Slavko Govorčin, Tomislav Sinković[1], Tomislav Sedlar[2]

Dimensional Stability of Olive (*Olea europaea* L.) and Teak (*Tectona grandis* L.)

Postojanost protega maslinovine (*Olea europaea* L.) i tikovine (*Tectona grandis* L.)

Original scientific paper • Izvorni znanstveni rad
Received – prispjelo: 12. 5. 2010.
Accepted – prihvaćeno: 14. 7. 2010.
*UDK: 630*812.23; 630*812.31; 674.031.191; 674.031.931.342*

ABSTRACT • *Olive, as a wood species, can be compared by its dimensional stability with teak wood, which is mainly used for products exposed to external conditions. Mean density in absolutely dry condition of researched olive wood is 0.810 g/cm^3 while the average value of teak wood is 0.610 g/cm^3. Regardless of higher density, the mean value of total tangential shrinkage for olive wood is only by 3.6 % higher than the one for teak wood, so the value for olive wood is 5.6 % and for teak wood 5.4 %. Based on this research of density in absolutely dry condition and total shrinkage, olive wood can be considered as a possible alternative indigenous species for use in products that are daily exposed to external conditions.*

Keywords: *dimensional stability, olive wood, teak wood, physical properties*

SAŽETAK • *Utezanje je fizikalno svojstvo drva koje bitno utječe na njegovu upotrebljivost u proizvodima. Male vrijednosti utezanja daju nekim vrstama drva prednosti pri upotrebi (Ugrenović, 1950), posebno pri izradi proizvoda koji su svakodnevno izloženi vanjskim vremenskim uvjetima (Giordano, 1976). Maslinovina se kao vrsta drva po postojanosti protega može usporediti s tikovinom, koja se najčešće rabi za proizvode svakodnevno izložene vremenskim uvjetima. Srednja vrijednost gustoće u apsolutno suhom stanju istraživane maslinovine iznosila je 0,810 g/cm^3, za razliku od tikovine, čija je srednja vrijednost iznosila 0,610 g/cm^3. Usprkos većoj gustoći, srednja vrijednost maksimalnoga tangencijalnog utezanja maslinovine samo je 3,6 % veća od srednje vrijednosti maksimalnoga tangencijalnog utezanja tikovine, te za maslinovinu iznosi 5,6 %, a za tikovinu 5,4 %. Na temelju ovog istraživanja gustoće u apsolutno suhom stanju i maksimalnih utezanja, može se zaključiti da se maslinovina pokazala kao moguća zamjenska domaća vrsta za upotrebu u proizvodima koji su svakodnevno izloženi vanjskim vremenskim uvjetima.*

Ključne riječi: *postojanost protega, maslinovina, tikovina, fizikalna svojstva*

1 INTRODUCTION
1. UVOD

Shrinkage is a physical property of wood that significantly affects its usability in products. Small shrinkage values are an advantage in use for some wood species (Ugrenović, 1950), especially in products that are daily exposed to external conditions (Giordano, 1976). The aim of this research was to compare some physical properties of olive and teak wood. In this research the following physical properties of wood

[1] The authors are professors at the Faculty of Forestry, University of Zagreb, Croatia. [2] Author is assistant at the Faculty of Forestry, University of Zagreb, Croatia.
[1] Autori su profesori na Šumarskom fakultetu Sveučilišta u Zagrebu, Hrvatska. [2] Autor je asistent na Šumarskom fakultetu Sveučilišta u Zagrebu, Hrvatska.

were studied: density in absolutely dry condition, density in raw condition, nominal density, water content, longitudinal, radial, tangential and volumetric shrinkage. Based on variations of the shrinkage value, it is possible to compare dimensional stability (Horvat and Krpan, 1967) of the two wood species, as one of the key factors in selecting wood for products daily exposed to external conditions. Olive, as a wood species, was chosen for comparison because of its appearance on wood market, and it is considered to be a substitute for teak.

2 MATERIAL AND METHODS
2. MATERIJAL I METODE

2.1 Olive
2.1 Maslinovina

Olive (*Olea europaea* L.) is classified in botanical genus *Olea* and family *Oleaceae*. It is reported to be indigenous to the Mediterranean, including Southern Europe, the Middle East and North Africa. Also, it has been extensively planted in areas of California, Arizona and Florida. For olive, sub tropical or Mediterranean climate is preferable, especially hot, dry regions under irrigation (Arno, 1988).

