https://doi.org/10.15255/KUI.2026.004
KUI-38/2026
Original scientific paper
Received February 5, 2026
Accepted March 18, 2026

Physicochemical Variation in Oils from Walnuts Cultivated in Serbia

M. Radovanović,[a] *B. Rabrenović*,[b] *L. Pejić*,[b] *D. Živanović*,[a] *K. Jevremović*,[a] *R. Ilić*,[a] *V. Đurović*,[a*] *G. Paunović*,[a] and *I. Glišić*[a]

[a] University of Kragujevac, Faculty of Agronomy in Čačak, Cara Dušana 34, 32 000 Čačak, Serbia
[b] University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11 080 Belgrade, Serbia

This work is licensed under a Creative Commons Attribution 4.0 International License

Abstract

Cold-pressed walnut oils obtained from foreign varieties (Chandler, Pieral Lara, Tulare, Gazenhajm 139, Šejnovo) and domestic varieties (Šampion and Rasna) cultivated in Serbia, were analysed to evaluate variation in fatty acid composition. Peroxide value, specific absorbances, and induction period determined by Oxitest were measured to provide a better understanding of oxidative changes in the oils. The iodine value (IV) and refractive index were also determined. Oil acidity and the catalytic effect of free fatty acids on oxidation were examined. The content of saturated fatty acids (SFAs) ranged from 8.91 to 10.47 %, monounsaturated fatty acids (MUFAs) from 14.75 to 20.75 %, and polyunsaturated fatty acids (PUFAs) from 68.76 to 76.32 %, while IV ranged from 153.45 to 162. A very strong negative correlation was observed between the contents of oleic and linoleic acids, as well as between total monounsaturated and polyunsaturated fatty acids. Walnut oils exhibited low atherogenic and thrombogenic indices, and a high ratio of hypocholesterolemia to hypercholesterolemia. A very strong positive correlation was noted between peroxide values and specific absorbances at 232 nm. Oil from the Šampion variety showed the best oxidative stability, which may be attributed to its fatty acid composition, namely, the highest oleic acid content and the lowest linoleic acid content.

Keywords

Cold-pressed oil, walnut varieties, fatty acids, oxidative state

1 Introduction

Walnut kernels have been used in the human diet since ancient times. In addition to the kernels, walnut leaves, bark, and shells have historically been used in traditional medicine.[1] Today, numerous studies report the health benefits associated with walnut consumption, including improved lipid profiles and a reduced risk of cardiovascular disease.[2,3] A significant contribution to these effects is attributed to the fatty acid (FA) composition of walnut oil. Walnut kernels contain approximately 62 to 74 % oil.[4] Walnut oil is a valuable source of linoleic, oleic, and linolenic fatty acids, with a favourable balance of *n*-6 and *n*-3 PUFAs at a ratio of 4 : 1.[5] Components present in minor amounts, such as phenolics, play an important role in protecting low-density-lipoprotein (LDL) cholesterol from oxidative modification.[6]

Although PUFAs are nutritionally essential, they significantly contribute to the oxidative instability of oils. Walnut oil contains one of the highest levels of PUFAs, comprising up to 78 % of total fatty acid content, with linoleic acid as the predominant component – approximately 50–62 %.[4] Walnut oil also contains natural antioxidants, particularly tocopherols, which influence the oxidation process. The chemical composition of walnut oil depends on the variety and growing conditions,[7] as well as on the extraction method and storage conditions of the fruit, kernels, and oil, where elevated temperature and humidity can accelerate oxidative processes.[8]

Cold pressing is a preferred method for producing nutritionally high-quality edible oils with preserved chemical composition. Oils obtained in this way are particularly suitable for analysis, as lower temperatures (not exceeding 50 °C) do not cause significant compositional changes, allowing the oil to retain its natural characteristics. Furthermore, the absence of organic solvents makes this technique environmentally friendly. This applies only to oils obtained from walnuts that are grown, stored, processed, and pressed under controlled conditions.

Many walnut varieties have already been studied, such as Chandler, Franquette, Hartley, Lara, Mayette, Marbot, Mellanaise, Parisienne, Criolla, Serr, Sorrento, and Tulare,[4] but there is limited information on varieties like Šampion, Šejnovo, and Rasna, which, among others, are commonly cultivated in Serbia.

In this study, cold-pressed oils from different walnut varieties (Chandler, Pieral Lara, Tulare, Šampion, Rasna, Šejnovo, and Gazenhajm 139) were analysed to evaluate variation in their physicochemical composition and oxidative stability.

