 °C for 8 h and they also attributed the weight loss to the removal of bound water and extractives from wood material. Hidayat *et al.* (2015) further ascribed wood weight loss to hemicellulose degradation during heat treatment. Regarding WL, all differences were statistically significant (Table 2). The influence of factors and their interaction on IBS, hardness, and thermal conductivity according to ANOVA are given in Table 3.

According to Table 3, wood species, thermal treatment temperature, and dual interaction of these factors on the IBS values were significant ($P \leq 0.05$). The effects of heat treatment in different temperatures on IBS, hardness, and thermal conductivity are shown in Figs. 4 to 6, respectively.

Table 3. Influence of Factors and Their interaction on IBS, Hardness, and Thermal Conductivity According to ANOVA

Properties	Source of variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prop (P)
IBS	Factor A	1	8939.967	8939.967	113.6162	0.0000
	Factor B	4	8106.098	2026.524	25.7547	0.0000
	AB	4	3963.232	990.808	12.5920	0.0000
	Error	90	7081.709	78.686		
	Total	99	28091.006			
Hardness	Factor A	1	11343.424	11343.424	688.6628	0.0000
	Factor B	4	883.184	220.796	13.4046	0.0000
	AB	4	288.096	72.024	4.3726	0.0000
	Error	240	3953.200	16.472		
	Total	249	16467.904			
Thermal Conductivity	Factor A	1	0.016	0.016	333.0817	0.0000
	Factor B	4	0.001	0.000	3.0999	0.0388
	AB	4	0.000	0.000	0.7182	NS
	Error	20	0.001	0.000		
	Total	29	0.018			
NS: not significant						

Figure 4 shows the average IBS values of poplar and beech samples. The increase in IBS values was caused by treatment at a temperature of 140 °C for beech samples. When the temperature was further increased to 160 °C, the IBS values began to decline, and this trend continued. The IBS performance of the poplar samples after thermal treatment decreased as the heating temperature increased. The effect of the temperature on poplar wood was less pronounced and had a smaller effect on IBS than on beech wood. Beech wood is affected by heat treatment more than poplar wood. Regarding the beech wood, the IBS values thermally treated at 140 °C increased by 33% compared to control samples. With a further temperature increase, the IBS gradually declined, and at 160 °C, its value was 5.2% lower compared to control samples. In addition, at 180 °C, the IBS decreased to 46.6%, and the maximum decrease was 66.5 % at 200 °C in comparison with control samples.

Regarding the poplar wood, at 140 °C, the IBS decreased by 35.5 % and although the downward trend slowed down thereafter, the highest IBS reduction was 55.7% at 200 °C. Compared to control samples, IBS reduction was 39% at 160 °C and 50.6 % at 180 °C. Based on these results, it is thought that the wood was made more brittle by the heat treatment in impact bending. Generally, the performance of mechanical strength change found in this work was like those reported in the literature (Kaygın *et al.* 2009; Ninane *et al.* 2021). Gaff *et al.* (2019) also found that the maximum decrease in IBS in European oak (*Quercus robur* L.) and Norway spruce (*Picea abies* (L.) H. Karst.) wood samples were 32.2% and 39.8% at treatment conditions of 210 °C, respectively. They also reported that, at higher temperatures, the decrease in IBS correlates with the degradation of hemicelluloses, and it is assumed that the content and structure of hemicelluloses are the main reason for the increase. The decreases in the strength properties can be explained by the rate of thermal degradation and losses of mass as a result of the treatment process. This is mainly due to the depolymerization reactions of wood polymers (Kotilainen 2000). In addition, Phuong *et al.* (2007) reported that wood became more brittle after exposure for a longer time or to higher temperatures. Brittleness could reach 60% or equivalent to four times higher than untreated wood for the most severe conditions of 200 °C and 12 h.

