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Properties of heat-treated ash wood

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Abstract. Ash wood is characterised by high mechanical and technological properties and has a beautiful texture, which leads to a high demand for furniture and joinery products made from it. However, the widespread and rapid spread of the fungal disease *Hymenoscyphus fraxineus* (chalar necrosis) and the invasive beetle *Agrilus planipennis* caused massive dieback of ash trees. All of this led to the transformation of healthy wood during one year into low-quality "deadwood" and limited its use in industry. The objective of the research was to investigate specific properties of ash deadwood subjected to sterilisation through high-temperature treatment using various thermal regimes. To renew its use, it is proposed to use sterilisation without the addition of chemicals by thermal modification at temperatures of 185 °C (schedule 1) and 195 °C (schedule 2), which does not impair the environmental properties of wood. The physical, mechanical, and technological properties of heat-treated 'deadwood' ash and healthy wood dried at a temperature of $t \leqslant 70$ °C were studied. It has been determined that the equilibrium moisture content of heat-treated 'deadwood' ash wood decreased by 3.5-4.0% compared to healthy wood; the density at actual moisture and in a completely dry state decreased by 8-12% and by 4-9%, shrinkage in the transverse direction by 53-67%; the bending strength decreased by only 6% in the case of schedule 1 and by 20% in the case of schedule 2. The static hardness in both the tangential and radial directions had an unexpected trend – an increase of 9-12% when using schedule 1 and a decrease of 1.7-13% when treated by schedule 2. The weight loss of samples of heat-treated 'deadwood' ash wood was 60-90% less than the weight loss of healthy wood. The accuracy factor of all experimental studies did not exceed 5%. The results obtained make it possible to effectively choose the use of heat-treated 'deadwood' ash wood under schedule 1 in joinery and furniture products, and treated under schedule 2 in furniture products such as tabletops, as there is a decrease in the relevant mechanical properties. The use of both treatment modes allows the use of low-cost ash wood in products that are used outdoors

Keywords: 'deadwood'; heat treatment; physical properties; strength; hardness; biostability

Introduction

The current environmental crisis, including climate change, has a significant impact on forests. Massive dieback of trees, in particular, of the ash (*Fraxinus excelsior*), caused by the fungal disease *Hymenoscyphus fraxineus* (chalar necrosis) and the invasive emerald ash borer (*Agrilus planipennis*), was recorded in a number of European countries as early as 2002. In Ukraine, since 2019, ash trees have been affected by halar necrosis and emerald ash borer, which makes the trees susceptible to infestation by the ash tree beetle *Hylesinus spp*. It is believed that the fungus *Hymenoscyphus fraxineus* may have entered Western Ukraine from Poland as early as 1994 (Davydenko *et al*., 2022).

M. Pugovytsia (2020) established that a characteristic appearance of chalara necrosis is the death of individual branches and further drying out of the tree. The first sign of an ash tree infection with this fungus is the appearance of white spots on the leaves or 'deadwood tops'. Despite extensive research, no effective way to combat the fungus has yet been found. Moreover, according to scientists, there are currently about 2 million km^2 of infected trees in Europe. The other threat is the emerald ash borer, for which ash has become an ideal breeding ground.

The larvae of the beetle penetrate the tree trunk and feed on its sap, and the speed of spread of this pest is impressive – 41 km per year. These pests are leading to large-scale dying of forests in Europe, increasing the amount of so-called 'dead wood'. In addition, such wood is often infected with wood-staining fungi, which creates difficulties for its use in industry.

Studies of ash tree mortality across various geographical locations, including England, Scandinavia, and the Baltic States, have provided valuable insights into the long-term effects of Chalara dieback (*Hymenoscyphus fraxineus*) on European ash (*Fraxinus excelsior*). Research has shown that the disease leads to high mortality rates, with regional variations influenced by climate, forest management practices, and the genetic resilience of local ash populations. For instance, long-term monitoring in Latvia recorded a maximum mortality rate of 69.4% in 2017, reflecting the devastating impact of the pathogen on ash populations in the Baltic region (Davies, 2017). Similarly, studies in Denmark have shown even more severe consequences, with up to 90% of ash trees being lost due to the disease (Coker *et al.*, 2022). These findings align with broader European trends, where mortality rates continue to rise as the pathogen spreads and trees experience progressive decline. While some individual trees have demonstrated tolerance or partial resistance, large-scale losses threaten the ecological and economic value of ash woodlands. T. Coker *et al.* (2018) highlighted the need for conservation efforts and breeding programmes to enhance resistance within ash populations, as well as adaptive forest management strategies to mitigate the ongoing decline.