Olive trees are extremely long lived, up to 1 500 years. They grow to heights that rarely exceed 8 m and diameters of 30 cm. Trunk is fluted and knotted. Sapwood is narrow, gold or yellow in color, and often striped. On the other hand, heartwood varies from golden-brown to dark brown (Horvat, 1983).

It is reported to dry very slowly, with very mild drying schedules recommended. The wood is moderately durable and somewhat resistant to fungi attack.

Olive fruits are rich in oil that is both used in nutrition and for medical purpose. In flooring industry olive is, together with teak, most valued wood. It is frequently used in production of expensive furniture.

2.2 Teak
2.2. Tikovina

Teak (*Tectona grandis* L.) is a tropical hardwood in genus *Tectona* and family *Verbenaceae*. It is native to the regions of Africa, Central and South America, Southeast Asia and Indonesia. As olive, it has been extensively planted in Europe (France) and North America (Florida) (Kaiser, 1992).

Teak trees are reported to attain heights of 39-45 m and diameters of 90-150 cm, while plantation trees grow to 45 m and can be ready for harvesting after 60 years. Trunk is irregular and narrow. The clearly demarcated sapwood is white to pale yellow in color, while heartwood varies in color from golden-brown to dark brown (Kline, 1976).

Teak wood dries very well, but slowly. Its natural durability and resistance to fungi attack is reported to be very high.

The wood is especially valued in carpentry (Ugrenović, 1948), production of expensive furniture, and it is used for floor coverings, stairs, windows, doors, etc. Considering its outstanding stability in external conditions it is suitable for external use, e.g. in horticulture and landscape tending, while in shipbuilding it is almost irreplaceable.

Olive (*Olea europea* L.) used in this research originates from the Island of Silba, region of North Dalmatia in Croatia, while teak (*Tectona grandis* L.) comes from the state of Sierra Leone, West Africa Region.

Sharp-edged samples for the determination of physical properties were made from heart boards. Physical properties of olive and teak wood were determined according to standards applicable Croatia. Maximum number of sharp-edged samples was made from heart boards. Dimensions of samples were 20x20x25 mm (*R*x*T*x*L*). The samples were then soaked in water for the time they required to achieve water content higher than the fiber saturation point. After reaching the specified water content, the samples were dried at the

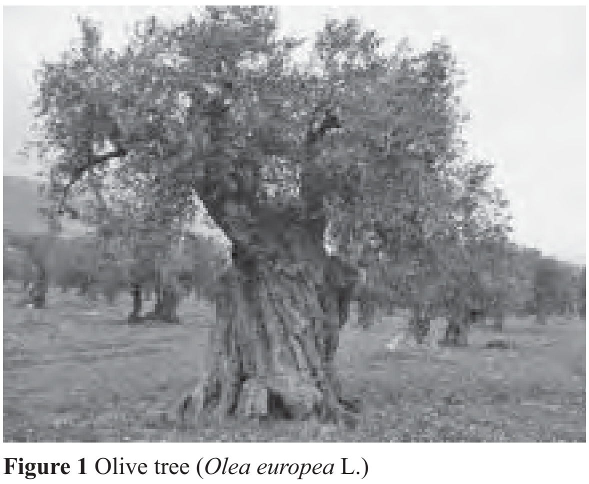

Figure 1 Olive tree (*Olea europea* L.)
Slika 1. Stablo masline (*Olea europea* L.)

Figure 2 Teak tree (*Tectona grandis* L.)
Slika 2. Stablo tika (*Tectona grandis* L.)

Table 1 Survey of statistical values of researched olive and teak wood
Tablica 1. Pregled statističkih vrijednosti rezultata istraživanja maslinovine i tikovine

Olive wood - *Maslinovina*							**Teak wood** - *Tikovina*					
ρ_w	ρ_0	w	β_{rmax}	β_{tmax}	β_{vmax}		β_{vmax}	β_{tmax}	β_{rmax}	w	ρ_0	ρ_w
g/cm^3	g/cm^3	%	%	%	%		%	%	%	%	g/cm^3	g/cm^3
62	62	62	62	62	62	N	16	16	16	16	16	16
1.0160	0.7498	42	2.5	0.0	6.9	MIN	6.6	4.4	1.5	44	0.5663	0.7498
1.0974	0.8047	51	4.5	5.6	10.9	AVE	7.9	5.4	2.2	48	0.6089	0.8276
1.1897	0.8899	69	10.0	9.0	15.8	MAX	10.0	8.2	3.7	52	0.6494	0.8840
0.0508	0.0370	7.9	1.56	2.11	2.54	SD	1.06	1.02	0.64	2.7	0.0242	0.0355
0.0026	0.0014	62.4	2.44	4.47	6.43	VAR	1.13	1.05	0.40	7.2	0.0006	0.0013

