Chemistry of Natural Compounds, Vol. 40, No. 5, 2004

INVESTIGATION OF KERNEL OILS OF *Quercus robur* AND *Quercus cerris*

S. Petrovic,[1] S. Sobajic,[2] S. Rakic,[3] A. Tomic,[1] and J. Kukic[1]

UDC 547.915

The kernel oils of Quercus robur *and* Quercus cerris *were obtained by Soxhlet extraction using petroleum ether. Oil yields were found to be 5.2–5.6% and 4.3–4.8% for* Q. robur *and* Q. cerris *kernel, respectively (expressed in g per 100 g of dried plant material). The physical and chemical constants, unsaponifiable matter and total fatty acids were determined. The total fatty acid composition of oils was determined by GC in the methyl ester form. Considering the composition and content of fatty acids, the examined kernel oils were very similar. Seven fatty acid components were identified in both oils: palmitic, stearic, arachidic, palmitoleic, oleic, linoleic, and α-linolenic. In* Q. robur *and* Q. cerris *kernel oils the principal acids were oleic (44.3% and 43.0%, respectively) and linoleic (37.2% and 32.6%, respectively), followed by a significant amount of palmitic acid.*

Key words: *Quercus robur* L., *Quercus cerris* L., kernel oils, physical and chemical constants, fatty acid composition, GC.

Kernels of *Quercus* L. species (Fagaceae) contain carbohydrates, proteins, fats, and tannins. During the roasting of kernels, starch transforms into dextrin and tannin content decreases, as well as the astringency. Active carbon, a good adsorptive agent, is obtained by further roasting. Roasted oak kernels, *Quercus semen tostum (Glandes Quercus tostae)*, are used in traditional medicine as astringent, antidiarrheal, antidote, and in menstrual dissorders. A mixture of grounded roasted oak kernels, wheat flour, and cocoa is used as food and mild antidiarrheal. Oak kernels can be used for making bread (up to 10% of quantity) in irregular situations. In that case kernels are shelled out and soaked or boiled in salty water to reduce their bitterness. Roasted kernels can also be used as a substitute for coffee [1, 2].

Oils of *Quercus* kernels have rarely been investigated so far. In this study we analyzed the oils of *Q. robur* L. (English Oak) and *Q. cerris* L. (Turkish Oak). English Oak is widely distributed in Europe, mainly in plains and river valleys. Turkish Oak grows in Southern Europe, especially in the Appenninian and Balcan Peninsula. These two *Quercus* species are common in Serbian flora [3].

We established that the oil yield in kernels of *Q. robur* and *Q. cerris* was 5.2–5.6% and 4.3–4.8%, respectively (expressed in g of oil per 100 g of dried plant material). The obtained oils were clear, yellow (*Q. robur*) and dark-yellow (*Q. cerris*) liquids.

1) Institute of Pharmacognosy, Faculty of Pharmacy, University of Belgrade, Belgrade; Serbia and Montenegro, fax: +(38111) 39 72 840, e-mail: silvana@afrodita.rcub.bg.ac.yu; 2) Institute of Bromatology, Faculty of Pharmacy, University of Belgrade, Belgrade; Serbia and Montenegro, fax: +(38111) 39 72 840, e-mail: sltimes@drenik.net; c) Department of Food Technology and Biochemistry, Faculty of Agriculture, University of Belgrade, Belgrade-Zemun, Serbia and Montenegro, fax: +(38111) 19 36 59, e-mail: sveto@agrifaculty.bg.ac.yu. Published in Khimiya Prirodnykh Soedinenii, No. 5, pp. 347-348, September-October, 2004. Original article submitted April 26, 2004.

 0009-3130/04/4005-0420

TABLE 1. Values of Physical and Chemical Constants of the *Q. robur* and *Q. cerris* Kernel Oils

Constant	*Q. robur*	*Q. cerris*
Relative density (d_{20}^{20})	0.9019-0.9024	0.9012-0.9018
Refractive index (n_D^{20})	1.4602-1.4669	1.4557-1.4605
Iodine number*	89.1-89.3	91.0-91.2
Saponification number**	157.8-158.6	186.1-186.5

*g of J_2 that can be fixed by 100 g of the substance;
**mg of KOH required to neutralize the free acids and to saponify the esters present in 1 g of the substance [9, 14].

TABLE 2. Fatty Acid Composition (%) of the *Q. robur* and *Q. cerris* Kernel Oils

Fatty acid	*Q. robur*	*Q. cerris*
Palmitic (16:0)	14.8	19.3
Stearic (18:0)	1.1	1.2
Arachidic (20:0)	0.2	0.2
Palmitoleic (16:1)	0.4	Tr.
Oleic (18:1)	44.3	43.0
Linoleic (18:2)	37.2	32.6
α-Linolenic (18:3)	1.8	3.7
$\Sigma_{Sat.}$	16.1	20.7
$\Sigma_{Unsat.}$	83.7	79.3
Σ Fatty acids	99.8	100.0

Tr.: trace < 0.1%.

The values of physical constants (relative density and refractive index) and chemical constants (iodine and saponification number) of the investigated oils are given in Table 1. The content of unsaponifiable matter in *Q. robur* oil and in *Q. cerris* oil was 2.9%. The total fatty acid fractions for *Q. robur* and *Q. cerris* oil were 90.8% and 90.6%, respectively. The total fatty acid composition of oils was determined by GC in the methyl ester form. Considering the composition and content of fatty acids, the examined *Q. robur* and *Q. cerris* kernel oils are very similar. In both oils seven fatty acids were identified: palmitic, stearic, arachidic, palmitoleic, oleic, linoleic, and α-linolenic (Table 2).

