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HARDNESS OF WOOD IN SOME OAK SPECIES

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ABSTRACT

The oaks are one of the most important species for our Dendroflora. This study of hardness complements the knowledge of the properties of their wood. Wood is a non-homogeneous material and its properties differ in different parts of the stem. Hardness is a property that is directly related to the construction of the wood. That is why knowledge of this property will be an important step towards more rational use of oak wood.

The work presents data on the hardness of the wood of pedunculate oak (summer) and sessile oak (winter oak). The influence of the habitat and the radius of the stem is examined. In order to compare the individual samples, the qualitative hardness coefficient was determined.

Key words: wood, oak, hardness, sessile oak, pedunculate oak.

1. INTRODUCTION

Representatives of the genus Quercus are widely distributed in our country – 35% of Bulgaria's forested area is oak, but predominantly drought (EAG, 2010). The oak (high stem) oak forests are distributed mainly in Eastern Bulgaria - Strandja, Eastern Stara Planina and Ludogorie, occupying only 20% of the total oak forest area (1300473 ha). There are also crops. The distribution of oak forests in our country is observed in the lower mountain belt and in the parks. Different habitats include clean and mixed plantations of oak forests.

Two species of oak – sessile oak (winter oak) and pedunculate oak from different habitats are selected for study.

The area of the summer oak covers almost all of Europe, Asia Minor, North Africa and the Caucasus, with an altitude of up to 1000 m. In Bulgaria is met in almost the whole country. The natural range of the sessile oak is more limited than the summer oak. It is found in Europe without its most northern, southern and eastern parts up to 1800 m above sea level. In Bulgaria it is mainly found on the heights, foothills and mountain slopes of almost all our mountains up to 1600 m above sea level.

On the radius, the wood in the stem has a different structure. In adult trees it is divided into juvenile, central (mature) and peripheral. The oaks are heartwoodtrees. Most often the heartwoodhas a higher hardness than the sapwood, and juvenile wood – a lower hardness than that of the central and the peripheral. However, previous studies have found the highest values of hardness in juvenile woods (Mladenova, D, 2016). Furthermore, it is also interesting to change the hardness in the construction of the wood of the two oak species depending on the habitat.

The aim of the work is to trace the change in the hardness of the wood of the sessile oak (winter oak, *Quercus petraea* Liebl) and pedunculate oak, European oak or English oak (*Quercus robur* L) in the stem structure (in juvenile, central and peripheral wood) and in different habitats.

2. METHODS AND MATERIALS

In order to determine the hardness to the longitudinal of the fibers, test bodies in the form of washers obtained at 1.3 m from

the base of the trees. All the washers were ground on the sides on which hardness was then determined. Larger washers were forced to fit into the test machine.

The oak wood is available for research from nine different habitats in Bulgaria. Only hardness in the longitudinal direction is determined. The analysis is based on comparing data obtained at a different location along the radius of the stem. Therefore, standard test bodies are not manufactured, and tests are done directly on the washers. In each zone the hardness is determined several times (Fig. 1). The sample values were determined by habitat, tree species and type of wood.

Figure 1: Distribution of areas by type of wood

The test was based on a standardized methodology used in previous studies on a universal test machine [5].

3. RESULTS AND DISCUSSION

3.1. Hardwood of sessile oak and pedunculate oak

The wood for sessile oak has been studied by seven habitats. The average hardness of the wood is 89.7 $N.mm^{-2}$ (Fig. 2). It is significantly higher than the literature value of 66.0 $N.mm^{-2}$ (Wagenffur, 1975). The resulting hardness is averaged by the three areas – juvenile, central and peripheral. Accuracy values are high for any of the samples ranging from 2.7 to 8.6%.