As the share of affected ash wood increases every year, the question is raised as to the need for its efficient and rational use in industry. One of the most promising approaches to improving the quality of ash 'dead wood' is its sterilisation. The European standards UNE EN 113-1:2021 (2021) and UNE EN 113-2:2021 (2021) recommend the use of such methods of sterilisation of damaged wood as steam treatment, gamma irradiation and ultra-high frequency current. The use of gamma irradiation and microwave insecticide has a positive effect, but the equipment for their implementation is quite expensive. In addition, the latter method is used mainly for disinfection of finished products during restoration (Appiah-Kubi *et al.*, 2021; Brischke *et al.*, 2022). The most common and environmentally friendly treatment is wood heating.

The Ministry of Agrarian Policy and Food of Ukraine regulates phytosanitary measures for wooden packaging material, which involve heating wood to a temperature of 56 °C for at least 30 minutes (Pyvovarov, 2024). Similar recommendations were given in the work by D. Jones *et al*. 2019). For complete sterilisation of wood, higher temperatures are used – over 110°C (Candelier & Dibdiakova, 2020), which leads to its thermal modification.

H. Pleschberger *et al*. (2014) researched that thermal modification of wood occurs when the material is heated in the temperature range of 120-240°C. This causes the wood to become a richer, darker colour, which creates the effect of expensive woods such as walnut or mahogany. This change can effectively hide the effects of fungal infestation, which is common in 'dry wood', giving the material a uniform appearance and masking possible stains or discoloured areas. In addition to masking defects, the heat treatment process increases the aesthetic appeal of wood, as the new colour makes it visually richer, which is especially appreciated in furniture production, decorative panels, flooring and other interior elements. Most thermal modification processes, even at moderate temperatures, reduce the hygroscopicity of wood, i.e. its ability to absorb moisture from the air. As a result of the loss of hygroscopic hemicellulose polymers during thermal modification, the equilibrium moisture content decreases, and swelling and shrinkage are reduced accordingly. According to B. Marcon *et al*. (2022), this leads to improved dimensional stability and resistance to biodegradation. On average, the equilibrium moisture content is reduced to about half the value of untreated wood. The hygroscopicity of thermally modified wood can vary significantly depending on the process parameters.

G. Milić *et al*. (2023) noted that the process of thermal modification of wood leads to a decrease in its density and mass, and the higher the modification temperature, the greater the decrease in these properties. Moreover, a greater decrease in wood density and its mass was observed for samples with a higher density and at a higher processing temperature. According to G. Milić *et al*. (2023), thermal modification affects the anatomical structure of wood, the chemical composition and structure of the wood cell wall change at the molecular level. Chemical reactions can be activated inside the cell walls at high temperatures: hydrolysis of acetyl groups in xylans produces acetic acid; hemicelluloses depolymerise into oligomeric and monomeric links without increasing crystallinity and further dehydrate to aldehydes in acidic conditions, which leads to less hydroxyl groups and lower hygroscopicity; lignin, as the most inactive component, can be broken down to form phenolic groups. S. Amirou *et al*. (2019) noted that thermally modified wood gets a more porous structure with an increase in the number and size of pores.

According to J.F. Herrera-Builes *et al*. (2021), compared to untreated wood, thermally modified wood becomes more fragile, showing lower strength in bending, compression and tension, which limits its use in engineering structures This was explained by a decrease in weight, degradation of hemicellulose. However, the study of the effect of different temperatures on the mechanical properties of pine (*Pinus oocarpa*) by H. Pleschberger *et al*. (2014) detected an increase in mechanical properties and, according to the authors, it is associated with cross-linking of the lignin network and cellulose rearrangement and crystallisation, which strengthen the middle layer. This led to the idea of using thermally modified pine (*Pinus oocarpa*) wood in engineering products.

