

Article

SPECTRAL-LUMINESCENT PROPERTIES OF RAPESEED OIL OBTAINED FROM SEEDS PURIFIED WITH AN ELECTROSTATIC FIELD

Stepan Kovalyshyn¹, Stepan Myagkota¹, Oleg Kushnir¹, Oleg Kovalyshyn¹, Vadym Ptashnyk¹, Andriy Pushak², Oksana Vasylenko³, Rafał Jończy⁴, Taras Hutsol^{5*}

¹ Faculty of Mechanics, Power Engineering and Information Technologies, Stepan Gzhytskyi National University Veterinary Medicine and Biotechnologies of Lviv, Ukraine, e-mail: (S.K.) stkovalyshyn@gmail.com, ORCID 0000-0002-7118-9360; (S.M.) smyagkota@gmail.com, 0000-0002-4746-2494; (O.K.) olegpkushnir@gmail.com, ORCID 0000-0002-1746-0383; (O.Kov.) kovalyshynoleh@gmail.com, ORCID 0009-0008-0741-9484; (V.P.) ptashnykproject@gmail.com ORCID 0000-0002-1018-1138

² Faculty of Physics, Ivan Franko National University of Lviv, Ukraine, e-mail: apushak@gmail.com, ORCID 0000-0003-4235-9639

³ Departments of Electrical Engineering, Mechanical Engineering and Engineering Management, Anhalt University of Applied Sciences, Bernburger Str. 57, 06366 Köthen, Germany; e-mail: oksana.vasylenko@hs-anhalt.de; ORCID: 0000-0001-9582-7980

⁴ Department of Production Engineering, Logistics, and Applied Computer Science, Faculty of Production and Power Engineering, University of Agriculture in Krakow, Balicka 116B, 30-149 Krakow, Poland; e-mail: rafal.jonczy@urk.edu.pl (R.J.), ORCID 0009-0004-9094-4597

⁵ Ukrainian University in Europe – Foundation, Balicka 116, 30-149 Krakow, Poland; e-mail: university.uue@gmail.com (T.H.), ORCID 0000-0002-9086-3672

* Corresponding author: taras.hutsol@urk.edu.pl

ABSTRACT

Samples of rapeseed oil obtained by cold pressing from seeds treated with an electrostatic field of intensity $E = (0.05-0.25) \text{ MV} \cdot \text{m}^{-1}$ for a duration of $t = 3-30 \text{ s}$ were analyzed. As a reference, the spectral-luminescent characteristics of rapeseed oil samples prepared similarly from control rapeseed that had not been treated with an electrostatic field were also recorded. The behaviour of rapeseed oil fluorophores, namely tocopherol, phenol, fatty acids, oxidation products, vitamins and pigments, which are part of its composition, was a source of information about the chemical composition of the seeds under study. It has been found that the fluorophores in rapeseed oil obtained from seeds pretreated with an electrostatic field with an intensity at $E = (0.05-0.25) \text{ MV} \cdot \text{m}^{-1}$ for $t = 3-30 \text{ s}$ exhibit spectral-luminescent properties identical to those of rapeseed oil obtained from seeds that were not subjected to additional electrostatic field treatment. Specifically, the spectral-luminescent properties of the fluorophores in rapeseed oil (tocopherol, phenol, fatty acids, oxidation products, vitamins, and pigments) obtained from seeds treated with an electrostatic field with an intensity at $E = (0.05-0.25) \text{ MV} \cdot \text{m}^{-1}$ for $t = 3-30 \text{ s}$ were identical to those of fluorophores in rapeseed oil obtained from rapeseed that had not been exposed to an electric field of the specified parameters. The results obtained indicate that additional cleaning of rapeseed using an electrostatic field under the specified conditions does not cause any changes in its chemical composition or in the nature of intermolecular interactions within it.

ARTICLE INFO

Keywords:

electrical stimulation,
spectral-luminescent
properties,
rapeseed,
rapeseed oil.

Article history:

Received: January 2026
Received in the revised form:
July 2026
Accepted: August 2026
Published: August 2026

Copyright: © 2026 by the Authors.
This article is distributed under
the terms and conditions of the
Creative Commons Attribution
License (CC BY 4.0).

Introduction

Among all vegetable oils produced worldwide, rapeseed oil is the most widely used (Morin and Lees, 2018; Rolewicz et al., 2025). This oil, obtained through cold pressing, is gaining increasing popularity due to the global trend toward consuming products that are minimally processed with chemical preservatives. The growing demand for rapeseed oil is also driven by the development of erucic acid-free and low-glucosinolate rapeseed varieties, as the presence

of these compounds previously limited its use as a food product. This type of rapeseed oil serves as a valuable alternative to olive oil.

The biological value of rapeseed oil is determined by its content of essential fatty acids - linoleic and linolenic, which are not synthesised in the human body. Additionally, rapeseed oil contains significant amounts of vitamins E and A, natural antioxidants that protect cells from free radical damage. Linoleic (ω -6) and linolenic (ω -3) fatty acids are components of cell membranes and determine their elasticity. It has been proven that ω -3 fatty acids reduce blood clotting, prevent thrombus formation, and protect blood vessels from cholesterol plaque formation, thus contributing to the prevention of cardiovascular diseases (Ogborn et al., 2002, Paschos et al., 2007, Yamaguchi et al., 2015).