ρ_w – density in raw condition (*gustoća u sirovom stanju*), ρ_0 – density in absolutely dry condition (*gustoća u apsolutno suhom stanju*), w – water content (*sadržaj vode*), β_{rmax} – total radial shrinkage (*maksimalno radijalno utezanje*), β_{tmax} – total tangential shrinkage (*maksimalno tangencijalno utezanje*), β_{vmax} – total volumetric shrinkage (*maksimalno volumno utezanje*)

temperature of 103±2 ºC until they reached constant mass. After obtaining an absolutely dry condition, the measurements were repeated and data were processed, all according to applicable standards.

The evaluation of the basic statistical data was made using statistical software Statistica 7.1, together with the comparison of researched mean property values in the same software using Mann-Whitney test.

3 RESULTS AND DISCUSSION
3. REZULTATI I DISKUSIJA

Statistical values of researched physical properties of olive and teak wood are shown in Table 1.

Mean values of researched physical properties of olive wood are higher in all segments than the ones of teak wood, as shown in Table 1. The mean value of water content after water soaking of olive wood is higher by 5.9 % than the mean value of water content after water soaking of teak wood. The mean value of density in raw condition after water soaking of olive wood is higher by 24.6 % than the same value of density in raw condition of teak wood. The mean value of density in absolutely dry condition of olive wood is higher by an almost identical percentage than the same value of density in absolutely dry condition of teak wood, and the mentioned value is 24.3 %. Mean values of total shrinkage in radial direction and volumetric shrinkage differ significantly from mean values of total shrinkage in tangential direction. The mean value of total radial shrinkage of olive wood is higher by 51.1 % than the mean value of teak wood, and with total volumetric shrinkage by 27.5 %. The mean value of total tangential shrinkage of olive wood is only by 3.6 % higher than the same value of teak wood.

Graphical view shown in Figure 3 was formed based on mean, maximum and minimum statistical values of shrinkage.

Figure 3 clearly shows the range of researched shrinkages. Figure 4 shows the relation between density in absolutely dry condition and tangential shrinkage. This view was given because such pieces of information are not available in literature and few researches of this kind were carried out.