Despite some contradictions in the results of the study of the mechanical properties of thermally modified wood by J.F. Herrera-Builes *et al.* (2021), the use of elevated processing temperatures for sterilisation of dry wood affected by pests is relevant, as the absence of sugars (hemicelluloses) and a significant amount of moisture necessary for the survival of fungi increase its biostability. In addition, the heat treatment process does not add any chemicals to the wood and is an environmentally friendly alternative to metal-based preservatives used to protect wood.

The rapid growth in the production of thermally modified wood due to improved biological stability furniture, dimensional stability, and thermal conductivity has led to its use for building facing, decking, joinery, and products used indoors, such as floors, panels, furniture (Scheiding *et al*., 2022).

The aim of the study was to determine some properties of ash ‘dead wood’ sterilised by treatment under high temperatures in different schedules. To achieve this aim, the following tasks were set:

- to determine the values of actual moisture content, equilibrium moisture content, density and shrinkage of heat-treated ash ‘dead wood’ by different schedules;

- to determine the values of the static bending strength, hardness and stability in soil of heat-treated ash ‘dead wood’ by different schedules.

The scientific novelty is to determine the possibilities of using heat-treated ash ‘dead wood’ in furniture and joinery products.

Materials and Methods

For the study, samples of ash wood the first year’s decay, ‘dead wood’ heat-treated at 185°C – schedule 1 and 195°C – schedule 2 for 40 hours, as well as samples of unaffected ash wood dried at a temperature of $t \leqslant 70°C$ were used as control samples (C). All samples (total 310 samples) had a clear orientation of the annual layers (tangential or radial) in cross-section. The method of DSTU 4922:2008 (2009) was used to determine the actual moisture content of the samples. The actual moisture content, W, %, was calculated by the formula:

$$W = \frac{m_1 - m_0}{m_o} 100\%, \tag{1}$$

where m_1 – mass of the sample before drying, g; m_0 – mass of the absolutely dry test sample, g. To determine the equilibrium moisture content of ash wood, the method P. Mitchell (2018) was used, according to which the samples were dried to absolutely dry moisture ($W = 0\%$) and then kept indoors for 50 days. The samples were weighed periodically. The test was considered complete when the samples stopped changing weight. The moisture content, W_p, %, was calculated using the formula:

$$W_p = \frac{m_f - m_0}{m_o} 100\%, \tag{2}$$

where m_f – mass of the sample after aging for 50 days, g; m_0 – mass of the absolutely dry test sample, g. The density of the samples at actual moisture content, ρ_w, g/sm^3 was determined and calculated according to DSTU EN 408:2007 (2009):

$$\rho_w = \frac{m_w}{V_w}, \tag{3}$$

where m_w – sample mass at actual moisture content, g; V_w – sample volume at actual moisture content, sm^3. To determine the density of absolutely dry samples, ρ_0, g/sm^3, was used the formula:

$$\rho_0 = \frac{m_0}{V_0}, \tag{4}$$

where V_0 – sample volume in an absolutely dry state, sm^3. The shrinkage of the samples was determined according to the method of ISO 4469:1981 (1982). The following formulas were used to calculate the amount of shrinkage in the tangential, β_t, %, and radial, β_r, %, directions:

$$\beta_t = \frac{a_{t_W} - a_{t_0}}{a_{t_W}}, \tag{5}$$

$$\beta_t = \frac{a_{t_W} - a_{t_0}}{a_{t_W}}, \tag{6}$$

where a_{tW}, a_{rW} – dimensions of samples at actual moisture content in the tangential and radial directions, mm, a_{t0}, a_{rW} – dimensions of samples at absolutely dry moisture content in the tangential and radial directions, mm. To determine the static bending strength, we used the method described in ISO 13061-3:2014 (2014). The strength was calculated using the formula:

$$\sigma_w = \frac{3P_{max}l}{2bh^2}, \tag{7}$$

where σ_w – tensile strength of the sample at actual moisture content, MPa; P_{max} – maximum load, N; l – distance between the centres of the supports, mm; b, h – sample height and width, mm. The bending strength at three-point loading was determined using a universal testing machine P5 (LTD “ASMA-PRYLAD”, Ukraine) (Fig. 1).