To obtain a sufficient amount of rapeseed oil, various measures must be implemented to increase the yield of winter rapeseed. One such measure is the pre-sowing treatment of seeds with a corona discharge electric field, which can increase seed yield by 10–15% (Kovalyshyn, 2016, Kovalyshyn et al., 2022, Kovalyshyn et al., 2024). However, there is currently a lack of well-founded scientific research providing information on potential detrimental changes to the chemical composition of seeds subjected to pre-sowing treatment with an electric field of the specified parameters.

In view of this, the aim of our study was to investigate the effect of pre-sowing treatment of rapeseed with a corona discharge electric field of intensity $E = (0.05-0.25) \text{ MV}\cdot\text{m}^{-1}$ for durations of $t = 3$ and 30 s on the potential occurrence of various types of destructive changes in intermolecular interactions within the seeds and, consequently, on the chemical composition of the oil obtained from seeds treated with an electrostatic field.

Spectral luminescence analysis of rapeseed oil was chosen as a source of information regarding possible changes in the structure and chemical composition of rapeseed. Spectral luminescence analysis is characterised by high sensitivity to the spectral position of fluorophore emission levels, which depends on the nature of the intermolecular interactions between seed components occurring in the treated seeds.

The absence of changes in the photoluminescence spectra and photoluminescence excitation spectra of oil components obtained from electrically treated seeds, compared with those characteristic of oil obtained from untreated seeds, may indicate that electrostatic treatment under the specified parameters has no effect on the structure of rapeseed.

If changes are observed in the spectra mentioned, it can be concluded that the additional treatment of rapeseed with an electrostatic field leads to changes in the structure and chemical composition of the rapeseed.

Experimental part

Photoluminescence and photoluminescence excitation spectra of oils obtained from stimulated and untreated seeds were recorded using the setup shown in Figure 1. Winter rapeseed (MAXIMUS-PR44DO6 hybrid) was used for the experiment. The seed used in the trials was uniform, of high quality and free from any damage.

For the photoluminescence spectrum measurements, the required excitation light region was selected from the continuum of a deuterium lamp using an MDR-12 monochromator (manufactured by LOMO (Leningrad, USSR)).

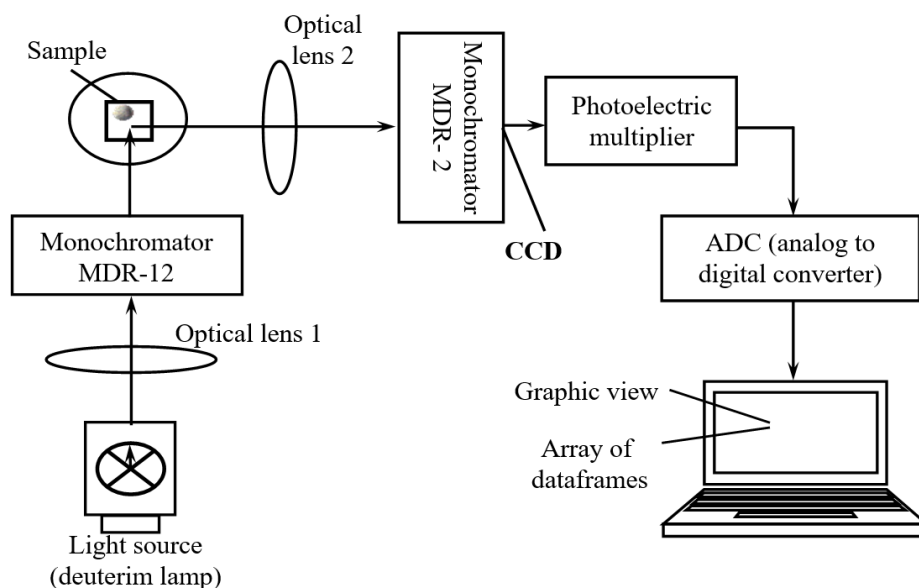


Figure 1. Block diagram of the setup for recording the spectral-luminescent characteristics of rapeseed oil obtained by cold pressing.

Measurements were carried out in a right-angle setup using quartz cuvettes (10 mm × 10 mm × 45 mm) filled with oil samples without prior preparation. The luminescence signal was recorded in single-photon counting mode using an MDR-2 monochromator and a PMT-100 photomultiplier tube. The discrete adjustment of the excitation light wavelength from the deuterium lamp continuum was performed using a stepper motor by rotating the diffraction grating of the MDR-12 monochromator. The signal from the FEP-100 photomultiplier was converted into a digital code via a channel converter and processed by a personal computer using Origin version 8.0. The measurement results were presented in graphical and digital formats.

To record the excitation spectra of photoluminescence of the studied oils in the same geometric configuration, the required section of the photoluminescence spectrum was selected using the MDR-2 monochromator. Similar to photoluminescence spectrum measurements, the photoluminescence signal was recorded using the FEP-100 photomultiplier tube. The signal from the FEP-100 photomultiplier was converted into a digital code via a channel converter and processed by a personal computer using Origin version 8.0.

Results and Discussion

As mentioned above, rapeseed oil contains several components that are luminescently active compounds. These include α -, β -, γ -, and δ -tocopherols, which are forms of vitamin E; polyunsaturated fatty acids such as linolenic (ω -3), linoleic (ω -6), arachidonic, and monounsaturated oleic (ω -9); vitamins B2 and E; the precursor of vitamin A, carotene; and pigments such as chlorophyll and pheophytin (Morin, 2018; Cert et al., 2000). These fluorophores can serve as indicators of potential destructive changes in the chemical composition of oil obtained from seeds with different pre-treatment histories. We anticipated that if the specificity of intermolecular interactions among the fluorophores in rapeseed oil changes, the nature of their relaxation channels may also be altered. As a result, the process of radiative relaxation of electronic excitations, which occur due to the absorption of UV radiation, should be sensitive to the specificity of intermolecular interactions among these fluorophores.