2 Experimental

2.1 Materials

Walnut kernels were obtained from the fruits of seven varieties: Chandler, Pieral Lara, Tulare, Šampion, Rasna, Šejnovo, and Gazenhajm 139, collected during the same

* Corresponding author: Assist. Prof. Vesna Đurović, PhD
Email: vesna.djurovic@kg.ac.rs

growing season from local farmers. All chemicals were p.a., with the exception of n-hexane for spectrophotometric (HPLC grade, Carlo Erba, France). The Supelco™ 37 Component FAME standard mix (Bellefonte, PA, USA) was used to identify fatty acid methyl esters.

2.2 Cold pressing

Partially crushed walnut kernels were pressed using a screw press model OPW 650 (Gorenje, Slovenia), with the outlet oil temperature kept below 50 °C. The crude walnut oils were left overnight at 4 °C. The cold-pressed oil was separated from the sediment by decantation and then stored at 4 °C until analysis.

2.3 Refractive index determination

To measure the refractive index (RI) of oil, an Abbe refractometer (A. KRUSS, Germany) was used, with a range of 1.3000–1.7000 ±0.0001, and monochromatic sodium light (589.6 nm) at 23 °C. The measurements were performed twice, with no differences between repetitions.

2.4 Determination of acid value

The acid value (AV) of cold-pressed walnut oils was determined according to ISO 660[9].

2.5 Determination of peroxide value

The samples were titrated with a 0.01 M aqueous solution of $Na_2S_2O_3$ with starch solution as an indicator, as described by *Trajkovska et al.*[10]

2.6 Determination of iodine value (IV)

Iodine values were calculated from fatty acid percentages according to Eq. (1).[11]

$$\begin{aligned} IV = {} & \%\ \text{oleic acid} \cdot 0.899 + \\ & + \%\ \text{linoleic acid} \cdot 1.814 + \%\text{linolenic acid} \cdot 2.737 \end{aligned} \quad (1)$$

2.7 Determination of specific absorbances

The specific absorbances of the oil solution in *n*-hexane were measured in the UV region of the spectrum at 232 and 270 nm for a concentration of 1 g *per* 100 ml of *n*-hexane solution according to ISO 3656[12].

2.8 Determination of fatty acid composition

Fatty acid composition of walnut oils was determined by gas chromatography using a GC 6890 instrument (Agilent Technologies, Santa Clara, CA, USA) equipped with a split-splitless injector and a flame ionisation detector (FID), following the standard method.[13,14] The procedure was carried out as described by *Muhović et al.*[15]

2.9 Oxidative stability – OXITEST method

Oxidative stability of the oil samples was measured using an OXITEST apparatus (Velp Scientifica, Usmate Velate MB, Italy) following the method of *Muhović et al.*[15] The samples were subjected to accelerated oxidation at 90 °C under an oxygen pressure of 600 kPa. The instrument was controlled using original software (OXISoftTM 5.0.6, Velp), which continuously monitored oxygen pressure. At the end of the test, the programme automatically calculated the induction period (IP) from the resulting oxidation curves using the two-tangent method, defined as the time required to reach the onset of oxidation, corresponding to a sudden change in oxygen consumption.

2.10 Determination of nutritional indexes

The atherogenicity index (AI), thrombogenicity index (TI), and the hypocholesterolemic to hypercholesterolemic ratio (*h*/*H*) were calculated using Eqs. (2), (3), and (4), according to reference[16].

$$AI = \frac{C12:0 + 4 \cdot C14:0 + C16:0}{\Sigma UFA} \quad (2)$$

$$TI = \frac{C14:0 + C16:0 + C18:0}{0.5 \cdot \Sigma MUFA + 0.5 \cdot \Sigma n-6\ PUFA + 3 \cdot \Sigma n-3\ PUFA + (n-3/n-6)} \quad (3)$$

$$h/H = \frac{cis-C18:1 + \Sigma PUFA}{C12:0 + C14:0 + C16:0} \quad (4)$$

2.11 Statistical analysis

For statistical data processing, Microsoft Excel and Statistics Kingdom were used. Principal component analysis (PCA) was performed using XL-STAT v. 7.5 (Addinsoft, Paris, France) after data standardisation.