Figure 1. Visualisation of tests of samples to determine the static bending strength
Source: compiled by the authors

The static hardness was determined by the method of the recovered impression of a depressed spherical indenter according to ISO 13061-12:2017 (2017). The calculation of the hardness of the samples, H_w, N/mm^2, at actual moisture content was determined by the formula:

$$H_w = \frac{P}{\frac{\pi D}{2}\cdot\left(D-\sqrt{D^2-d^2}\right)}, \tag{8}$$

where P – applied load, kPa; D – ball diameter, mm; d – print diameter, mm. The stages of determining the static hardness of ash wood samples in the tangential and radial directions by the method of the depressed spherical indenter are shown in Figure 2. The results of indentation on different samples are shown in Figure 3.

Figure 2. Visualisation of static hardness tests of ash wood samples
Source: compiled by the authors

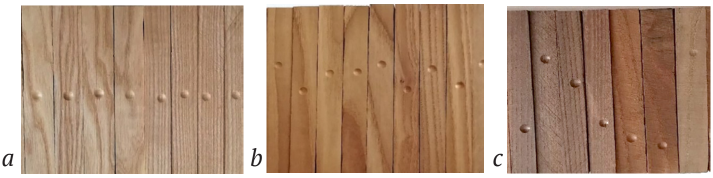

Figure 3. Imprints of the indenter on ash wood samples
Note: a – control samples C; b – samples treated by schedule 1, c – samples treated by schedule 2
Source: compiled by the authors

The determination of wood stability in soil conditions was determined by the loss of their mass after placing control samples and thermally modified samples of ash 'dead wood' in a special container for 60 days (Sirko *et al.*, 2024). The mass loss of the samples, Δm, %, was calculated by the formula:

$$\Delta m = \frac{m_{01} - m_{02}}{m_{01}} 100\%, \quad (9)$$

where m_{01} – mass of the sample in an absolutely dry state before placing it in a container with soil, g; m_{02} – mass of the sample in an absolutely dry state after placing it in a container with soil, g. To determine the stability of wood in soil conditions, ash wood samples dried to an absolutely dry state (Fig. 4a) were stored in soil (Fig. 4b). The soil moisture content was maintained at 60-70% by periodic moistening.

The number and dimensions of the test specimens for one series of tests, due to the methods used, are given in Table 1.

a *b*

Figure 4. Placement of samples for decay resistance testing

Note: a – drying ash wood samples to an absolutely dry state in a thermostat at a temperature of 103 ± °C; b – holding ash wood samples in a container with soil

Source: compiled by the authors

Table 1. General characteristics of test areas

The property under study	Sample dimensions, mm	Quantity, pcs.
Actual moisture content	20 × 20 × 30 (length)	25
Equilibrium moisture content	20 × 20 × 30 (length)	25
Density of the samples at actual and absolutely dry moisture content	20 × 20 × 30 (length)	16
Shrinkage in the transverse direction	20 × 20 × 30 (length)	16
Static bending strength	20 × 20 × 300 (length)	35
Static hardness	20 × 20 × 150 (length)	23
Stability of wood in soil conditions	20 × 20 × 5 (length)	15

Note: dimensions and number of test specimens

Source: developed by the authors

Accordingly, three times as many samples were used for the study, taking into account the treatment schedule of 'deadwood' and unaffected wood. To determine the actual and equilibrium moisture content, the samples were weighed (Fig. 5a), then placed in a laboratory drying oven SNOL67|150 LTD "TermoLab", Ukraine (Fig. 5b) and dried at 103 ± 2°C to a constant weight. The actual moisture content of the samples was calculated using formula (1).

a *b*

Figure 5. Example of weighing (a) and drying of test samples (b)
Source: compiled by the authors

Results and Discussion

The actual moisture content of the samples was calculated using formula (1). The results of determining the actual moisture content of the samples are shown in Figure 2, which shows that the heat-treated wood had almost 3-4 times less moisture. Similar results were obtained C. Hill *et al*. (2021) when determining the moisture content of different species of wood, indicating the removal of not only adsorption moisture, but also chemically bound and decomposition of anatomical elements. After storing the absolutely dry samples in a room with the following climatic parameters: temperature t = 22°C, relative humidity φ = 65%, their equilibrium moisture content was calculated using formula (2). The calculation results are shown in Figure 6.