Figure 2 shows the luminescence spectra (curves 1, 2) and the luminescence excitation spectra (curves 1', 2') of control samples of rapeseed oil (curves 1, 2) and oil obtained by cold pressing of seeds treated with an electrostatic field of intensity $0.05 \text{ MV} \cdot \text{m}^{-1} \leq E \leq 0.25 \text{ MV} \cdot \text{m}^{-1}$ and treatment duration $3 \text{ s} \leq t \leq 30 \text{ s}$ (curves 1', 2') during excitation at $\lambda_{\text{exc}} = 280 \text{ nm}$.

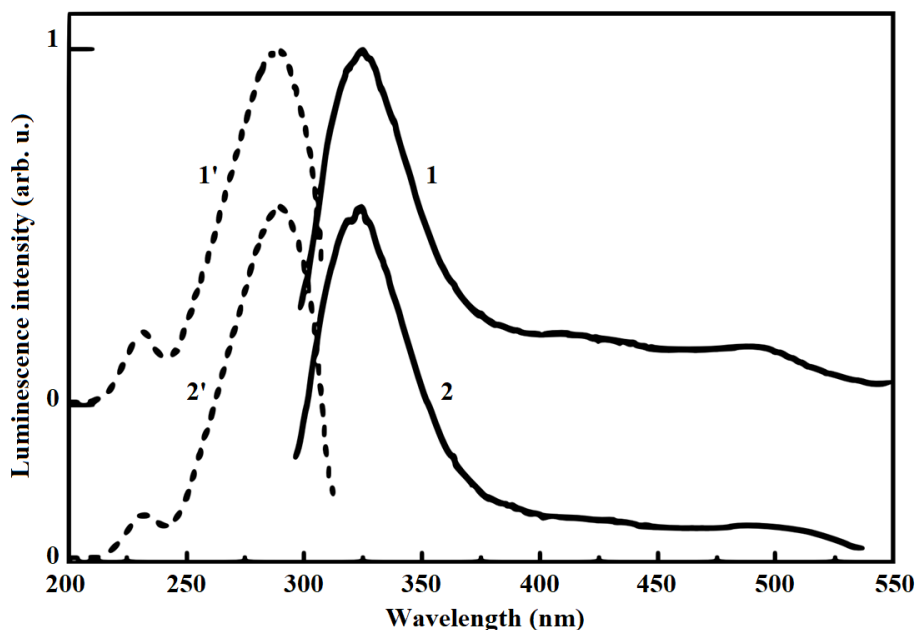


Figure 2. Photoluminescence spectra of rapeseed oil samples obtained from seeds that were either untreated (curve 1) or subjected to additional purification with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s (curve 2) under excitation at $\lambda_{\text{exc}} = 280 \text{ nm}$, and excitation spectra of the photoluminescence band at $\lambda_{\text{max}} = 325 \text{ nm}$ for the mentioned oils (curves 1' and 2', respectively).

In both cases, the luminescence spectra exhibit a non-elementary band at $\lambda_{\text{max}} = 335 \text{ nm}$ with asymmetry in the region of 325 nm and a structured long-wavelength continuum in the spectral range of 400-550 nm.

The excitation spectrum of the non-elementary band at $\lambda_{\text{max}} = 335 \text{ nm}$ is identical for both rapeseed oil samples, regardless of whether the rapeseed seeds were treated with an electrostatic field of the specified parameters, and consists of bands at $\lambda_{\text{exc},1} = 285$ and 235 nm (curves 1', 2'). These spectral-luminescent characteristics of the rapeseed oil samples match those of α -tocopherol (Sikorska et al., 2012; Myagkota et al., 2022; Escuderos et al., 2009).

Based on the identical spectral-luminescent characteristics of rapeseed oil samples obtained from seeds that were not treated with an electrostatic field (curves 1, 2) or those treated with an electrostatic field with an intensity at $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s (curves 1', 2'), it can be concluded that the treatment of rapeseed seeds with an electrostatic field under the specified parameters did not lead to noticeable changes in the nature of the interaction between the tocopherol component and other constituents of rapeseed oil obtained from the mentioned seeds when the oil samples were excited at $\lambda_{\text{exc}} = 280 \text{ nm}$.

It should be added that the spectral and luminescence characteristics of rapeseed oil obtained from rapeseed treated with an electrostatic field of intensity $E \leq 0.25 \text{ MV} \cdot \text{m}^{-1}$ and an exposure time of $3 \text{ s} \leq t \leq 30 \text{ s}$ were identical.

The identical nature of the relaxation channel in rapeseed oil samples obtained from both treated and untreated rapeseed seeds indicates the invariability of the interaction between the tocopherol component and other fluorophores (the presence of which is confirmed by the long-wavelength continuum in the spectral range of 370-550 nm). The high sensitivity of the

spectral position of the luminescence peak of the tocopherol component in vegetable oils, which can vary under the influence of external factors and the chemical composition of the oil, enables the investigation of specific interactions between rapeseed oil fluorophores resulting from the exposure of rapeseed to a constant electrostatic field with an intensity within the range of $E \leq 0.25 \text{ MV} \cdot \text{m}^{-1}$ for a duration of $t \leq 30 \text{ s}$.

