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STUDY ON THE HARDNESS OF OAK WOOD

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ABSTRACT

The hardness is among the most important properties of wood. It is closely correlated with the density and mechanical properties. Moreover, it determines the processing of wood. The scope of the stem varies greatly by determination is often very difficult to define.

This work considers the hardness of oak wood, sourced from different habitats in the country and its distribution in the radius of the stem. The influence of age, the width of the annual ring, habitat and altitude are also considered.

Key words: wood, oak, hardness, annual ring.

1. INTRODUCTION

The deciduous forests in Bulgaria are occupied much by the oak trees that are natural or coppice ones. There are also other crops. Distribution of oak forests in our country is observed in the lower mountain zone and in the parks. In different habitats occur pure and mixed plantations of oak forests.

For Object of the study are selected two types of oak – Hungarian oak and Pubescent oak.

The Hungarian oak encompasses places with a transient Mediterranean, temperate continental and mountain climate with altitude up to 1600 m. The main habitat of Pubescent oak is on the hills and foothills, up to 1000 m altitude.

In the present exposure interest is the change in the hardness of the wood composition of both types of oak, depending on the habitat.

Wood in the stem has a different structure. In older trees it is divided into juvenile, central and peripheral. Most often, heartwood has a greater hardness compared to the sapwood.

The main objective is to track the evolution of the hardness of the wood of oak (Q. frainetto Ten) and pubescent oak (Q. pubescens Willd) in trunk posture (in juvenile, central and peripheral timber) in different habitats.

2. METHODS AND MATERIALS

For the determination of the hardness longitudinally of fibers are used test pieces in the form of discs, harvested of 1,3 m from the base of trees. Supplied for the exploration oak is from 5 habitats in Bulgaria: Pubescent oak - Vratsa, Kresna and Sandanski and Hungarian oak - Topolovgrad and Tsarevo.

The analysis is based on a comparison of data obtained at different locations in the radius of the stem.

On each of the discs are determined areas in which is tested the hardness of the longitudinal fibers. Within each area, the hardness was determined several times. Therefore, a sample is taken for the amount of habitat values in tree species and type of wood.

The determination of the hardness is done by the method of Janka of the universal testing machine, which ensures a constant test speed. In different areas of the test samples, insert punch under pressure at a depth of 5.64 mm. The loading has rate such that the the time required for penetration of the punch, to be 1.5 ± 0,5 min. When reach that penetration depth is determined load F, with an error of less than 1 % (according to ST of the CMEA 2366: 1980).

Static directional hardness of wood is determined by the following formula:

$$Hw = \frac{F}{nr^2}, \text{ N/mm}^2 \quad \textbf{(1)}$$

Where:

F is the load penetration under compression of the punch in the test specimen, N;

nr^2 – imprint area of the, 100 mm^2.

For the purposes of the study those mentioned above habitats have been selected as typical for the country. Medium modelled trees are selected under the forest development plan.

3. RESULTS AND DISCUSSION

3.1. Distribution of hardness species

Hungarian oak. The study of the wood of the Hungarian oak is of two habitats. The resulting average hardness of the wood is 102 N/mm^2. It is similar, but higher than the value of 96.4 N/mm^2 (Enchev, E; 1972). The author has researched climate longitudinally the hardness of the the fibers in the two areas, respectively on 3 and 9 cm from the periphery (Enchev E; 1972). Specified therein values were 90.7 N/mm^2 for the area close to the bark and 107.7 N/mm^2 for the area including the heartwood The resulting average hardness of the wood of the Hungarian oak is 101.9 N/mm^2. The hardness of the test timber is measured in three areas - Juvenile, central and peripheral (Fig. 1).

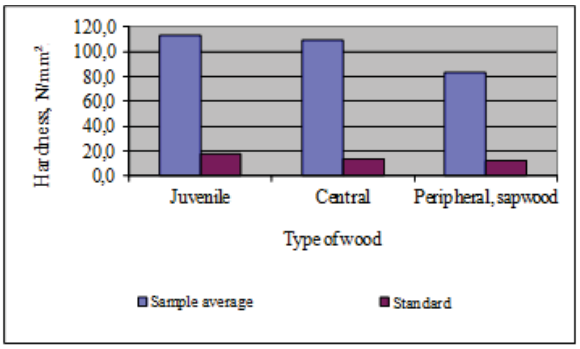

Figure 1: Distribution of the hardness radius in Hungarian oak

The values of the indicator of the accuracy ranging between 2.3 and 2.8 %.

Pubescent oak. The wood of the Pubescent oak was investigated in three habitats. The resulting average hardness of the wood for the studied habitats is 107.4 N/mm^2. In the literature there are no data about the hardness of Pubescent oak. It is also measured in three areas - Juvenile, central and peripheral (Fig. 2).

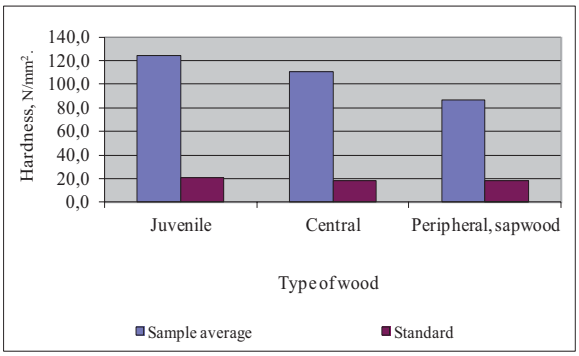

Figure 2: Distribution of the hardness radius in Pubescent oak

The two species are similar in hardness, in different areas are reduced values in the same way. Unlike most types here juvenile wood has a high central. This can be explained by the wider annual rings of the juvenile wood which exceed in size than the central by about two times.