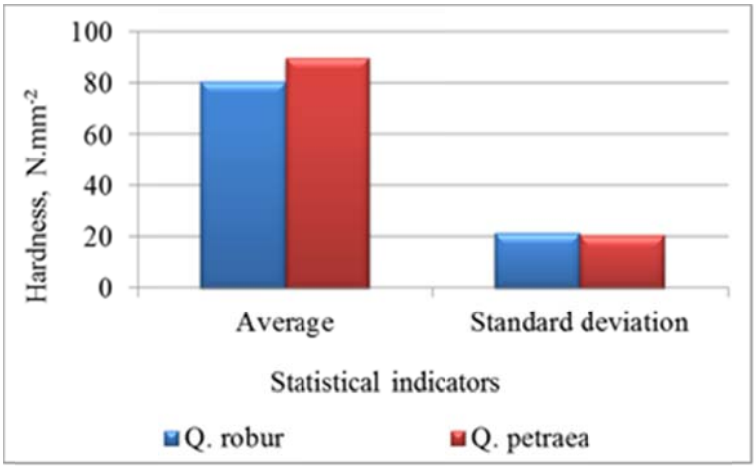

Figure 2: Distribution of hardness depending on the wood species

The wood of the pedunculate oak is studied by three habitats. The resulting average hardness of the wood is 79.8 N.mm^{-2}. It is close but higher than the literature value of 71.0 N.mm^{-2} (Enchev, E., 1972, Enchev, E. 1975). In his studies prof. Enchev examines the change of stiffness in two zones, respectively at 3 and 9 cm from the periphery. The values in the literature are 66.6 N.mm^{-2} for the sapwood and 79.3 N.mm-2 for the hearthwood.

3.2. Distribution of hardness depending the radius of the stem

Both are similar in hardness, with values decreasing gradually in identical way. Unlike most species, juvenile wood has higher values than the central. This can be explained to some extent by the wider annual rings of juvenile wood, which exceed the size of the central ones by about twice. It is known that in the case of ringporouswood with an increase in the annual ring, the density of the wood also increases.

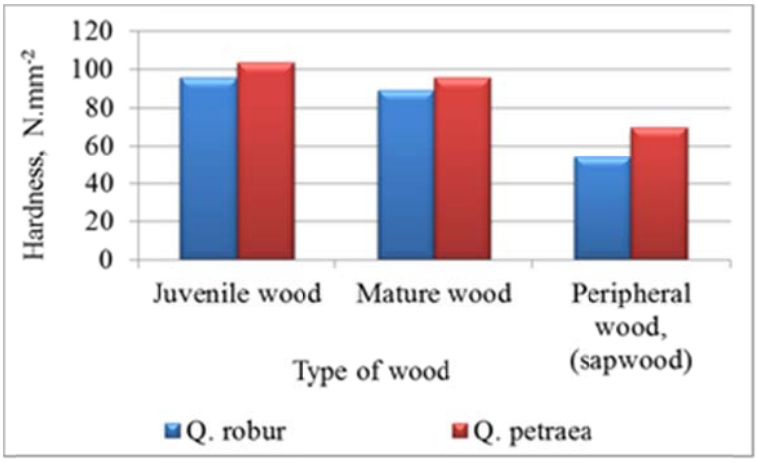

Figure 3: Distribution of hardness depending the radius of the stem

The values obtained for the hardness of central wood for both wood species are almost uniformly distributed almost across the range of habitats. Wood of sessile oak is hardest – 95.7 N.mm^{-2}, compared to the pedunculate oak – 89.3 N.mm^{-2}. Peripheral wood hardness values for both wood species differ significantly from the other two areas. Here harder wood is also sessile oak –

69.7 N.mm^{-2}, while the pedunculate oak is 54.0 N.mm^{-2}.

In order to compare the two types correctly, the qualitative coefficient is also formed (This is the relationship between density and hardness of wood). Here the differences become even bigger. In juvenile wood, at a coefficient of 0.15 for sessile wood, the pedunculate oak is only 0.12. Similar trends remain with other areas.