3 Results and discussion

Five dominant fatty acids were identified in the oils of all walnut varieties: linoleic (C18:2) 57.77–64.67 %; oleic acid (C18:1) 14.65–20.66 %; linolenic acid (C18:3) 9.44–12.15 %; palmitic acid (C16:0) 6.71–8.01 %; and stearic acid (C18:0) 2.02–2.67 %. Smaller amounts of arachidic (C20:0), gondoic (C20:1), and myristic (C14:0) acids were also detected (Table 1). The relative distribution of individual fatty acids was the same in all varieties. Content of SFAs ranged 8.91–10.47 %, MUFAs from 14.75–20.75 %, and PUFAs from 68.76–76.32 %. Similar results were reported by *Rabrenović et al.*[17] for walnut varieties grown in Serbia. Those authors also identified the presence of palmitoleic

Table 1 – Fatty acid composition, nutritional parameters, iodine value, refractive index, and induction period of cold-pressed oil from different walnut varieties

Tablica 1 – Sastav masnih kiselina, nutritivni parametri, jodni broj, indeks loma i indukcijski period hladno prešanog ulja različitih sorti oraha

	Walnut varieties						
Fatty acid / %	Chandler	Pieral Lara	Tulare	**Šampion**	Rasna	**Šejnovo**	G139
C14:0	0.04	0.05	0.04	0.05	0.05	0.04	0.04
C16:0	6.71	7.28	6.85	8.01	7.05	6.90	7.24
C18:0	2.02	2.67	2.45	2.28	2.51	2.32	2.22
C18:1	14.65	17.06	15.29	20.66	16.01	17.05	16.33
C18:2	64.17	63.12	64.67	57.77	64.67	61.54	62.25
C18:3	12.15	9.54	10.44	10.99	9.44	11.87	11.66
C20:0	0.14	0.15	0.14	0.13	0.15	0.15	0.14
C20:1	0.10	0.11	0.10	0.09	0.10	0.11	0.10
ΣSFA	**8.91**	**10.15**	**9.48**	**10.47**	**9.76**	**9.41**	**9.64**
ΣMUFA	**14.75**	**17.17**	**15.39**	**20.75**	**16.11**	**17.16**	**16.43**
ΣPUFA	**76.32**	**72.66**	**75.11**	**68.76**	**74.11**	**73.41**	**73.91**
AI	0.08	0.08	0.08	0.09	0.08	0.08	0.08
TI	0.11	0.15	0.13	0.14	0.14	0.12	0.13
h/*H*	13.48	12.24	13.12	11.09	12.69	13.03	12.40
IV	162.83	155.95	159.63	153.45	157.54	159.45	159.52
RI (23 °C)	1.4750	1.4745	1.4745	1.4740	1.4745	1.4745	1.4745
IP (h) at 90 °C	1.42	2.59	2.09	3.19	1.22	2.13	3.05

fatty acid in the Šampion and Gazenhajm139 varieties, but not in the Šejnovo variety. In contrast, myristic and gondoic fatty acids were not detected in any variety in their study.[17] It is well established that variety is the primary source of variability in fatty acid composition; however, geographical origin and agricultural practices also have an impact.[18,4,19] A strong negative linear correlation was observed between oleic and linoleic fatty acid contents ($r = -0.94$, $p < 0.01$) in agreement with *Martinez and Maestri*[12]. A very strong negative linear correlation was also found between MUFA and PUFA contents ($r = -0.99$, $p < 0.01$).

The values of the nutritional parameters provide insight into how FA composition influences human health. The atherogenicity index (AI) reflects the potential of FAs to contribute to atherosclerosis, while the thrombogenicity index (TI) indicates their thrombogenic potential in relation to blood clot formation and the risk of thrombosis. Oils with low AI and TI values are considered desirable. The hypocholesterolaemic/hypercholesterolaemic (*h*/*H*) ratio may indicate the effects of different FAs on cholesterol metabolism, with higher *h*/*H* ratios being associated with more favourable health effects.[16] The nutritional indices varied among oils from different walnut varieties, with the exception of AI. AI values were 0.8 for all samples, except for oil from the Šejnovo variety, which had a value of 0.9. TI ranged from 0.11 to 0.15, while *h*/*H* ranged from 11.09 to 13.48. *Aydın and Güven*[20] reported AI values from 0.08 to 0.11, TI from 0.05 to 0.06, and *h*/*H* ratios from 9.59 to 12.07. Compared with other fruit seed oils, walnut oil exhibits a higher *h*/*H* ratio and lower AI and TI values.[16]The iodine value (IV) indicates fatty acid unsaturation and is used to identify the type and origin of the oil. In this study, IV ranged from 153.45 to 162.83 (Table 1). High IVs are expected for walnut oil due to its high content of unsaturated fatty acids. Similar results were reported by *Martinez and Maestri*,[11] who found IVs in the range of 154.3–166.0 g I_2/100 g.