The mentioned continuum in the spectral region $\lambda > 370 \text{ nm}$ becomes more structured when the oil samples are excited with light at a wavelength of 325 nm (Fig. 3, curves 1–2).

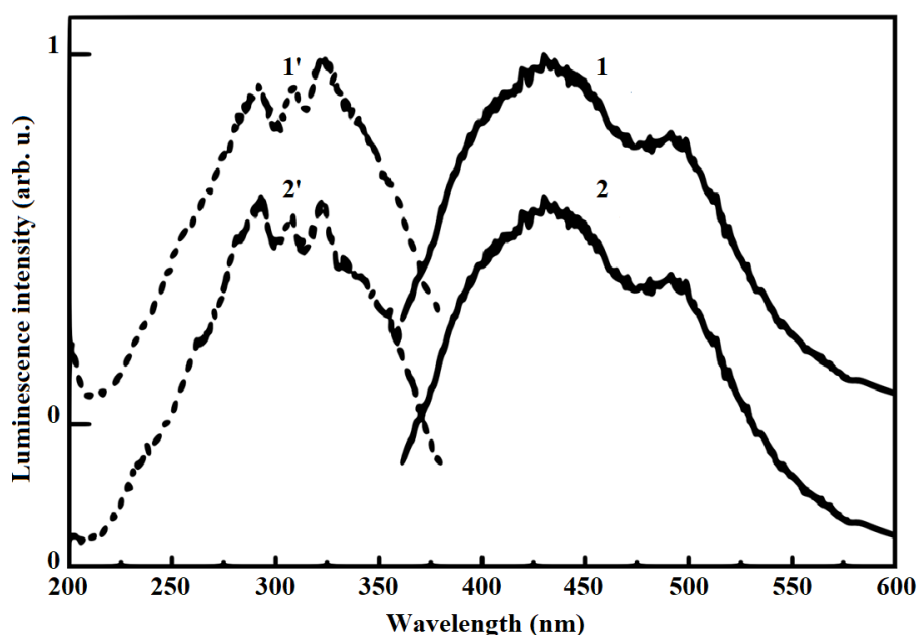


Figure 3. Photoluminescence spectra of rapeseed oil samples obtained from seeds that were either untreated (curve 1) or subjected to additional treatment with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s (curve 2) under excitation at $\lambda_{\text{exc}} = 325 \text{ nm}$, and excitation spectra of the photoluminescence band at $\lambda_{\text{max}} = 425 \text{ nm}$ for the mentioned oils (curves 1' and 2', respectively).

The presence of luminescence bands in rapeseed oil obtained from both treated and untreated rapeseed seeds in the spectral region $\lambda > 370 \text{ nm}$ indicates the existence of additional luminescence centers. Indeed, when the luminescence of rapeseed oil is excited with light at $\lambda_{\text{exc}} = 325 \text{ nm}$, identical intense luminescence bands with $\lambda_{\text{max}} = 425$ and 490 nm are registered in the luminescence spectrum (Fig. 3, curves 1, 2). The excitation spectra of the luminescence band at $\lambda_{\text{max}} = 425 \text{ nm}$ are presented in Figure 3 (curves 1', 2'). According to previous studies (Sikorska et al., 2019; Szukay et al., 2019; Saleem and Ahmad, 2018), luminescence bands in the spectral region ($370 \text{ nm} < \lambda < 550 \text{ nm}$) are attributed to oxidation products of rapeseed oil components, similarly to luminescence bands in the same spectral range characteristic of olive and linseed oils (Escuderos et al., 2009; Szukay et al., 2019; Saleem and Ahmad, 2018; Dupuy et al., 2005; Zandomeneghi et al., 2005; Kovalyshyn et al., 2022). In particular, the $410\text{--}480 \text{ nm}$ range is associated with primary oxidation products, while the $480\text{--}540 \text{ nm}$ range corresponds to secondary oxidation products of vegetable oils (Mishra, 2018). Primary oxidation products of oil, such as hydroperoxides, are unstable compounds. At temperatures above room temperature, they decompose, forming aldehydes, ketones, esters, alcohols, and short-chain hydrocarbons, which contribute to the unpleasant odor of oxidised oils and deterioration of their taste properties (Myagkota et al., 2022; Sikorska et al., 2019; Berto et al., 2020).

However, it should be noted that the intense bands in the 295, 315 and 325 nm regions of the excitation spectrum of the luminescence band at $\lambda_{\text{max}} = 425$ nm are identical to the structure of the excitation spectra of polyunsaturated fatty acids, including linoleic (ω -6), linolenic (ω -3), and monounsaturated oleic (ω -9) acids (Krasnikov et al., 1987; Khosroshahi, 2018; Lobo-Prieto et al., 2020). This coincidence indicates that the mentioned polyunsaturated fatty acids are components of rapeseed oil obtained by cold pressing.

Indeed, according to the results of chromatographic analysis of rapeseed oil obtained by cold pressing, the main fatty acids were oleic, linoleic, and linolenic acids. Their content ranged from 51-70%, 15-30%, and 5-14%, respectively, of the total fatty acid content (Morin and Lees, 2018).

It is not excluded that, at the initial stage of oxidation of freshly pressed rapeseed oil obtained by cold pressing, these polyunsaturated fatty acids contribute to luminescence in the 390-430 nm region. In other words, the luminescence band at 425 nm may represent the cumulative result of radiative annihilation of rapeseed oil components (in this case, monounsaturated oleic acid and polyunsaturated linoleic and linolenic acids) and the primary oxidation products of the mentioned oil.