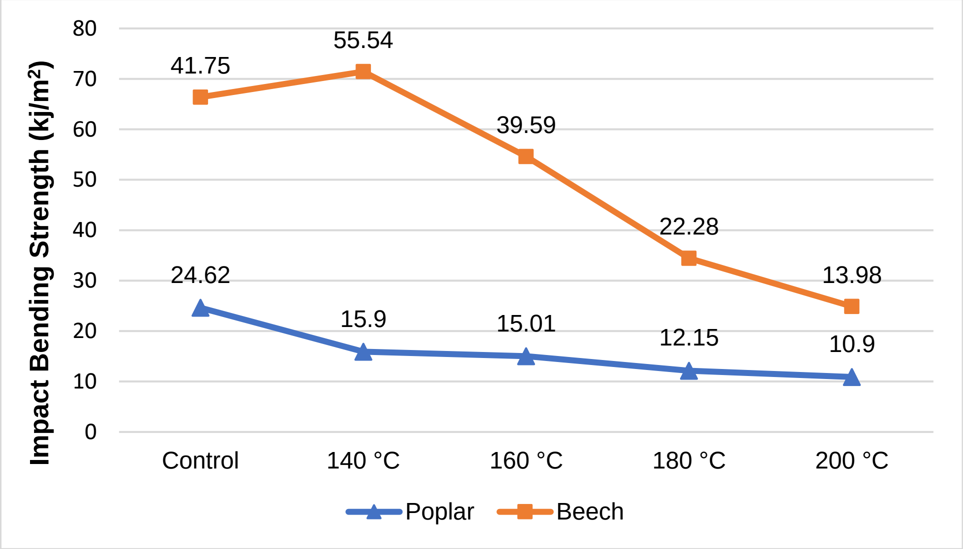

Fig. 4. Average IBS values of thermally treated poplar and beech samples

According to Table 3, wood species, thermal treatment temperature, and dual interaction of these factors on the hardness values were significant ($P \leq 0.05$). Figure 5 shows the hardness (tangential surface) values caused by thermal degradation. There were some differences in hardness due to heat treatment temperature and wood species. The hardness values of beech wood are higher than poplar wood. Both treatment temperature and wood species affected the hardness values, and hardness values increased slightly after heat treatment in both wood species.

The thermal treatments had a significant influence on the Shore-D hardness of poplar and beech woods. Regarding beech wood, the increase in hardness at temperatures of 140, 160, 180, and 200 °C were 8.94%, 14.19%, 8.27% and 11.7%, respectively according to control samples. Regarding poplar wood, hardness increases were 6.20% at 140 °C, 4.41% at 160 °C, 5.88% at 180 °C and 5.31% at 200 °C relative to control samples.

The increase in strength and hardness of thermally treated wood is attributed to chemical condensation between polysaccharides and lignin (Sundqvist 2004). Different reports on hardness variation in thermally treated woods have been given in the literature. Dubey (2010) mentioned that oil-heat-treated *Pinus radiata* wood at 160 °C showed increased hardness in the tangential surfaces by 4.3% compared to the untreated samples. Boonstra *et al.* (2007) found that the hardness of air-heat-treated Scots pine (*Pinus sylvestris* L) wood increased by 48% parallel to the grain and by 5% perpendicular to the grain. Cao *et al.* (2012) reported that the hardness of steam-heat-treated Chinese fir (*Cunninghamia lanceolata* (Lamb) Hook) wood increased at temperatures below 200 °C, compared to the untreated samples. Suri *et al.* (2022) studied *Paulownia tomentosa* and *Pinus koraiensis* wood samples heat-treated in oil and air. They reported that the hardness of the transverse and tangential surfaces of *Pinus koraiensis* wood significantly increased at 180, 200, and 220 °C for 1 and 2 h.