The refractive index (RI) of oil depends on chain length, degree of fatty acid unsaturation and oxidation state. RI values ranged from 1.4740 to 1.4750 (Table 1). *Đurović et al.*[21] reported similar RI values of 1.4725 to 1.4745 (at 23 °C) for cold-pressed oils from 12 different walnut genotypes from central and western Serbia, while *Radovanović et al.*[22] reported an RI of 1.4755 (at 25°C) for fresh cold-pressed walnut oil. A higher content of polyunsaturated fatty acids results in higher RI values. Therefore, some authors have reported lower RI for oils from walnut varieties with lower levels of unsaturated fatty acids.

For example, *Aydın and Güven*[20] reported RI (at 25 °C) in the range 1.4677–1.4694, which may be attributed to the significantly lower content of linolenic acid (44.95–48.90 %) as the predominant unsaturated fatty acid. Oil from the Chandler variety, which exhibited the highest RI, was also characterised by the highest IV and PUFA content. In contrast, oil from the Šampion variety, which showed the lowest RI, had the lowest IV and PUFA content.

Acidity is a fundamental parameter of oil quality, and all samples exhibited acid values (AV) within the regulatory limit of <4 mg KOH for cold-pressed edible oils (Fig. 1), as defined by the *Codex Alimentarius*.[23] Oil from the Rasna variety had an AV very close to this limit, which may be attributed to triacylglycerol hydrolysis resulting from increased lipolytic activity during improper storage of walnut fruits under conditions of elevated humidity and temperature.[24] Additionally, lipases present in bacteria and moulds – contaminants of walnuts, can catalyse triacylglycerol hydrolysis and release fatty acids, as explained by *Martínez and Maestri*.[11]

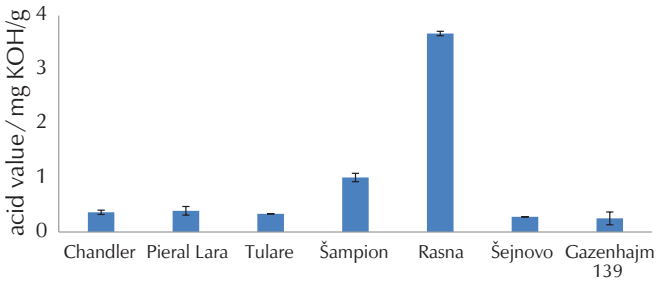


Fig. 1 – Acid values of cold-pressed oils from different walnut varieties
Slika 1 – Kiselinski broj hladno prešanih ulja različitih sorti oraha

The peroxide value (PV) indicates the initial stage of oil oxidation and the presence of primary oxidation products: peroxides and hydroperoxides. In this study, PV increased significantly in oils from all walnut varieties (Fig. 2), suggesting that oxidative processes occurred during walnut storage. In oils from the Chandler and Šejnovo varieties, oxidation had progressed to the extent that the oils were no longer suitable for consumption, as the regulatory limit for cold-pressed oils is 7.5 mmol of active oxygen/kg (15 meq of active oxygen/kg).[23] *Martínez and Maestri*[11] reported a positive correlation between AV and PV, which was explained by the pro-oxidative effect of free fatty acids formed during the hydrolytic decomposition of triglycerides.[25]However, this correlation was not observed in the present study, and intensive hydrolytic changes and elevated free fatty acid levels were not detected in most oils. Moreover, oil from the Šejnovo variety exhibited one of the lowest AVs.

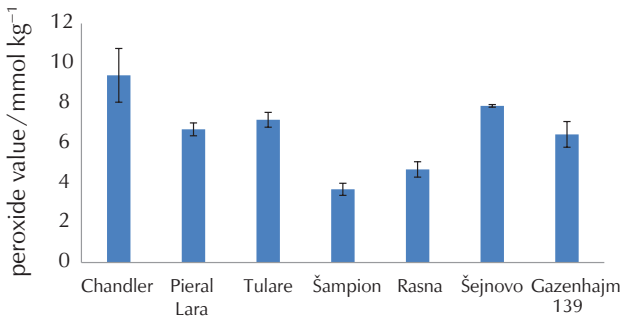


Fig. 2 – Peroxide values of cold-pressed oils from different walnut varieties
Slika 2 – Peroksidni broj hladno prešanih ulja različitih sorti oraha

These findings suggest that free fatty acids did not catalyse the oxidative changes in this case. This observation may be associated with a higher concentration of natural antioxidants, such as tocopherols and phenolic compounds.

Additional parameters for assessing the oxidative state of oil include specific absorbances in the UV region of the spectrum at 232 nm and 270 nm (K_{232} and K_{270}). Measurement of specific absorbances has been shown to be a more sensitive method than PV for detecting minor oxidative changes in hazelnut oil induced by thermal treatment.[26] Increased K_{232} values indicate the onset of oxidative processes and the formation of primary oxidation products. In this study, K_{232} values ranged from 2.02 to 2,85 (Fig. 3). Significantly lower values have been reported in the literature, ranging from 1.04 to 1.21 for eight walnut varieties,[12] and 1.39 for the Chandler variety, even after four months of storage of cold-pressed oil.[27] These findings are consistent with the low PV values reported in those studies. A strong positive correlation was found between PV and K_{232} ($r = 0.98$, $p < 0.01$).