It should be noted that in the excitation spectrum of the luminescence band at $\lambda_{\text{max}} = 425$ nm of rapeseed oil obtained by chemical extraction, an intense band is registered in the 250 nm region, which is characteristic of the luminescence of hexane used as a solvent in the chemical extraction process. As a result of solvent excitation in the 250 nm region, it emits a band at $\lambda_{\text{max}} = 320$ nm, which is reabsorbed by rapeseed oil, leading to the emission of a band at $\lambda_{\text{max}} = 425$ nm (Kovalyshyn et al., 2022).

An increase in the excitation UV radiation wavelength to $\lambda_{\text{exc}} = 350$ nm leads to the appearance of bands at $\lambda_{\text{max}} = 420$, 460, and 490 nm in the luminescence spectrum, as well as intense luminescence in the 520 nm region and a weakly intense band at $\lambda_{\text{max}} = 675$ nm (Fig. 4, curve 1).

The weakly intense band at $\lambda_{\text{max}} = 675$ nm is not shown in Figure 4, and its nature is discussed below. The structure and spectral position of the excitation spectra of the luminescence bands at $\lambda_{\text{max}} = 425$, 460, and 490 nm (Fig. 4, curves 1', 2', 3') are similar to those presented in Kovalyshyn et al. (2024) and Kyriakidis and Skarcalis (2000), where the bands in the 425, 460, and 490 nm regions were identified as luminescence bands of rapeseed oil oxidation products, while the luminescence band in the 520 nm region is attributed to the emission of vitamins E, B2, and carotene (Baltazar et al., 2020; Silva et al., 2015).

Thus, the luminescence spectrum and the excitation spectrum of the luminescence bands of oil obtained from seeds treated with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s were identical in structure and intensity to those characteristic of oil obtained from untreated seeds with the specified characteristics when excited by UV radiation at $\lambda_{\text{exc}} = 350$ nm.

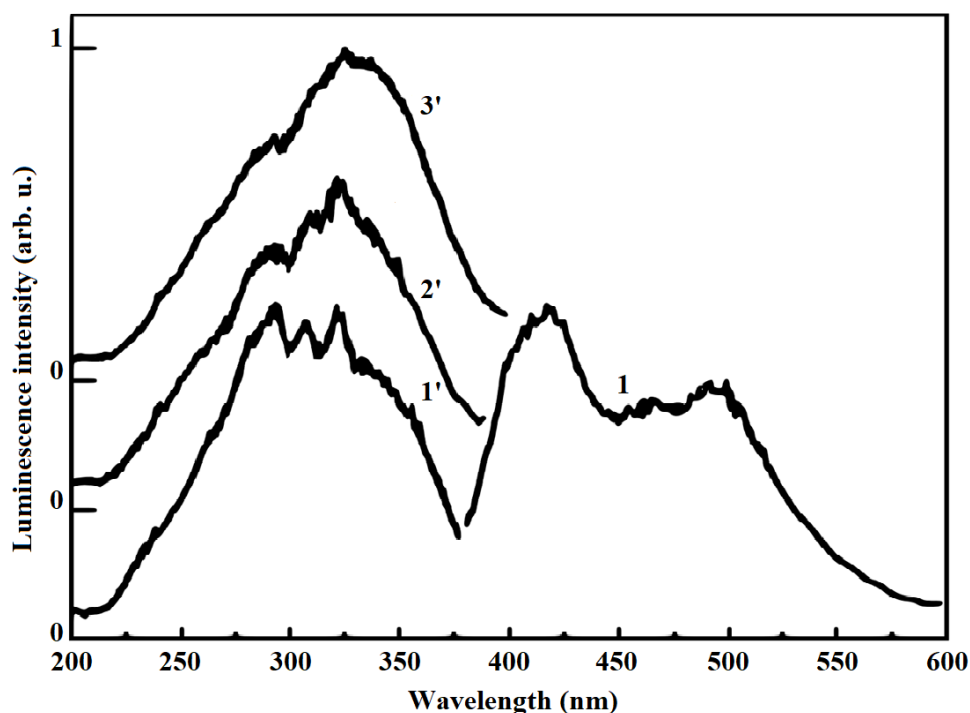


Figure 4. Photoluminescence spectrum of rapeseed oil obtained from seeds that were not subjected to additional treatment with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s (curve 1) under excitation at $\lambda_{\text{exc}} = 350 \text{ nm}$, and excitation spectra of the photoluminescence bands at $\lambda_{\text{max}} = 420, 460, \text{ and } 490 \text{ nm}$ for the mentioned oils (curves 1', 2', and 3', respectively).

It should be noted that the luminescence bands at $\lambda_{\text{max}} = 520$ and 530 nm were attributed to vitamin E and carotene (a precursor of vitamin A) in olive oil as well (Dupuy et al., 2005; Zandomeneghi et al., 2005; Silva et al., 2015; Corradini et al., 2016).

When luminescence is excited in rapeseed oil samples obtained from seeds that were either untreated or treated with an electrostatic field of $0.05 \text{ MV} \cdot \text{m}^{-1} \leq E \leq 0.25 \text{ MV} \cdot \text{m}^{-1}$ for a duration of $3 \text{ s} \leq t \leq 30 \text{ s}$ using UV radiation with a wavelength of $\lambda_{\text{exc}} = 380 \text{ nm}$, the spectra are structurally similar to those obtained when luminescence is excited at $\lambda_{\text{exc}} = 350 \text{ nm}$.