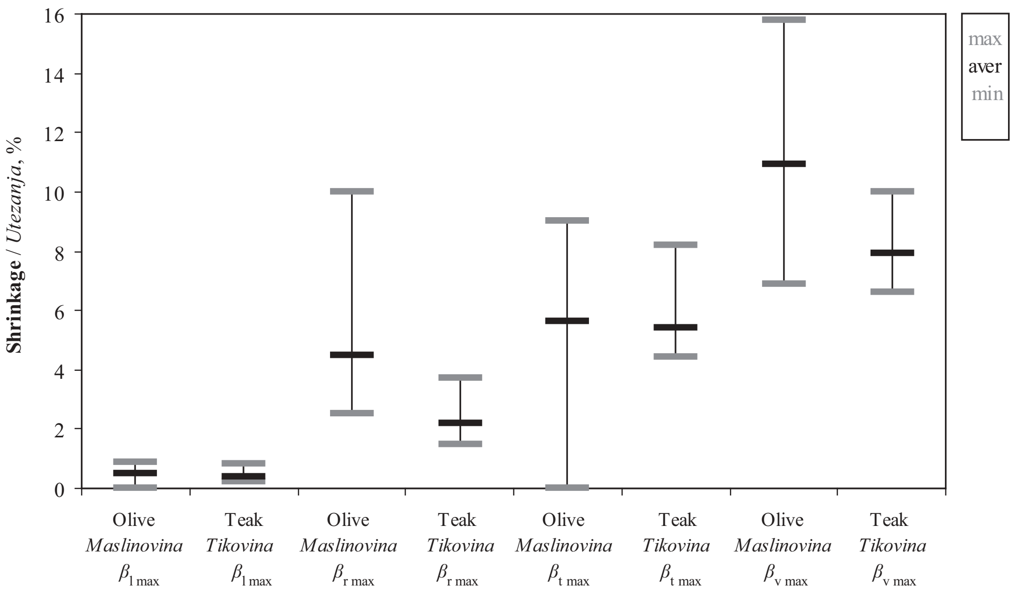

Figure 3 Comparison of maximum, minimum and mean values of total longitudinal, radial, tangential and volumetric shrinkage of olive and teak wood
Slika 3. Usporedba maksimalnih, minimalnih i srednjih vrijednosti maksimalnoga longitudinalnog, radijalnog, tangencijalnog i volumnog utezanja masline i tika

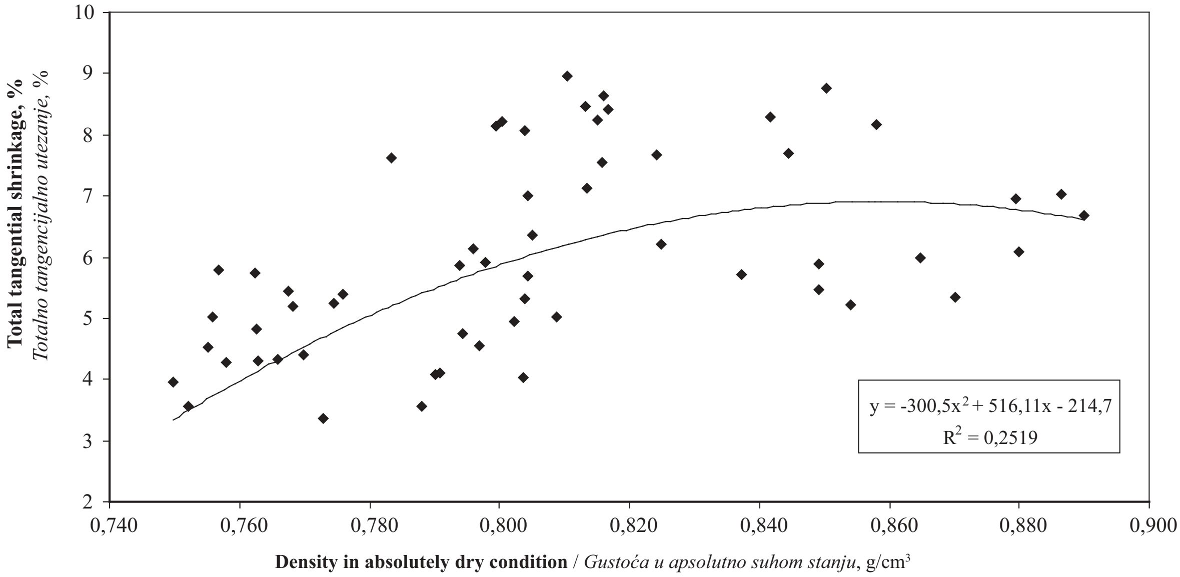

Figure 4 Relation between total tangential shrinkage and density in absolutely dry condition for olive wood
Slika4. Odnos maksimalnog tangencijalnog utezanja i gustoće u apsolutno suhom stanju za maslinu

Figure 4 shows the growth trend of total tangential shrinkage with the increase in density in absolutely dry condition for olive wood. Figure 5 shows the relation between density in absolutely dry condition and total volumetric shrinkage for olive wood.

The results obtained by comparison of mean values of researched physical properties show that mean values are significantly different.

This is because structural elements of teak wood are evenly arranged in the ring width compared to olive wood. Macroscopic structure of teak wood, with respect to its structural elements, is uniform, while this is not the case with olive wood. Disparity in structure and structural elements affects greater variability in properties for olive wood. The cause of such discrepancies also results from the fact that teak grows in relatively constant climatic conditions, while olive grows in highly variable climatic conditions.