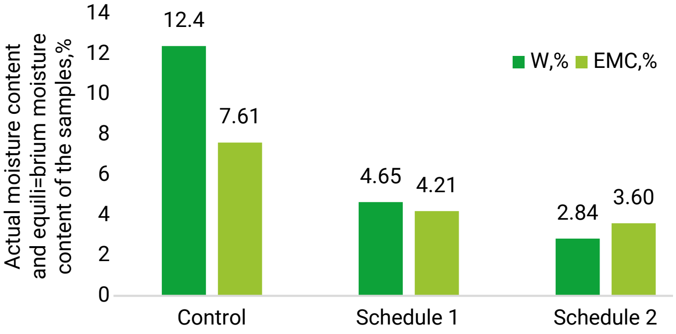

Figure 6. Results of determining the actual and equilibrium moisture content of ash samples
Source: compiled by the authors

There is a significant decrease in the equilibrium moisture content of heat-treated wood by almost 50%, which is consistent with the results of numerous studies conducted on different species of wood (Candelier & Dibdiakova, 2020; Hill *et al*., 2021). This is due to a change in chemical properties when wood is exposed to high temperatures, which leads to a decrease in the hygroscopicity of wood. The results of determining the density of ash samples at actual moisture content and in an absolutely dry state are shown in accordance with formulas (3) and (4) in Figure 7.

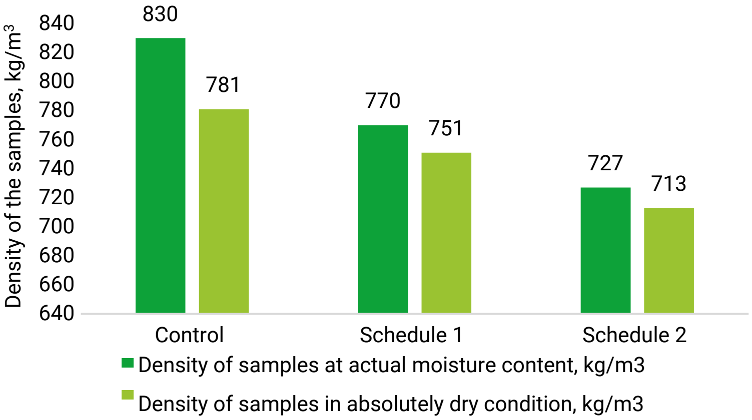

Figure 7. Density values of ash wood samples at actual moisture content and in an absolutely dry state

Source: compiled by the authors

The results obtained are consistent with those of previous researchers G. Milić *et al*. (2023), which were carried out on other wood species, but have a similar tendency to decrease in density when high processing temperatures are used, as this leads to changes in the morphological, chemical and physical properties of the wood cell wall. The amount of shrinkage of the samples in the tangential and radial directions was calculated using formulas (5-6), and the visualisation of the property changes depending on the heat treatment is shown in Figure 8.

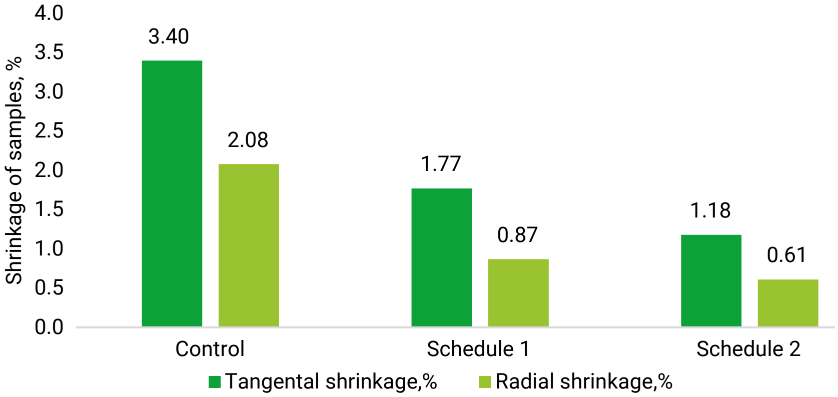

Figure 8. The amount of shrinkage of ash samples in the tangential and radial directions

