საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 10, №1, 2016
BULLETIN OF THE GEORGIAN NATIONAL ACADEMY OF SCIENCES, vol. 10, no. 1, 2016

Biotechnology

Technological Evaluation of Azerbaijan Oak Wood for Wine-Making

Taryiel Panahov

Azerbaijan Scientific Research Institute of Viticulture and Wine-Making AZ SRIVW, Baku, Azerbaijan

(Presented by Academy Member Giorgi Kvesitadze)

ABSTRACT. Anatomical properties and chemical composition of oak wood determining its applicability in wine-making are considered in the paper. Technological assessment of the oak raw material is carried out and vast information is provided on the high-quality composition of Azerbaijan oak wood compared to those of other countries. The peculiarities of the components distribution in different parts of trunk are described in the paper. *© 2016 Bull. Georg. Natl. Acad. Sci.*

Key words: oak, chemical composition, wine-making, tannin, different parts of the trunk, cask

The goal of technological evaluation of oak wood is to select the oak wood for production of wine and cognac barrels with such anatomical, physical and chemical properties, which will provide harmonic blend of aromatic components in white and red wine materials as well as in wine distillates (brandy spirits) during the period of aging in barrels.

Oak wood is characterized by specific anatomical properties and chemical composition, which determine its applicability in technological processes of wine-making.

The main criteria for assessment of oak wood are its botanical species, age, geographical origin and anatomic (microscopic) structure (width of the tree rings, ratio of the early and late wood, size of the vascular rings: small, medium, large) also concentration of chemical components, which is an important factor in production of high-quality wine and brands. Technological evaluation of the resources of oak raw materials was never carried out in Azerbaijan. In this regard, the goal of our research was to carry out technological assessment of Azerbaijanian oak in order to find out its applicability in technological processes of wine-making and the possibility of rational use of its raw materials.

Among the species of the genus Quercus spread in the forests of Azerbaijan five of them are tree species: chestnut-leaved oak (*Q. castaneifolia* C.A.M.), Georgian oak (*Q. iberica* Stev.), Araks oak (*Q. araxina (Trautv*.), Eastern oak (*Q. macranthera F .et M*.), *A. Grossh*.), pedunculate oak (*Q. longipes.* Stev.). Four species: Erucifolia oak (*Q. erucifolia* Stev.), pubescent oak (*Q. crispata* Stev.), Irish oak (*Q. hypochrysa* Stev.) and downy oak (*Q. anatolica* (Schwarz) D.Sosn) are less common, usually no more than 10-15% of the total growing stock. English oak (*Q.robut*),

eastern oak (*Q. macranthera* F.et M.) and the Georgian oak (*Q. iberica* Stev.) are highly valued for wine barrel. Wine barrels are rarely made of chestnut oak (A. *castaneifolia* SAM). Other local species of oak are hardly ever used in wine-making.

Azerbaijan Oak forests constitute about 23.4% of the forested area and take the 3rd place after beech and hornbeam forests. Though the largest areas of oak forests (40.4%) are located in the forest vegetation area of the Greater Caucasus, the greatest reserves of oak wood are available in Lenkoran mountain system (38.2%) because of the most favorable climatic conditions.

Compared to the main regions of mass production of oak timber (France, Ukraine, Krasnodar and Stavropol regions of Russia, Abkhazia) Azerbaijan oak stands are characterized by less average density (0.47), average bondability (III), stock (90 m3 / ha). Their mean age is approximately 65 years. The area of maturing, mature and overmature forests is 40.4%, while their reserves make 49.0% of total in the country. This is due to the fact that most of the mature and overmature plantations are located in remote mountainous regions, where logging is unprofitable.

Most of the forests of Azerbaijan are represented by the first and second groups (of protective and recreational functions), and in a lesser extent by the third group of forest exploitation.

Gradual shelter-wood felling, group-selective and selective logging, thinning of forests and sanitary cutting are allowed in the oak forests of Azerbaijan. Very often there is an excessive intensity of logging associated with a timber deficit in the domestic market.