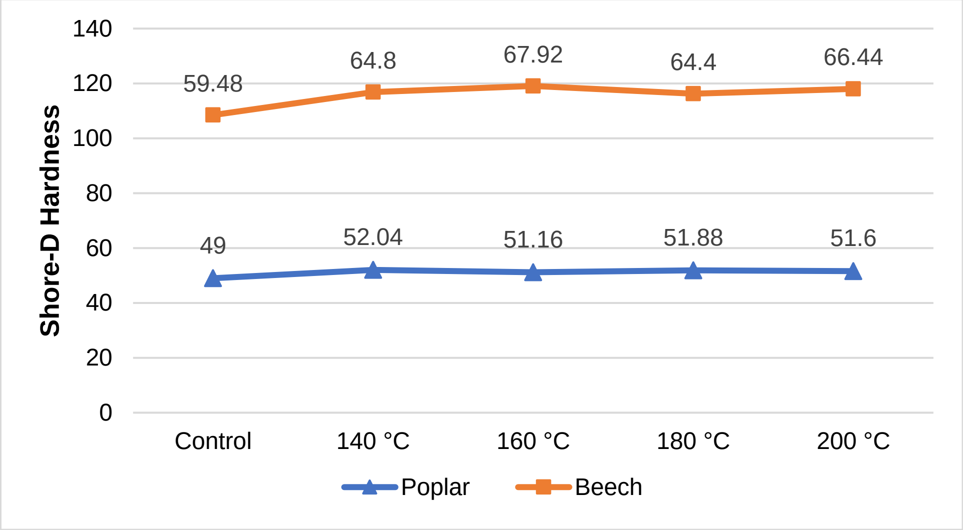

Fig. 5. Hardness (tangential surface) of thermally treated poplar and beech samples

According to Fig. 6, thermal conductivity changes are similar in both wood types, depending on the same heat treatment conditions. Thermal conductivity decreased in poplar and beech wood samples after heat treatment, except for samples heat-treated at 160 °C. At 160 °C, the thermal conductivity values of the heat-treated poplar and beech samples were slightly higher than the control samples. The treatment at 160 °C caused a statistically insignificant change in thermal conductivity compared to the initial values. According to Table 3, the factor with the most significant effect was the wood species for the thermal conductivity values. The heat treatment temperature was effective at a lower level, but the interaction between the wood species and thermal modification temperature was not statistically significant on thermal conductivity (Table 3). The thermal conductivity of wood is affected by density, moisture content, extractive content, grain direction, temperature, and structural irregularities such as knots (Korkut *et al.* 2013).

The thermal conductivity of beech samples increased with increasing density, with a clear distinction between the two species (Fig. 6). The density values of both wood species decreased with increasing heat treatment temperature. As a result of the high temperatures applied to the wood during the thermal treatment, some permanent changes or degradation occur in the structure of the chemical compounds of wood (Kocaefe *et al.* 2008; Tümen *et al.* 2010; Sikora *et al.* 2018). Thermal degradation of the chemical compounds of wood occurs first in hemicelluloses and then in cellulose and lignin (Yang *et al.* 2007). The degradation of the wood chemical components during the heat treatment results in lower density and more air in the material. This determines the lower thermal conductivity of the heat-treated material, which means better insulation properties (Olarescu *et al.* 2015).