Source: compiled by the authors

According to S.Y. Zhang *et al*. (2021) the amount of wood shrinkage directly depends on its density, decreasing with decreasing density. The same tendency is observed in the case of heat treatment of wood (Xu *et al*., 2019; Nhacila *et al*., 2020). The average values of the tensile strength of the tested samples calculated by (7) are shown in Figure 9.

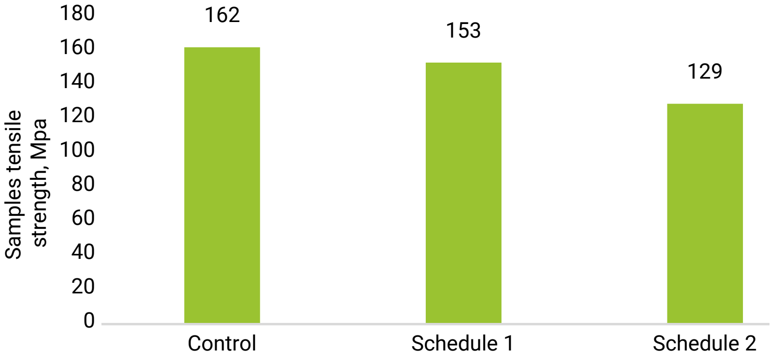

Figure 9. Tensile strength values of ash wood samples

Source: compiled by the authors

In the case of heat treatment under schedule 1, a minor decrease in strength was observed – only 6%. The insignificant decrease in strength was probably due to the connection of lignin fibres and cellulose crystallisation under the influence of elevated temperature. Similar results were obtained in C. Hill *et al*. (2021) when determining the mechanical properties of heat-treated *Pinus oocarpa* wood at a processing temperature of 170°C. The authors believe that such wood can be used for construction purposes. The results of calculation of static hardness are shown in Figure 10.

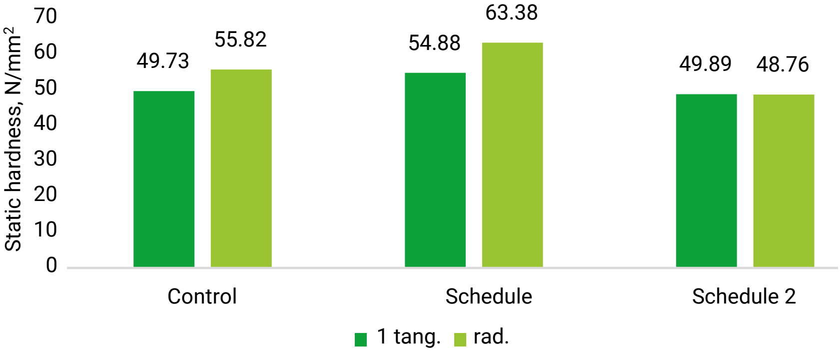

Figure 10. Hardness values of ash wood samples

Source: compiled by the authors

The hardening of microfibres due to cellulose crystallisation at high temperatures, as well as an increase in the relative proportion of lignin (Hill *et al*., 2021) during the processing of ash wood, almost did not reduce its hardness, which also adds weight to the above statement about the possibility of using thermally modified wood in some structural products. Information on a similar situation with the hardness of wood, even when treated at a temperature of 200°C, is given in the works by W. Moliński *et al*. (2016) and G. Milić *et al*. (2023). The results of calculating the mass loss of ash wood samples according to (9) are shown in Figure 11.