In the case of luminescence excitation of rapeseed oil samples obtained from seeds that were either untreated or treated with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s using UV radiation with a wavelength of $\lambda_{\text{exc}} = 405 \text{ nm}$, the luminescence spectrum registers bands at $\lambda_{\text{max}} = 520 \text{ nm}$ and $\lambda_{\text{max}} = 675 \text{ nm}$ (Fig. 5, curve 1), which are attributed to vitamin E, carotene (a precursor of vitamin A), and the chlorophyll pigment, respectively (Dupuy et al., 2005; Zandomeneghi et al., 2005; Silva et al., 2015; Kyriakidis and Skarcali, 2000; Lobo-Prieto et al., 2020).

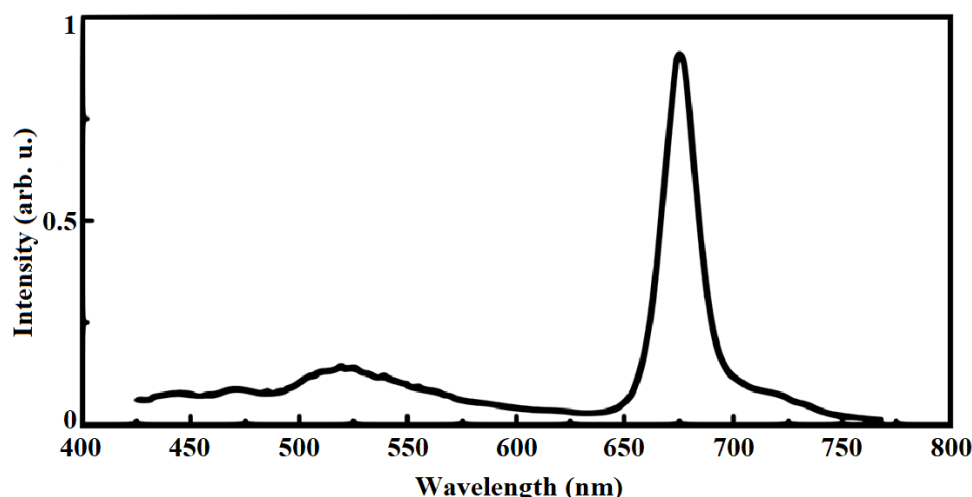


Figure 5. Photoluminescence spectra of rapeseed oil samples obtained from seeds that were either untreated or subjected to additional purification with an electrostatic field at an intensity of $E = 0.25 \text{ MV} \cdot \text{m}^{-1}$ for 30 s under excitation at $\lambda_{\text{exc}} = 405 \text{ nm}$.

The luminescence spectrum and the excitation spectrum of the luminescence bands of oil treated with an electrostatic field of intensity $0.05 \text{ MV} \cdot \text{m}^{-1} \leq E \leq 0.25 \text{ MV} \cdot \text{m}^{-1}$ for a duration of $3 \text{ s} \leq t \leq 30 \text{ s}$ were identical in structure and intensity to those characteristic of oil that had not been treated with an electrostatic field under the specified conditions, when excited by UV radiation with $\lambda_{\text{exc}} = 405 \text{ nm}$.

The identical spectral-luminescent properties of rapeseed oil obtained from seeds treated with an electrostatic field at an intensity of $E = 0.05 \div 0.25 \text{ MV} \cdot \text{m}^{-1}$ for $t = 3 \div 30 \text{ s}$ indicate that the mentioned treatment does not lead to changes in the chemical composition or the nature of interactions among the fluorophores of rapeseed oil – phenols, tocopherol, polyunsaturated fatty acids, vitamins, pigments, and oxidation products.

It can therefore be concluded that the treatment of rapeseed with an electrostatic field (under the specified conditions) did not result in any changes to the nature of the intermolecular interactions between the seed components, and consequently to its fatty acid composition.

Conclusion

1. Luminescence analysis confirms literature data on the presence of fluorophores in rapeseed oil – phenols, tocopherol (a form of vitamin E), polyunsaturated fatty acids (linolenic, linoleic, arachidonic), vitamin B2, the precursor of vitamin A (carotene), the pigment chlorophyll, and oxidation products of oil components.
2. Treating rapeseed with an electrostatic field at a field strength of $E = 0.05 \div 0.25 \text{ MV} \cdot \text{m}^{-1}$ for a duration of $t = 3 \div 30 \text{ s}$ does not result in any changes to the chemical composition of the fluorophores in rapeseed oil, as confirmed by identical photoluminescence spectra and photoluminescence excitation spectra of the fluorophores present in rapeseed oil, which are determined by the specific intermolecular interactions of the oil's components.

Author Contributions: Conceptualization, S.K. and T.H.; Methodology, S.M., O.V.; Software, O.K. and O.Kov.; Investigation, S.K., S.M., O.Kov and V.P.; Validation, V.P., O.V. and R.J.; Formal Analysis, S.K. and A.P.; Writing – Original Draft, S.K., S.M., O.K., O.Kov and T.H.; Writing – Review & Editing, A.P., O.V. and R.J.; Visualization, R.J. and T.H.; Supervision, T.H. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

Funding: Financed by a subsidy from the Ministry of Science and Higher Education allocated to the Hugo Kołłątaj University of Agriculture in Krakow for 2026.