Unless the species are changed, natural regeneration of the forest is rarely enough to create sustainable oak forests due to grazing and dry climate.

It is advisable to plant acorns to form a tap root and a strong root system.

According to the literature data the following can be concluded:

1. The most valuable native species of oak for production of high-quality wine casks are the English oak (*Q.robur*), Eastern oak (*Q. macranthera* F. et M.) and the Georgian oak (*Q.iberica* Stev.).

2. In view of the high protective and recreational values as well as low productivity of oak forests and forest land for the national revival of cooperating production we must increasingly rely on the import of wood from England, Russia and Ukraine.

Many researchers noted a direct relationship between the site conditions and anatomic features of oak, between the microscopic and chemical composition of wood, even in different parts of the trunk, etc. [1 - 8].

The first step in the research on formation of chemical composition in Azerbaijan oak was the study of the chemical components distribution in different parts of the oak trunk.

Phenolic substances (tannins) are among those components, which determine the quality of wood and the future of wine and brand. Accordingly, it is due to it that the oak wood is classified for wine-making.

Chemical composition of oak trunk was studied in many countries. There were identified some components produced by 80-year-old oaks, which are valuable for wine-making. So, it is considered reasonable not to cut the trees until the age of 90 - 100 years. Also, the tannin content in oak wood was found to be various in its longitudinal and transverse cross sections: maximum concentration is in the outer zone of the nucleus with smaller amount in the core; far less concentration is in the sapwood than in the core of the tree and in the butt part there is less concentration than in vertex [9].

There are no other research results on the peculiarities of the components distribution in chemical composition of oak trunks, and if there are any, they are incomplete or contradictory. Such an investigation of the oak wood properties was never carried out for wine-making in Azerbaijan.

Our objective was to investigate the distribution of chemical components as well as anatomical and chemical properties of the transverse and longitudinal sections in the oak species, which are most com-

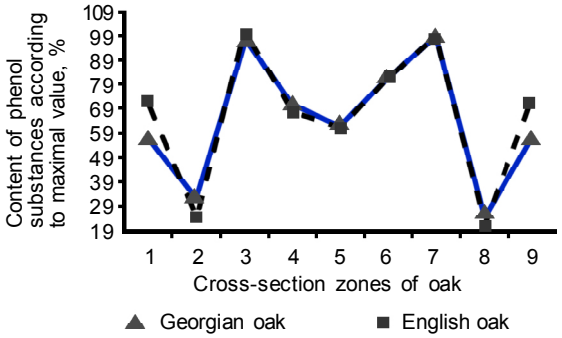

Fig. 1. Distribution of phenolic substances in the cross section of the oak wood

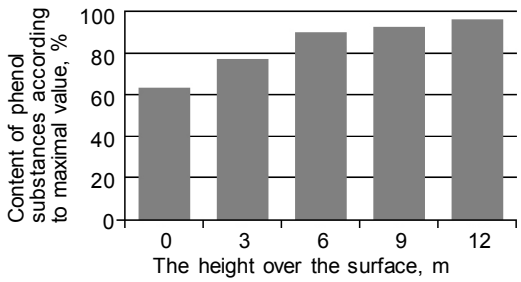

Fig. 2. Distribution of phenolic substances by the height of the trunk

mon and suitable for wine-making. To determine the concentration of water and alcohol-soluble phenolic substances the samples of petiolate and Georgian oak wood were used.

The test areas were selected in the regions of Azerbaijan more or less characterized by oak growing and favorable conditions for that: fresh and moist oak forests and sudubravah, seed plants capacity (Fig. 1). The samples of oak for analysis were selected from specific areas of the trunk: Zone 1 - central part of the core; zone 2 and zone 3 – middle part of the tree used for the main part of the wine barrel; zones 4 and 5 – the earlier zone of core (the zone of biochemical formation of nuclei is a smaller portion of the total mass of the heartwood compared with the zones 2 and 3); zones 6 and 7 - sapwood and zone 8 - bark.