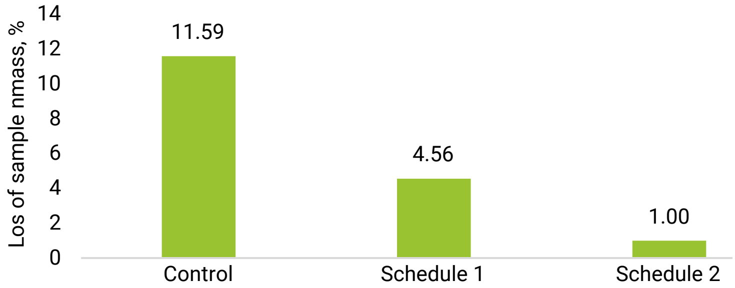

Figure 11. Average mass loss values of ash samples

Source: compiled by the authors

The positive effect of thermal modification of ash wood on biostability is visible, which is characterised by a significantly lower mass loss (2.5 times – 11.5 times, depending on the treatment temperature) compared to untreated ash 'dead wood'. A small mass loss (< 2%) of samples of fungus-infested plywood made of birch and beech wood after heat treatment at 215°C was observed in the work by J.B. Paes *et al.* (2021). This is consistent with the results of current studies. Based on the results of the tests, the following statistical characteristics were determined: standard deviation (± S), coefficient of variation (V, %), accuracy (P, %) for control samples (C) and samples treated at a temperature of t = 185°C (1) and t = 195°C (2). The average values of the obtained characteristics for different types of tests are given in Table 2.

Table 2. Average values of statistical characteristics

Type of test	± S			V, %			P, %		
	Schedules								
	C	1	2	C	1	2	C	1	2
Equilibrium moisture content, %	0.1	4.21	0.12	1.32	13.6	3.23	0.33	3.4	0.1
Actual moisture content, %	0.28	0.3	0.43	2.27	6.38	!5.1	0.57	1.6	3.8
Density of the samples at actual moisture content, kg/m^3	2.8	26.2	18.1	0.33	3.4	3.9	0.08	0.85	0.97
Density of the samples at absolutely dry moisture content, kg/m^3	3.3	28.1	23.2	0.42	3.75	3.25	0.1	0.94	0.81
Shrinkage in the transverse direction, %	0.06	0.05	0.04	2.36	3.55	4.66	0.59	0.89	1.16
Static bending strength MPa	14.6	39.9	28.1	9.0	16.0	21.8	1.52	4.34	3.69
Static hardness, N/mm^2	8.5	7.9	11.0	15.9	13.1	22.6	3.3	2.7	4.7
Stability of wood in soil conditions- mass loss, %	2.0	0.7	0.1	17.2	15.3	6.9	4.3	3.8	1.8

Source: compiled by the authors

The obtained data on the physical and mechanical properties of thermally modified ash 'deadwood' are quite reliable (the accuracy rate does not exceed 5%) and allow us to confirm that the applied sterilisation allows its use in various products both indoors and outdoors. Depending on the treatment regime and the experience of using heat-treated wood of other species (Pinchevska *et al*., 2019; 2022) facture of furniture and joinery. This will help preserve the environment and help to implement new design solutions in joinery and furniture made of heat treatment ash 'deadwood', which has an attractive texture and good physical and mechanical properties.

Significant deterioration of ash due to the influence of pests makes it impossible to use its valuable and aesthetically pleasing wood for the manufacture of furniture and other products. Sterilisation of the affected wood by thermal modification is proposed, which is safe for the environment and gives new properties to the "deadwood" ash. High-temperature treatment changes the chemical structure of wood, in particular, affects the cell walls, which causes a decrease in its density, moisture content and hygroscopicity, and increases its form stability due to reduced shrinkage. Studies have shown that these changes were most pronounced at 195°C (schedule 2). However, due to the reduced strength of wood at high temperatures, schedule 1 is a higher priority, since its effect on strength is almost imperceptible. In addition, an increase in the hardness in the radial direction was observed in this mode, which is probably due to the crystallisation of cellulose. This confirms the possibility of using ash wood processed under schedule 1 for structural elements of furniture, in particular for the manufacture of chairs. The high bio stability of the modified wood also allows it to be used for the production of garden furniture. The obtained research results are consistent with the data of other scientists who have studied the properties of thermally modified wood of various species.