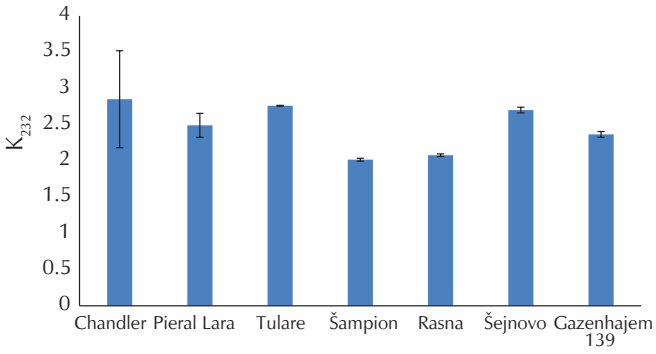


Fig. 3 – Specific absorbances of cold-pressed oils from different walnut varieties at 232 nm
Slika 3 – Specifične apsorbancije hladno prešanih ulja različitih sorti oraha na 232 nm

K_{270} ranged from 0.17 to 0.20 and there were no significant differences in K_{270} among the analysed oils (Fig. 4). Other authors reported lower K_{270} values, ranging from 0.05 to 0.07.[12] *Ampofo et al.*[27] reported that the K_{270} of oil from the Chandler variety was 0.09 even after four months of storage of the cold-pressed oil. Oils that have undergone more intense oxidative damage show increased specific absorbance values at 270 nm due to the formation of secondary oxidation products.

The induction period (IP) of cold-pressed walnut oils ranged from 1.22 to 3.19 h (Table 1). The lowest IP values were observed for oils from the Rasna and Chandler varieties, at 1.22 h and 1.42 h, respectively. This is consistent with the highest PV and K_{232} values observed for the Chandler variety and the highest acid value recorded for the Rasna variety. The best oxidative stability was exhibited by oil from

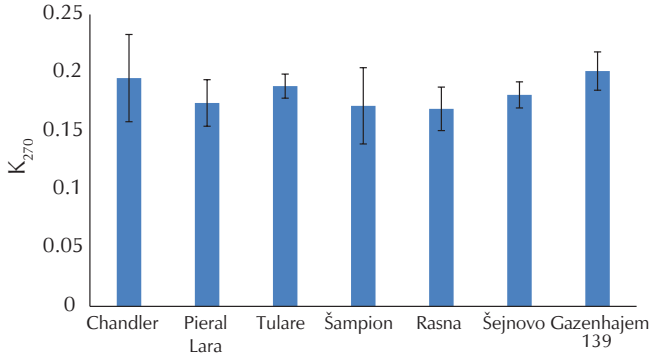


Fig. 4 – Specific absorbances of cold-pressed oils from different walnut varieties at 270 nm
Slika 4 – Specifične apsorbancije hladno prešanih ulja različitih sorti oraha na 270 nm

the Šampion variety, which had the lowest PV and K_{232} values and the highest IP (h). The IP values for all samples were lower than those reported in the literature, likely due to the presence of oxidative changes in the oils. Walnut oil is known to be less stable than other edible oils[28] due to the presence of polyunsaturated fatty acids. Therefore, appropriate storage of walnut fruits, kernels, and oil is essential for maintaining quality. Principal component analysis (PCA) revealed a clear separation of walnut varieties based on fatty acid composition and oxidative quality parameters (Fig. 5). PC1 was mainly associated with ΣMUFA, ΣSFA, C16:0, AI and IP, while ΣPUFA, IV, PV and K_{232} showed negative loadings. The Šampion variety was characterised by higher MUFA content and superior oxidative stability, whereas the Chandler variety was associated with higher polyunsaturation and oxidation indices.

Pieral Lara and Rasna were positioned closer to C18:0 and TI, indicating a less favourable nutritional lipid profile compared with the other varieties.