The samples were taken from two symmetrical points of every cross-section as the tree rings (layers) in the oak-wood cross-sections are of different width in the opposite directions of the core.

The results of the research on distribution of phenolic substances in the wood cross-sections of the English oak (*Quercus robur*) and Georgian oak (*Quercus iberica* Stev.) are shown in Fig. 1.

The analysis of cross-sections of the trunk at different heights from the ground showed maximum concentration of phenolic substances in the core in the zones 4, 5, 2 and 3; minimum concentration is observed in sapwood - 1-2, 8-9.

No positive result was yielded from the attempts of finding differences between the distribution of phenolic substances in the trunks of English and Georgian oaks from different regions of Georgia. As is seen from Fig. 1. Distribution of phenolic substances in the cross-sections of trunks of English and Georgian oaks is similar.

The content of phenolic substances in middle part of core (zones 2 and 3), from which 80% of staves are made, is 20% less than in zones 4 and 5, and in zone 10 it is 25% more than in the heartwood. Thus, a significant part of phenolic substances is concentrated right in those zones of the core, which is used for production of wine barrel staves [10].

In the longitudinal sections of English oak and Georgian oak the content of phenolic increases from the butt to the top of the trunk, i.e., young tree trunks contain more phenolic substances in the upper part (Fig. 2). This is characteristic of these oak species. Between the upper and middle parts of the young trunk from which the staves are cut out, the difference in the content of phenol substances is 10 ... 25% (Fig. 3).

It was estimated that the content of water- and an alcohol-soluble fractions of phenol substances are 42% less in Georgian oak wood than in the English oak wood (Fig. 4). In English and Georgian oak wood the water-soluble fractions dominate. However, there is a significant difference in the ratio of the factions. In the English oak wood the content of the water-soluble fraction of phenol substances is 61% and alcohol-soluble fraction 35% (ratio: 1.7: 1.0), while in the Georgian oak wood it is 58 and 39%, respectively (ratio of 1.5: 1.0).

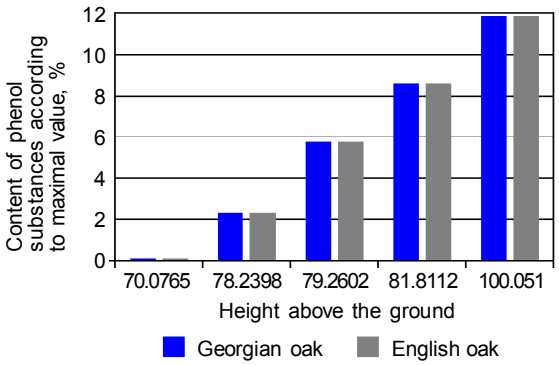

Fig. 3. Distribution of phenolic substances by the height of the trunk of the English and Georgian oak wood.

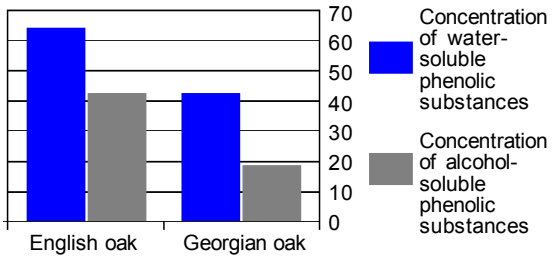

Fig. 4. Concentration of water- and alchohol-soluble phenolic substances in the English and Georgian oak wood.

Studies suggest the following conclusions:

- Distribution of phenolic substances in the cross-sections of the trunk of English and Georgian oak in different regions of Azerbaijan are similar - their maximum concentration is in the heartwood – in zone 4, 5, 2 and 3, and the minimum in the sapwood;

- Most phenolic substances of oak wood is concentrated in zones 2- and 3 of the core, from which the staves are made;

- In the longitudinal cross-sections of English and Georgian oak the concentration of phenolic substances increases from the butt to the top of the trunk;

- The content of phenolic substances is 42% less in Georgian oak wood. Than in the English oak wood.