3.3. Distribution of hardness by habitat

In order to investigate the impact of habitat on the hardness of the wood, the factor wood speciesis neglected, the values for both species being averaged. The habitat is divided into groups depending on the altitude. From the studies on the hardness of wood in the habitats, it is concluded that the hardest wood is formed in the habitat Kresna – 120 N.mm^{-2}. The lowest values of the hardness of these types of wood is in the habitat Blagoevgrad – 80 N.mm^{-2}. The reason for this may be both the altitude and the climatic conditions in the respective areas (Fig. 4).

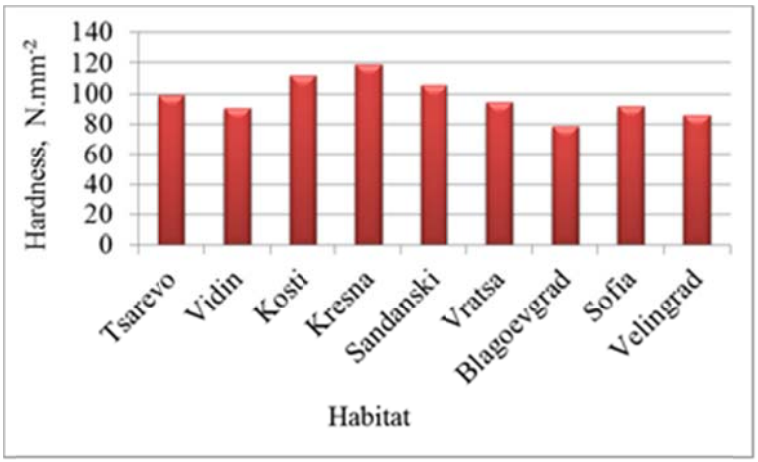

Fig. 4. Distribution of hardness by habitat

For other habitats, wood hardness values vary, with no relationship between altitude and hardness of the wood. The data shows that altitude affects differently the hardness of the wood.

The high values obtained for the precision indicator for all the studied habitats can be explained not only by a small number of experiments but also by a wide variety that brings each tree species into the hardness values.

4. CONCLUSIONS

After the analysis of the results obtained for the individual habitats and the individual tree species, the following more important conclusions can be made:

Depending on the tree species. The wood of the oak studied is similar in hardness, with a harder sessile oak average of about 10%;

Distribution of the hardness of the stem. The values obtained for the juvenile and central woods are very close, as the sapwood yields considerably;

Change of hardness in location. Hardness in individual habitats varies greatly. The altitude factor itself, isolated from the other elements of the habitat conditions, has no established dependence on the influence on hardness.

REFERENCES

ENCHEV, E. 1972. Contribution to the study of physical and mechanical properties of wood of the

lazhnika, oak, white oak and Turkey oak. Forestry science, Year IX, (issue. 1, Sofia 1972, p. 87–97.

ENCHEV, E. 1975. Structure, properties, use the wood of the oaks. Innovations in support of the forest management techniques. Scroll Wood industry, Sofia.

ZHELEV, P., et al. 2010. Study of the structural, biochemical and genetic characteristics of the representatives of the river. Quercus in Bulgaria and opportunities for sustainable use. Quadrilateral project involving UF VHPH Plovdiv, Agrobioinstitute Union of environmentalists in Bulgaria. Stimulate research in state universities.

KALINKOV, V. 1976. Shipchano. Anatomy of wood of the some oaks. Forestry science, year XIII, Br. 5, Sofia 1976, p. 21–32.

MLADENOVA, D. 2016. Study on the hardness of oak wood. Innovation in woodworking industry and engineering design, vol. V, 2016, p. 15–19.

PROCEEDINGS. 1970. Production and complex use of the oak wood. State Publishing Zemizdat. Sofia. p. 153–162.

JURUKOV, S. 2003. Dendrology. Sofia. p. 75–78.

RADKOV. IL. 1963. J. Minkov oak forests in Bulgaria, Varna.

CT CMEA 2366 – 80. Wood. Method for determination of static hardness.

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