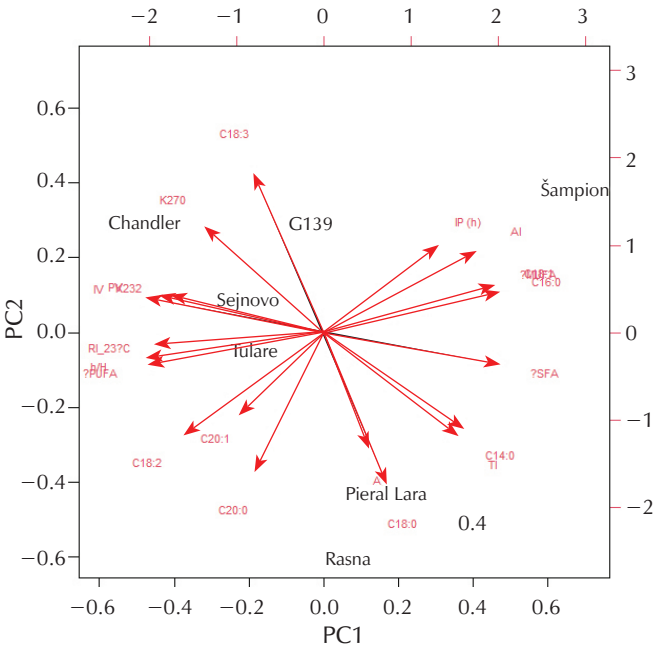


Fig. 5 – Principal component analysis (PCA) biplot of walnut varieties based on fatty acid composition and oxidative quality parameters
Slika 5 – Analiza glavnih komponenti (PCA) sorti oraha na temelju sastava masnih kiselina i parametara oksidativne kvalitete

4 Conclusion

The results of this study demonstrate significant differences in fatty acid composition, acidity, and oxidative stability among analysed oils obtained from seven walnut varieties cultivated in Serbia. A very strong negative correlation was observed between the proportions of oleic and linoleic acids, as well as between MUFA and PUFA contents. All analysed oils exhibited signs of oxidation processes, which were not catalysed by free fatty acids. A very strong positive correlation was found between PV and K_{232}. Oil from the Šampion variety was characterised by the highest oleic acid content, the lowest linoleic acid content, and the greatest oxidative stability.

Nutritional indices varied among the oils from different varieties, with the exception of the atherogenicity index. As the walnuts were not cultivated under the same experimental conditions, further research is required to confirm the superior chemical properties observed in certain varieties.

ACKNOWLEDGEMENTS

This research was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Project Ref. No. 451-03-136/2025-03/200088 and 451-03-137/2025-03/200116.

List of abbreviations and symbols
Popis kratica i simbola

FA – fatty acid
– masna kiselina

SFA – saturated fatty acid
– zasićena masna kiselina

MUFA – monounsaturated fatty acid
– mononezasićena masna kiselina

PUFA – polyunsaturated fatty acid
– polinezasićena masna kiselina

AV – acid value
– kiselinski broj

PV – peroxide value
– peroksidni broj

IV – iodine value
– jodni broj

RI – refractive index
– indeks loma

IP – induction period
– indukcijski period

AI – atherogenicity index
– indeks aterogenosti

TI – thrombogenicity index
– indeks trombogenosti

h/*H* – ratio of hypocholesterolemic to hypercholesterolemic
– omjer hipokolesterolemičnog i hiperkolesterolemičnog