Conclusions

The results of the studies on the possibility of using "deadwood" ash wood affected by pests have shown that when it is sterilised by thermal modification, it acquires properties that allow it to be used in the manufacture of furniture and joinery. Experimental studies of moisture content, density and equilibrium moisture content were carried out in accordance with the methodology of national standards; the methodology of international standards was used to determine static bending strength and static hardness. A total of 310 samples of healthy and "deadwood" thermally modified ash were tested. It was found that the density of thermally modified "dead wood" decreased by 10% compared to healthy wood, which facilitates the production of solid wood products (furniture, panels, etc.). The studies of drying and equilibrium moisture content of thermally modified healthy and "deadwood" wood showed a significant, almost twofold decrease in these indicators for "deadwood" wood, which allows it to be used in the manufacture of joinery (windows, doors, etc.). The loss of bending strength by 9-33 MPa and virtually unchanged hardness in the radial and tangential directions makes it possible to use such wood in some structural elements of furniture. Studies of the biological stability of thermally modified healthy and "deadwood" ash wood have shown that weight loss decreased by 2.5-11 times depending on the treatment regime, which facilitates the use of products outdoors. The results of the studies with an accuracy rate of less than 5% showed that the use of "deadwood" ash affected by pests in the case of its sterilisation under high temperature is possible for use in industry

In the future, it is planned to investigate the effect of UV radiation on the colour change of thermally modified ash wood and to identify rational finishing materials and adhesives that will improve the properties of products used outdoors.

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Conflict of Interest

None.

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Анотація. Деревина ясена характеризується високими механічними та технологічними властивостями, має красиву текстуру, що зумовлює високий попит на меблеві та столярні вироби з неї. Проте широке та стрімке розповсюдження ураження грибковим захворюванням *Hymenoscyphus fraxineus* (халаровий некроз) та інвазійним жуком – смарагдовою вузькотілою златкою (*Agrilus planipennis*) викликало масове усихання ясенів. Все це призвело до перетворення протягом року здорової деревини у низькотоварну «сухостійну» і обмежило її використання у промисловості. Метою роботи було дослідити специфічні властивості сухостою ясена звичайного, підданого стерилізації шляхом високотемпературної обробки з використанням різних теплових режимів. Для поновлення використання запропоновано використання стерилізацію без додавання хімічних речовин шляхом термічного модифікування за температур 185 °C (режим 1) і 195 °C (режим 2), що не погіршує екологічних властивостей деревини. Проведені дослідження фізичних, механічних та технологічних властивостей термічно обробленої «сухостійної» деревини ясена та здорової деревини висушеної за температури t ≤ 70 °С. Визначено, що рівноважна вологість термічно обробленої «сухостійної» деревини ясена зменшилась на 3,5-4,0 % порівняно із здоровою деревиною; щільність за фактичної вологості та у в абсолютно сухому стані зменшилась на 8-12 % та на 4-9 %, усихання у поперечному напрямку на 53-67 %; межа міцності на згин зменшилась лише на 6 % у разі використання режиму 1 та на 20 % при використанні режиму 2. Статична твердість як у тангенціальному, так і радіальному напрямках мала неочікувану тенденцію - збільшення на 9-12 % при застосуванні режиму 1 і зменшення на – 1,7-13 % при обробці за режимом 2. Втрата маси зразків термообробленої «сухостійної» деревини ясена була на 60-90 % менше за втрату маси здорової деревини. Коефіцієнт точності усіх проведених експериментальних досліджень не перевищував 5 %. Отримані результати дають можливість ефективно вибирати застосування термообробленої «сухостійної» деревини ясена за режимом 1 у столярних і меблевих виробах, а обробленої за режимом 2 – у меблевих виробах, таких як стільниці, оскільки спостерігається погіршення відповідних механічних властивостей. Використання обох режимів обробки дозволяє використовувати низькотоварну деревину ясена у виробах, що експлуатуються просто неба

Ключові слова: «сухостійна» деревина; термічне оброблення; фізичні властивості; міцність; твердість; біостійкість