3.2. Distribution of the hardness in the radius of the stem

The obtained values for the hardness of the juvenile wood for both wood species are distributed almost uniformly over the entire range. The research shows that the hardness of the wood is oak hairy 124.2 N/mm^2, which is higher than that of the Hairy oak – 113.2 N/mm^2 (Fig. 3).

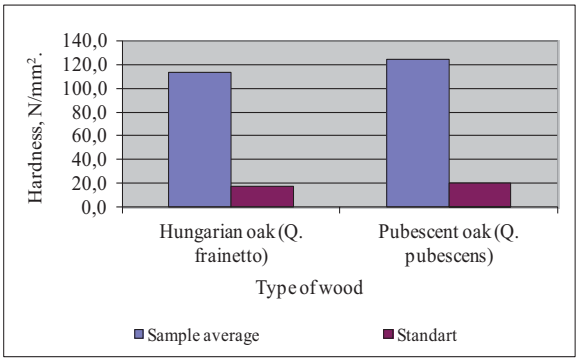

Figure 3: Distribution of the hardness of juvenile wood in the studied species

Similar trends are observed in the hardness of the central and peripheral timber (Fig. 4).

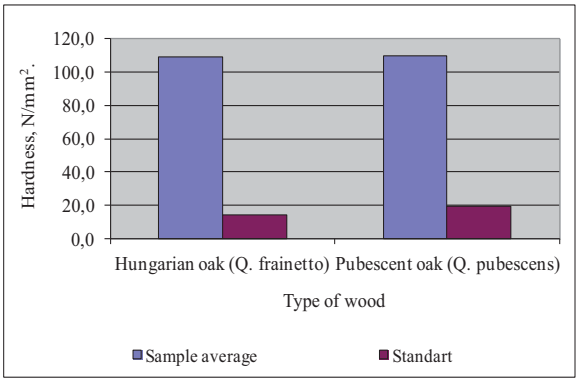

Figure 4: Distribution of the hardness of the wood in a central target species

The values obtained for the hardness of the central timber for both tree species distributions are almost evenly throughout the range. Harder the wood of Pubescent oak – 111.0 N/mm^2, and that of the Hungarian oak is 109.2 N/mm^2. (Fig. 4).

The values of hardness of the peripheral timber for both wood species are distributed almost uniformly over the entire range. The hardness of the wood of the Hungarian oak in the peripheral zone is 83.3 N/mm^2, and that of the Pubescent oak – 86.9 N/mm^2 (Fig. 5).

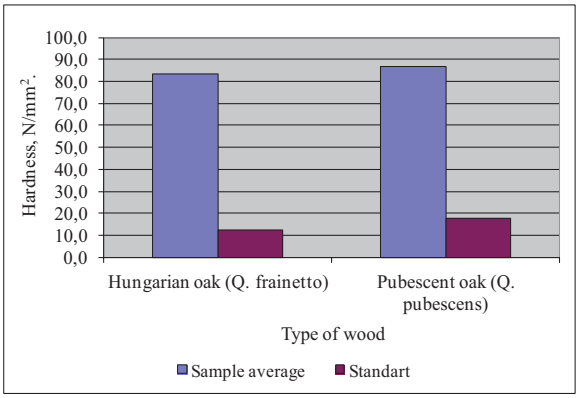

Figure 5: Distribution of the hardness of the wood in peripheral sapwood studied species

3.3. Stiffness distribution in habitat

In an attempt to exclude the impact of tree species on the hardness of the wood, the values are grouped by habitat. The analysis of the simple average and variance is included.

By the studies conducted on the hardness of the wood in habitats are summarized the hardest juvenile, central and peripheral timber is formed by species habitat Kresna. The lowest values of hardness of these wood species in habitat Vratsa. The reason for this can be both altitude and weather conditions in the regions (Table 1).

Table 1: Distribution of habitats in altitude

Habitat	Altitude, m	Juvenile wood, N/mm^2	Central wood, N/mm^2	Peripheral wood, N/mm^2
Tsarevo	10	109.2	105.9	82.0
Kresna	233	135.9	124.0	96.7
Sandanski	297	127.9	104.6	84.5
Topolovgrad	312	112.4	106.2	81.1
Vratsa	345	107.4	97.0	78.9

In other habitat values for the hardness of the wood in the same range.

The obtained high values for indicators of the accuracy for all studied habitats can be explained not only by a small number of experiments, but with a wide variety importing each tree species in the values of the hardness.

4. CONCLUSIONS

After the analysis of the results obtained for the different habitats and individual species can be drawn the following important conclusions:

The wood of oaks studied is similar in hardness, as a harder is that of Pubescent oak, averaging around 5 %;

Values obtained for the juvenile and center wood are very similar to those of sapwood considerably a step back to them;

In both species studied the hardest wood is in the habitat Kresna and the lowest hardness - in the habitat Vratsa.

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