References
Literatura

1. *M. Rashki, M. Ghasemzadeh Rahbardar, M. H. Boskabady,* Nutritional advantages of walnut (*Juglans regia* L.) for cardiovascular diseases: a comprehensive review, Food Sci. Nutrit. **13** (1) (2025) e4526, doi: https://doi.org/10.1002/fsn3.4526.
2. *S. Lockyer, A. E. de la Hunty, S. Steenson, A. Spiro, S. A. Stanner,* Walnut consumption and health outcomes with public health relevance – A systematic review of cohort studies and randomized controlled trials published from 2017 to present, Nutrit. Rev. **81** (1) (2023) 26–54, doi: https://doi.org/10.1093/nutrit/nuac040.
3. *S. M. Alshahrani, R. M. Mashat, D. Almutairi, A. Mathkour, S. S. Alqahtani, A. Alasmari, A. H. Alzahrani, R. Ayed, M. Y. Asiri, A. Elsherif, A. Alsabaani*, The effect of walnut intake on lipids: A systematic review and meta-analysis of randomized controlled trials, Nutrients **14** (21) (2022) 4460, doi: https://doi.org/10.3390/nu14214460.
4. *M. L. Martínez, D. O. Labuckas, A. L. Lamarque, D. M. Maestri*, Walnut (*Juglans regia* L.): genetic resources, chemistry, by-products, J. Sci. Food Agric. **90** (2010) 1959–1967, doi: https://doi.org/10.1002/jsfa.4059.
5. *A. P. Simopoulos,* The importance of the ratio of omega-6/omega-3 essential fatty acids, Biomed. Pharmacother. **56** (2002) 365–379, doi: https://doi.org/10.1016/S0753-3322(02)00253-6.
6. *K. J. Anderson, S. S. Teuber, A. Gobeille, P. Cremin, A. L. Waterhouse, F. M. Steinberg*, Walnut polyphenolics inhibit in vitro human plasma and LDL oxidation, J. Nutr. **131** (2001) 2837–2842, doi: https://doi.org/10.1093/jn/131.11.2837.
7. *O. Kodad, G. Estopañán, T. Juan, R. Socias, M. Sindic*, Genotype and year variability of the chemical composition of walnut oil of Moroccan seedlings from the high Atlas Mountains, Grasas y Aceites. **67** (1) (2016) e116, doi: https://doi.org/10.3989/gya.0256151.
8. *C. Rébufa, J. Artaud, Y. Le Dréau*, Walnut (*Juglans regia* L.) oil chemical composition depending on variety, locality, extraction process and storage conditions: A comprehensive review, J. Food Comp. Anal. **110** (2022) 104534, doi: https://doi.org/10.1016/j.jfca.2022.104534.
9. ISO 660; Animal and vegetable fats and oils – Determination of acid value and acidity, 2020.
10. *B. Trajkovska, V. Djurovic, M. Radovanović, G. Nakov*, Effect of semi-defatted walnut and pumpkin flour fortification on the physicochemical, microbiological, and sensory properties of yogurt, LWT **228** (2025) 118114, doi: https://doi.org/10.1016/j.lwt.2025.118114
11. *M. L. Martínez, D. M. Maestri,* Oil chemical variation in walnut (*Juglans regia* L.) genotypes grown in Argentina, Europ. J. Lipid Sci. Technol. **110** (12) (2008) 1183–1189, doi: https://doi.org/10.1002/ejlt.200800121.
12. ISO 3656; Animal and vegetable fats and oils – Determination of ultraviolet absorbance expressed as specific UV extinction, 2002., url: https://cdn.standards.iteh.ai/samples/34627/6b5d96ae13754f0d97d47841d1684de9/ISO-3656-2002.pdf.
13. ISO 12966-2; Animal and Vegetable Fats and Oils – Gas Chromatography of Fatty Acid Methyl Esters – Part 2: Preparation of Methyl Esters of Fatty Acids. International Organization for Standardization: Geneva, Switzerland, 2017.
14. ISO 12966-4; Animal and Vegetable Fats and Oils – Gas Chromatography of Fatty Acid Methyl Esters – Part 4: Determination by Capillary Gas Chromatography. International Organization for Standardization: Geneva, Switzerland, 2015.
15. *D. Muhović, G. Cvijanović, M. Bajagić, L. Pezo, L. Pejić, B. Rabrenović*, Enhancing Oxidative Stability and Nutritional Quality of Flaxseed Oil Using Apricot, Sesame, and Black Cumin Oil Blends, Foods **14** (11) (2025) 2000, doi: https://doi.org/10.3390/foods14112000
16. *J. Chen, H. Liu,* Nutritional indices for assessing fatty acids: A mini-review, Int. J. Mol. Sci. **21** (16) (2020) 5695, doi: https://doi.org/10.3390/ijms21165695.
17. *B. Rabrenović, E. Dimić, M. Maksimović, S. Šobajić, Lj. Gajić-Krstajić*, Determination of fatty acid and tocopherol compositions and the oxidative stability of walnut (*Juglans regia* L.) cultivars grown in Serbia, Czech J. Food Sci. **29** (1) (2011) 74–78, doi: https://doi.org/10.17221/180/2010-CJFS.
18. *S. Sarikhani, K. Vahdati, W. Ligterink*, Biochemical properties of superior Persian walnut genotypes originated from southwest of Iran, Int. J. Hortic. Sci. Technol. **8** (1) (2021) 13–24, doi: https://doi.org/10.22059/ijhst.2020.309363.392.
19. *P. Gao, J. Jin, R. Liu, Q. Jin, X. Wang,* Chemical compositions of walnut (*Juglans regia* L.) oils from different cultivated regions in China, J. Am. Oil Chem. Soc. **95** (7) (2018) 825–834, doi: https://doi.org/10.1002/aocs.12097.
20. *Ç. M. Aydın, A. Güven*, Seed content and its oil composition in walnut cultivated from Tunceli, Türkiye, Cogent Food Agric. **10** (1) (2024) 2297517, doi: https://doi.org/10.1080/23311932.2023.2297517.
21. *V. Đurović, M. Radovanović, D. Tomić, M. Marjanović, D. Marković, L. Mandić,* Characteristics of cold-pressed walnut (*Juglans regia* L.) oil from Western and Central Serbia, J. Cent. Eur. Agric. **25** (1) (2024) 234–242, doi: https://doi.org/10.5513/JCEA01/25.1.4141.
22. *M. Radovanović, D. Živanović, V. Đurović,* Thermo-oxidative stability of cold-pressed walnut oil, Proceedings, 3rd International Symposium on Biotechnology. Faculty of Agronomy in Čačak, University of Kragujevac, 2025, pp. 459–466, doi: https://doi.org/10.46793/SBT30.55MR.
23. Codex Alimentarius, Named Vegetable Oils, Codex Stan. **210** (8) (2005) 11–21.
24. *S. Pournik, M. Abbasi-Rostami, H. R. Sadeghipour, F. Ghaderi-Far*, True lipases beside phospholipases contribute to walnut kernel viability loss during controlled deterioration and natural aging, Environ. Exp. Bot. **164** (2019) 71–83, doi: https://doi.org/10.1016/j.envexpbot.2019.04.016.
25. *N. Frega, M. Mozzon, G. Lercker*, Effects of free fatty acids on