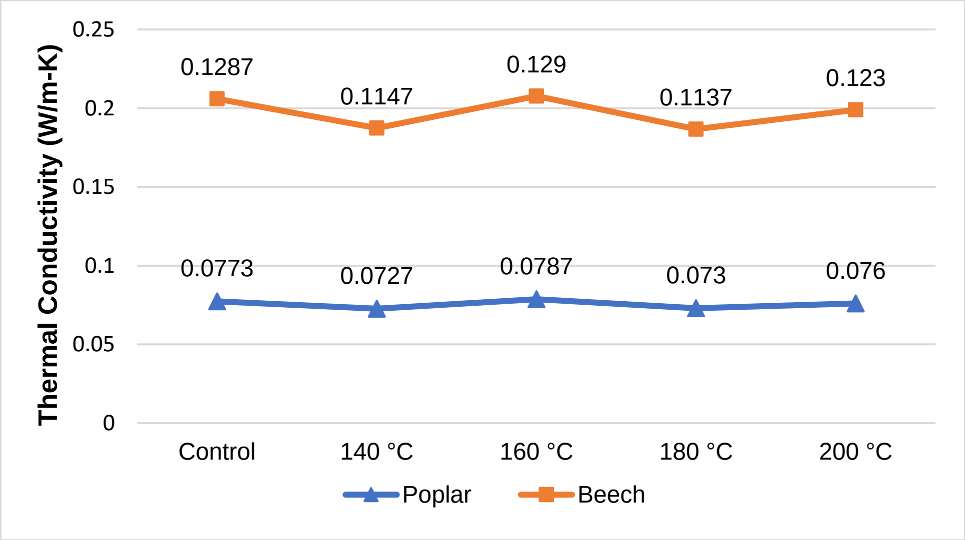

Fig. 6. Thermal conductivity of thermally treated poplar and beech samples

Srivaro *et al.* (2019) studied the effect of heat treatment at 180 °C for 15, 25, and 35 h on the thermal conductivity of rubberwood (*Hevea brasiliensis*) specimens. The result showed that the thermal conductivity of untreated rubberwood and heat-treated rubberwood increased with increasing temperature for all durations as a linear relationship in which the values of heat-treated rubberwood were lower at all examined temperatures. They also noted that heat-treated rubberwood for 35 h was less sensitive to temperature compared with the untreated samples, showing a relatively small change of thermal conductivity with temperature, while the others were similar to the untreated wood.

Thermal conductivity properties of different wood types and heat treatment conditions have been analyzed previously in the literature. Pásztory *et al.* (2017) studied changes in the thermal conductivity and density of Pannónia poplar and spruce woods caused by heat treatment at 180 °C for 15, 25, and 35 h. They reported that treatment duration had a different impact on the density and thermal conductivity of poplar and spruce. They also reported a decrease in the thermal conductivity with the duration of heat treatment in spruce and poplar wood at 180 °C, but even this treatment affected the thermal conductivity of spruce and poplar wood. In addition, Pásztory *et al.* (2020) studied the thermal conductivity properties of paulownia wood after heat treatment. They reported that although the density decreased at 180 °C, the thermal conductivity value did not change; however, as the temperature increased, the thermal conductivity decreased. Kol and Sefil (2011) researched heat-treated fir (*Abies bornmülleriana* Mattf.) and Oriental beech (*Fagus orientalis* Lipsky) woods at different temperatures (170, 180, 190, 200, 212 °C) for 2 h and thermal conductivity was observed after the heat treatment. They noted that thermal conductivity generally decreased with increasing heat treatment temperature, the effect of heat treatment temperature on thermal conductivity was the same for fir and beech, and the lowest thermal conductivity was determined at 212 °C for beech samples (0.1556 for tangential and 0.1564 for radial directions).

CONCLUSIONS

1. The results indicate that the impact bending strength (IBS) of all heat-treated samples decreased compared with the control (untreated) samples, and the IBS generally decreases with increasing heat treatment temperature. The IBS value of the beech samples increased at 140 °C, and then the IBS decreased at all temperature values in both wood types.
2. The Shore-D hardness of heat-treated wood species increased, and the maximum increase was determined as 14.19% at 160 °C for beech and 6.20% at 140 °C for poplar samples according to control (untreated) samples.
3. The thermal conductivity behavior of poplar and beech wood according to heat treatment temperature was relatively similar. Thermal conductivity of both wood species decreased with heat treatment temperature except for samples heat treated at 160 °C. The thermal conductivity of heat-treated beech wood was higher than that of heat-treated poplar wood.
4. The value of weight loss (WL) increased with increasing heat treatment temperature, and the maximum weight loss ratio was realized at 200 °C in both wood species, as 4.16% for poplar and 5.96% for beech wood.
5. The density of both wood species decreased with an increase in heat treatment temperature, reaching a maximum decrease of 7.7% for poplar and 11.5% for beech wood samples at 200 °C.

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