References

- Baltazar, P., Hernandez-Sanches, N., Diezma, B., & Lleo, L. (2020). Development of rapid extra virgin olive oil quality assessment procedures based on spectroscopic technologies. *Agronomy*, 10, 41–56. <https://doi.org/10.3390/agronomy10010041>
- Berto, B. M., Garcia, R. K. A., Fernandes, G. D., Barrera-Arellano, D., & Pereira, G. G. (2020). Linseed oil: Characterization and study of its oxidative degradation. *Grasas y Aceites*, 71(1), e337–e337. <https://doi.org/10.3989/gya.1059182>
- Cert, A., Moreda, W., & Perez-Camino, M. (2000). Chromatographic analysis of minor constituents in vegetable oils. *Journal of Chromatography A*, 881, 131–148. [https://doi.org/10.1016/S0021-9673\(00\)00389-7](https://doi.org/10.1016/S0021-9673(00)00389-7)
- Corradini, M., Wang, Y., Lavinia, L., & Le, A. (2016). Identifying and selecting edible luminescent probes as sensors of food quality. *AIMS Biophysics*, 3(2), 319–339. <https://doi.org/10.3934/biophy.2016.2.319>
- Dupuy, N., Le Dréau, Y., Ollivier, D., Artaud, J., Pinatel, C., & Kister, J. (2005). Origin of French virgin olive oil registered designation of origins predicted by chemometric analysis of synchronous excitation– emission fluorescence spectra. *Journal of agricultural and food chemistry*, 53(24), 9361–9368. <https://doi.org/10.1021/jf051716m>
- Escuderos, M., Sayago, A., Morales, M., & Aparicio, R. (2009). Evaluation of α -tocopherol in virgin olive oil by a luminescent method. *Grasas Y Aceites*, 60(4), 336–342. <https://doi.org/10.3989/gya.108308>
- Khosroshahi, M. (2018). Effect of temperature on optical properties of vegetable oils. *Optics and Photonics Journal*, 8, 247–263. <https://doi.org/10.4236/opj.2018.87021>
- Kovalyshyn, S. (2016). Study of structural changes in the cells of the stimulated seed sprouts. *International Agrophysics*, 30(4), 545–550. <https://doi.org/10.1515/intag-2016-0012>
- Kovalyshyn, S., Myagkota, S. V., Ptashnyk, V., Kharchenko, S., Tomporowski, A., & Kielbasa, P. (2022). Investigation of the effect of pre-sowing electrical stimulation of winter rapeseed on its spectral-luminescent properties. *Przegląd Elektrotechniczny*, 1, 79–83. <https://doi.org/10.15199/48.2022.01.13>
- Kovalyshyn, S., Ptashnyk, V., Nester, B., Kielbasa, P., Ovcharuk, O., Kovalyshyn, O., Tkach, O., Bi-liuk, M. & Shubenko, V. (2024). Optimization of the Modes of Pre-Sowing Electrical Stimulation of Winter Rape Seeds Based on the Study of the Intensity of Single Photon Emission by Them. *Agricultural Engineering*, 28(1), 9–21. <https://doi.org/10.2478/agriceng-2024-0002>
- Krasnikov, V., Timoshkin, E., & Titkova, A. (1987). *Spectral Luminescent Analysis of Food Products*. Moscow, Russia: Agroizdat, 342.
- Kyriakidis, N., & Skarcalis P. (2000). Fluorescence spectra measurement of olive oil and other vegetable oils. *Journal of AOAC INTERNATIONAL*, 83(6), 1435–1439. <https://doi.org/10.1093/jaoac/83.6.1435>
- Lobo-Prieto, A., Tena, N., Aparicio-Ruiz, R., García-González, D. L., & Sikorska, E. (2020). Monitoring virgin olive oil shelf-life by fluorescence spectroscopy and sensory characteristics: A multidimensional study carried out under simulated market conditions. *Foods*, 9, 1846–1866. <https://doi.org/10.3390/foods9121846>
- Mishra, P., Lleó, L., Cuadrado, T., Ruiz-Altisent, M., & Hernández-Sánchez, N. (2018). Oxidation changes in commercial extra virgin olive oils with fluorescence spectroscopy-based prototype. *European Food Research and Technology*, 244, 565–575. <https://doi.org/10.1007/s00217-017-2984-1>
- Morin, J.-F., & Lees, M. (2018). *Food Integrity Handbook: A Guide to Food Authenticity Issues and Analytical Solutions*. Eurofins Analytics France, Nantes, France. <https://doi.org/10.32741/fihb>