- In English and Georgian oak wood the water-soluble fractions dominate. In English oak wood the water soluble fraction is 67%, and the alcohol soluble 33% , while in the Georgian oak wood it is 59% (per unit mass of wood 1.9 times less than in English oak) and 41% (per unit mass of wood 1.3 times less than in the English oak), respectively.

The same model samples of oak wood selected in different regions of Azerbaijan, were used to assess the dependence of anatomical and chemical composition of the oak wood on the site [11, 12].

Technological evaluation of raw materials for the production of oak barrels for wine and cognac barrels was carried out in these regions according to the International Classification of anatomical structure and the concentration of aromatic components of oak.

ბიოტექნოლოგია

აზერბაიჯანული მუხის მერქნის ტექნოლოგიური შეფასება მეღვინეობაში

ტ. პანახოვი

(წარმოდგენილია აკადემიის წევრის გ. კვესიტაძის მიერ)

სტატიაში განხილულია მუხის მერქნის ანატომიური თვისებებისა და ქიმიური შემადგენლობის გამოსადეგობის განსაზღვრა მეღვინეობაში. ჩატარებულია მუხის ნედლი მასალის ტექნოლოგიური შეფასება და მოცემულია ვრცელი ინფორმაცია აზერბაიჯანის მუხის მერქნის მაღალხარისხოვანი შემადგენლობის შესახებ სხვა ქვეყნების მუხის ხეებთან შედარებით. სტატიაში აღწერილია ღეროს სხვადასხვა ნაწილებში მისი კომპონენტების განლაგების თავისებურებები.

REFERENCES

1. *Dubrovin V.N., Kokarev G.D.* (1969) Ispol'zovanie dubovoi i bukovoi drevesiny (Obzor). M. 54 s. (in Russian).
2. *Puech J.-L.* (1987) Am. J. Enol. Vitic. **38**, 23: 236-238.
3. *Vivas N.* (2002) Manuel de tonnellerie a l'usage des utilisateurs de futaille / Vivas N. / Vivas N. // Editions Feret. - Bordeaux. 207 p.
4. *Yakovlev A.N.* (1933) Bondarnaia tara. M. 226 p. (in Russian).
5. *Porosha S.I., Orlov B.P., Khmaladze G.G.* (1983) Sovremennye problemy lesnoi tipologii: vsesoiuz. konf., 10, 15.10.83 g.: tezisy dokl. L'vov, pp. 116-117 (in Russian).
6. *Prida A.* (2006) J. Agric. Food Chem. **54**. 21: 8115-8126.
7. *Lukanin O.S., Zrazhva S.G., Agafonov M.F., Bayluk C.I., Panahov T.M.* (2010) Rekomendatsii schodo tehnologii visushuvannia-dozrivannia dubovoi klepki dlya vinnikh, koniachnykh ta kal'vadosnykh bochok - Kyiv, 56 p. (in Ukrainian).
8. *Valuiko G.G.* (2006) Tekhnologicheskie pravila vinodeliia. Tom 2: (Igristie vina. Kon'iaki. Plodovo-iagodnye vina.) Simferopol': Tavrida, 288 p. (in Russian).
9. *Korovin V.V. et al* (2007) Dub v lesovodstve i vinodelii. M.: DeLi print, 480 p. (in Russian).
10. *Vikhrov V.E.* (1954) Stroenie i fiziko-mekhanicheskie svoistva drevesini duba. M; AN SSSR, 264 pp. (in Russian).
11. *Aksenov P.A., Kurakova O.V.* (2004) Sb. trudov IV Mezhdunarodnogo simpoziuma "Stroenie, svoistva i kachestvo drevesini, Sankt-Peterburg. T. 1., S.-P., 115 p.

Received November, 2015