In the *Q. robur* and *Q. cerris* kernel oils the percentage of the unsaturated fatty acids was significantly higher (83.7% and 79.3 %, respectively) than the saturated ones (16.1% and 20.7%, respectively). The dominant acids were oleic (44.3% and 43.0%, respectively) and linoleic (37.2% and 32.6%, respectively), followed by a significant amount of palmitic acid (14.8% and 19.3%, respectively).

According to Hopkins and Chisholm, in *Q. alba* kernel oil oleic acid is also dominant [4]. Cantos et al. have also found oleic acid as the principal fatty acid in the endosperm of *Q. ilex*, *Q. rotundifolia* and *Q. suber* (> 63% of total fatty acids), followed by palmitic and linoleic acids at similar concentrations (12–20%) [5].

The investigated oils are characterized by the presence of α-linolenic acid (1.8% for *Q. robur* and 3.7% for *Q. cerris*). α-Linolenic acid belongs to the family of omega-3 polyunsaturated fatty acids that have important functions in the body as precursors of various eicosanoids. Numerous trials showed that these fatty acids, and especially α-linolenic acid, can have a role in prevention of cardiovascular diseases [6]. In several prospective studies α-linolenic acid was inversely related to nonfatal and fatal myocardial infarction [7, 8]. This fatty acid is commonly present in average diets in small quantitites (soy oil, flaxseed oil, canola oil, walnuts) and new potential dietary sources are of interest for the oil industry.

EXPERIMENTAL

Plant Material. Mature acorns of *Q. robur* (English Oak) were collected in October 2003 in Central Serbia, from the Belgrade outer city area (the shores of river island Ada Ciganlija) and of *Q. cerris* (Turkish Oak) in October 2002 in Western Serbia, 20 km southeastern from Bajina Basta (Zaglavak village). Acorns were shelled out and the kernels dried at room temperature and powdered.

Extraction. Kernel oils were obtained in petroleum ether by Soxhlet extraction until exhausted. Organic solvent was removed under reduced pressure at 40°C and the residue dissolved in a mixture of abs. EtOH–toluene (1:1) and dried in a vacuum desiccator.

Physical and Chemical Constants. Determination of physical constants (relative density and refractive index) and chemical constants (iodine and saponification number) was made according to Ph. Jug. IV [9].

Unsaponifiable Matter and Total Fatty Acids. Determination of unsaponifiable matter and total fatty acids was performed according to the Yugoslav Official Register [10].

Preparation of Fatty Acid Methyl Esters. The total fatty acid composition of the kernel oils was determined by GC in the methyl ester form. Fatty acid methyl esters were prepared using 14% BF_3–MeOH solution and extracted with hexane [11].

Gas Chromatography (GC). GC analysis was performed on a VARIAN chromatograph, Model 1400, equipped with a flame ionization detector and a 30 m × 0.32 cm steel column, packed with LAC-3R-728 (20%) on Chromosorb W/AW (80-100 mesh). Nitrogen was used as a carrier gas (flow rate 24 ml/min). The GC oven temperature was kept at 180°C. The detector and injector temperature was 200°C. GC analysis was performed according to the International Standards [12, 13]. Fatty acids were identified by comparison with retention times (Rt) of standards (Supelco™ FAME Mix). The relative content of each fatty acid, in %, was calculated from the ratio of the relevant peak area to the total peak area for fatty acids.

ACKNOWLEDGMENT

This research was supported by the Ministry of Science, Technology and Development of the Republic of Serbia (Grant No. 1568).

REFERENCES

1. H. A. Hoppe, *Drogenkunde*, 7. Auflage, Gram, De Gruyter & CO, Hamburg, 1958, pp. 754–756.
2. M. S. Gorunovic and P. B. Lukic, *Farmakognozija*, Faculty of Pharmacy, University of Belgrade, Belgrade, 2001, pp. 97, 410.
3. M. Jankovic, *Quercus* L. In: *The Flora of FR Serbia*, Vol. **II**. Ed. M. Josifovic, SANU, Belgrade, 1975, pp. 83–87.
4. C. Y. Hopkins and M. J. Chisholm, *Can. J. Chem.*, **31**, 1173 (1953).
5. E. Cantos, J. C. Espin, C. Lopez-Bote, L. Hoz, J. A. Ordonez, and F. A. Tomas-Barberan, *J. Agric. Food Chem.*, **51**, 6248 (2003).
6. S. C. Renaud and D. Lanzmann-Petithory, In: *World Rev. Nutr. Diet*, Vol. **88**, Eds. T. Hamazaki, H. Okuyama, Karger, Basel, 2001, pp. 79–85.
7. E. Guallar, A. Aro, F. J. Jimenez, et al., *Arterioscler. Thromb. Vasc. Biol.*, **19**, 1111 (1999).
8. F. B. Hu, M. J. Stampfer, J. E. Morison, E. B. Rimm, A. Wolk, G. A. Colditz, C. H. Hennekens, and W. C. Willett, *Am. J. Clin. Nutr.*, **69**, 890 (1999).
9. *Yugoslav Pharmacopoeia, Pharmacopoea Jugoslavica editio quarta, Ph. Jug. IV*, National Institute for Health Protection, Belgrade, 1984, pp. 33–59.
10. *Yugoslav Official Register (Sluzbeni list SFRJ)*, **25**, 840 (1973).
11. L. D. Metcalfe and A. A. Schmitz, *Annal. Chem.*, **33**, 363 (1961).
12. *International Standard ISO* 5508-1978 (E).
13. *International Standard ISO* 5508-1979 (E).
14. *European Pharmacopoeia, Third Edition.* Council of Europe, Strasbourg, 1997, pp. 63–64.