oxidative stability of vegetable oil, J. Am. Oil Chem. Soc. **76** (3) (1999) 325–329, doi: https://doi.org/10.1007/s11746-999-0239-4.

26. *M. Radovanović, J. Kurtić, M. Petković, N. Miletić, V. Đurović*, Changes in cold-pressed oil due to roasting of hazelnut kernels, Acta Agric. Serb. **29** (58) (2024) 85–90, doi: https://doi.org/10.5937/AASer2458085R.
27. *J. Ampofo, F. S. Grilo, S. Langstaff, S. C. Wang,* Oxidative stability of walnut kernel and oil: chemical compositions and sensory aroma compounds, Foods **11** (19) (2022) 3151, doi: https://doi.org/10.3390/foods11193151.
28. *J. S., Amaral, S. Casal, J. A. Pereira, R. M. Seabra, B. P. Oliveira,* Determination of sterol and fatty acid compositions, oxidative stability, and nutritional value of six walnut (*Juglans regia* L.) cultivars grown in Portugal, J. Agric. Food Chem. **51** (26) (2003) 7698–7702, doi: https://doi.org/10.1021/jf030451d.

SAŽETAK

Fizikalno-kemijske varijacije u uljima oraha uzgajanih u Srbiji

Mirjana Radovanović,[a] *Biljana Rabrenović*,[b] *Lazar Pejić*,[b] *Darinka Živanović*,[a] *Katarina Jevremović*,[a] *Radmila Ilić*,[a] *Vesna Đurović*,[a*] *Gorica Paunović* [a] i *Ivan Glišić* [a]

Analizirana su hladno prešana ulja oraha stranih sorti (Chandler, Pieral Lara, Tulare, Gazenhajm 139, Šejnovo) i domaćih sorti (Šampion i Rasna) uzgajanih u Srbiji da bi se procijenila varijacija u sastavu masnih kiselina. Da bi se bolje razumjele oksidacijske promjene u uljima, izmjeren je peroksidni broj, specifična apsorbancija i indukcijski period Oxitestom. Također je određen jodni broj (IV) i indeks loma. Ispitana je kiselost ulja i katalitički učinak slobodnih masnih kiselina na oksidaciju ulja. Sadržaj zasićenih masnih kiselina (SFA) kretao se od 8,91 do 10,47 %, mononezasićenih masnih kiselina (MUFA) od 14,75 do 20,75 %, a polinezasićenih masnih kiselina (PUFA) od 68,76 do 76,32 %, dok se IV kretao od 153,45 do 162. Utvrđena je vrlo jaka negativna korelacija između sadržaja oleinske i linolne kiseline, kao i između ukupnih mononezasićenih i polinezasićenih masnih kiselina. Ulja oraha imala su niske vrijednosti aterogenog i trombogenog indeksa te visok omjer hipokolesterolemije i hiperkolesterolemije. Uočena je vrlo jaka pozitivna korelacija između peroksidnih vrijednosti i specifičnih apsorbancija na 232 nm. Ulje sorte Šampion pokazalo je najbolju oksidacijsku stabilnost, na što može utjecati sastav masnih kiselina: najveći sadržaj oleinske kiseline i najniži sadržaj linolne kiseline.

Keywords
Hladno prešano ulje, sorte oraha, masne kiseline, oksidacijsko stanje

[a] *Univerzitet u Kragujevcu, Agronomski fakultet u Čačku, Cara Dušana 34, 32 000 Čačak, Srbija*
[b] *Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11 080 Beograd, Srbija*

Izvorni znanstveni rad
Prispjelo 5. veljače 2026.
Prihvaćeno 18. ožujka 2026.