4 CONCLUSIONS
4. ZAKLJUČCI

This research of density in absolutely dry condition, density in raw condition, nominal density and total values of longitudinal, radial, tangential and volumetric shrinkage shows that all mean values of the above mentioned properties are significantly different between olive and teak wood. After observing the mean values of researched properties, it is evident that they are higher for olive than for teak wood. Also, by observing variations between mean values of researched properties in percentages, it can be concluded that they are relatively small, apart from total radial shrinkage. All the above shown property values, their arrangement and relations show that olive wood can be substituted with teak wood, from the aspect of total shrinkage. As far as density is concerned, olive wood has

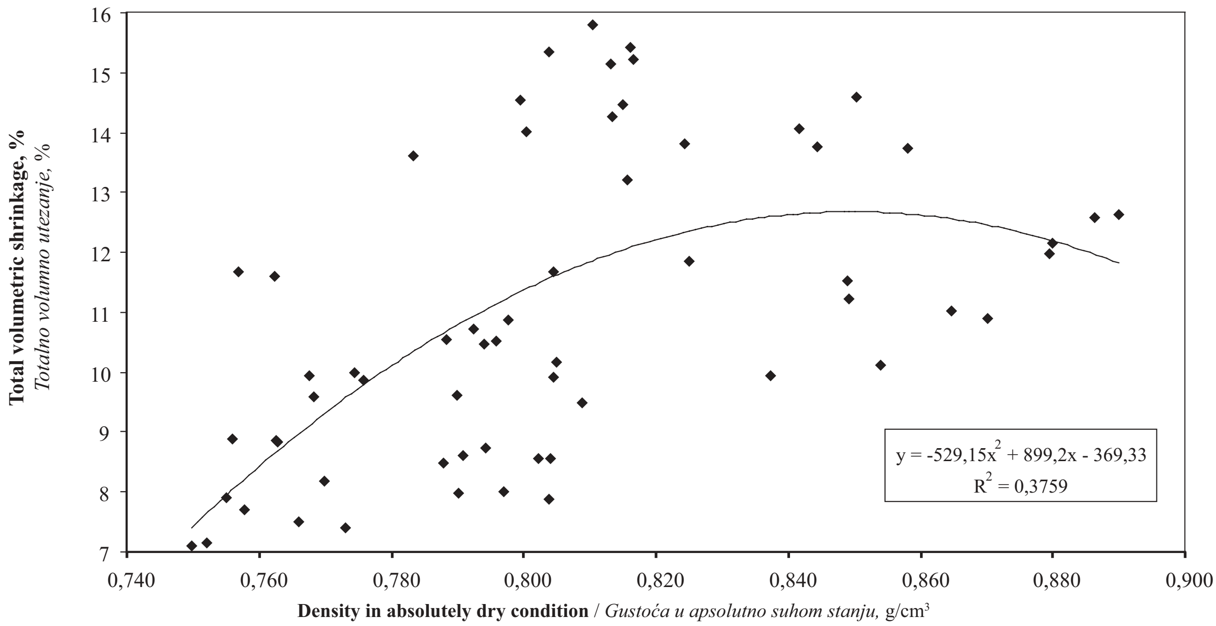

Figure 5 Relation between total volumetric shrinkage and density in absolutely dry condition for olive wood
Slika 5. Odnos maksimalnog volumnog utezanja i gustoće u apsolutno suhom stanju za maslinovinu

somewhat higher density in absolutely dry condition than teak wood.

5 REFERENCES
5. LITERATURA

1. Arno, J. 1988: Olea europea – Olive. In A Guide to Useful Woods of the World. Flynn Jr., J.H., Editor. King Philip Publishing Co., Portland, Maine.
2. Giordano, G. 1976: Tecnologia del legno 3, Torino.
3. Horvat, I.; Krpan, J. 1967: Drvnoindustrijski priručnik, Zagreb.
4. Horvat, I. 1983: Maslina. Šumarska enciklopedija. Jugoslavenski leksikografski zavod. Zagreb.
5. Kaiser, J. 1992: Wood of the Month - Teak: The Ironwood of China.
6. Kline, M. 1976: Tectona grandis - Teak. In A Guide to Useful Woods of the World, Flynn, J. H., Editor. King Philip Publishing Co., Portland, Maine.
7. Ugrenović, A. 1948: Upotreba drveta i sporednih produkata šume. Nakladni zavod Hrvatske. Zagreb.
8. Ugrenović, A. 1950: Tehnologija drveta. Nakladni zavod Hrvatske. Zagreb.

Corresponding address:

Assoc. Prof. TOMISLAV SINKOVIĆ, Ph.D.

University of Zagreb
Faculty of Forestry
Svetošimunska 25
HR-10002 Zagreb
e-mail: sinkovic@sumfak.hr