- Myagkota, S., Shevchuk, R., Sukach, O., Pushak, A., Malyi, T., & Fulmes, M. (2022). Spectral and luminescent characteristics of linseed oils of different prehistory. *Fluorescence*, 32, 1991–1998. <https://doi.org/10.1007/s10895-022-02993-4>
- Ogborn, M., Nitschmann, E., Bankovic-Calic, N., Weiler, H., & Aukema, H. (2002). Dietary flax oil reduces renal injury, oxidised LDL content, and tissue n-6/n-3 FA ratio in experimental polycystic kidney disease. *Lipids*, 37, 1059–1065. <https://doi.org/10.1007/s11745-002-1001-4>
- Paschos, G., Magkos, F., Panagiotakos, D., Votteas, V., & Zampelas, A. (2007). Dietary supplementation with flaxseed oil lowers blood pressure in dyslipidaemic patients. *European Journal of Clinical Nutrition*, 61, 1201–1206. <https://doi.org/10.1038/sj.ejcn.1602631>
- Rolewicz, A., Krajewska, M., & Starek-Wójcicka, A. (2025). Opportunities for the Use of Post-Production Raw Materials of the Fruit and Vegetable Industry in the Agri-Food Sector: A Review. *Agricultural Engineering*, 29(1), 135–155. <https://doi.org/10.2478/agriceng-2025-0009>
- Saleem, M., & Ahmad, N. (2018). Characterization of canola oil extracted by different methods using fluorescence spectroscopy. *PLoS One*, 13(12), e0208640. <https://doi.org/10.1371/journal.pone.0208640>
- Sikorska, E., Khmelinskii, I., & Sikorski, M. (2012). Analysis of olive oil by fluorescence spectroscopy: Methods and applications. *Olive Oil: Constituents, Quality, Health Properties and Bioconversions*. D. Boskou, Ed. London, UK: IntechOpen, 63–88. <https://doi.org/10.5772/30676>
- Sikorska, E., Wójcicki, K., Kozak, W., Gliszczynska-Świątło, A., Khmelinskii, I., Górecki, T., Caponio, F., Paradiso, V.M., Summo, C., Pasqualone, A. (2019). Front-face fluorescence spectroscopy and chemometrics for quality control of cold-pressed rapeseed oil during storage. *Foods*, 8, 665–680. <https://doi.org/10.3390/foods8120665>
- Silva, V. D., Conceição, J. N., Oliveira, I. P., Lescano, C. H., Muzzi, R. M., Filho, O. P., Edemilson, C. Casagrande, G.A., Caires, A. R. (2015). Oxidative stability of baru (*Dipteryx alata* Vogel) oil monitored by fluorescence and absorption spectroscopy. *Journal of Spectroscopy*, 2015(1), 803705. <https://doi.org/10.1155/2015/803705>
- Szukay, B., Stachura, W., Saletnik, Ł., Budzyński, J., Szymańska, J., & Fisz, J. (2019). Changes in the fluorescence excitation and emissions spectra of heated and frying rapeseed oil and sunflower oil. *Biotechnology and Food Science*, 83(1), 49–56. <https://doi.org/10.34658/bfs.2019.83.1.49-56>
- Yamaguchi, T., Devassy, J., & Gabbs M. (2015). Dietary flax oil rich in α -linolenic acid reduces renal disease and oxylipin abnormalities, including formation of docosahexaenoic acid-derived oxylipins in the CBd-psy/psy mouse model of nephronophthisis. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 94, 83–89. <https://doi.org/10.1016/j.plefa.2014.11.009>
- Zandomenighi, M., Carbonaro, L., & Caffarata, C. (2005). Fluorescence of vegetable oils: Olive oils. *Journal of Agricultural and Food Chemistry*, 53(3), 759–766. <https://doi.org/10.1021/jf048742p>

WŁAŚCIWOŚCI WIDMOWO-LUMINESCENCYJNE OLEJU RZEPAKOWEGO POZYSKANEGO Z NASION OCZYSZCZONYCH POŁEM ELEKTROSTATYCZNYM

Streszczenie. Analizie poddano próbki oleju rzepakowego uzyskanego metodą tłoczenia na zimno z nasion poddanych działaniu pola elektrostatycznego o natężeniu $E = (0,05-0,25) \text{ MV} \cdot \text{m}^{-1}$ przez czas $t = 3-30 \text{ s}$. Jako odniesienie, zarejestrowano również charakterystykę widmowo-luminescencyjną próbek oleju rzepakowego, przygotowanych w podobny sposób z nasion kontrolnych, które nie zostały poddane działaniu pola elektrostatycznego. Zachowanie fluoroforów oleju rzepakowego, a mianowicie tokoferolu, fenolu, kwasów tłuszczowych, produktów utleniania, witamin i pigmentów, wchodzących w jego skład, stanowiło źródło informacji o składzie chemicznym badanych nasion. Stwierdzono, że fluorofory w oleju rzepakowym otrzymanym z nasion poddanych wstępnej obróbce polem elektrostatycznym o natężeniu $E = (0,05-0,25) \text{ MV} \cdot \text{m}^{-1}$ przez $t = 3-30 \text{ s}$ wykazują identyczne właściwości widmowo-luminescencyjne jak olej rzepakowy otrzymany z nasion, które nie zostały poddane dodatkowej obróbce polem elektrostatycznym. W szczególności, właściwości widmowo-luminescencyjne fluoroforów w oleju rzepakowym (tokoferol, fenol, kwasy tłuszczowe, produkty

utleniania, witaminy i pigmenty) otrzymanych z nasion poddanych obróbce polem elektrostatycznym o natężeniu $E = (0,05-0,25) \text{ MV} \cdot \text{m}^{-1}$ przez $t = 3-30 \text{ s}$ były identyczne z właściwościami fluoroforów w oleju rzepakowym otrzymanym z nasion rzepaku, które nie zostały poddane działaniu pola elektrycznego o określonych parametrach. Uzyskane wyniki wskazują, że dodatkowe oczyszczanie nasion rzepaku polem elektrostatycznym w określonych warunkach nie powoduje żadnych zmian w jego składzie chemicznym ani w charakterze oddziaływań międzycząsteczkowych.

Słowa kluczowe: stymulacja elektryczna, właściwości spektralno-luminescencyjne, rzepak, olej rzepakowy.