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REVIEW

**of the doctoral dissertation of M.Sc. Eng. Yolanda Victoria Rajagukguk
entitled: “Physicochemical, thermal, and spectroscopic characterisation of
oils from berry seed by-products in terms of authenticity assessment”
carried out under the supervision of Prof. Jolanta Tomaszewska-Gras**

Legal basis for the review

The review was conducted on the basis of a resolution of the Scientific Council of the Food Technology and Nutrition Discipline of the Poznań University of Life Sciences dated October 23, 2025. The legal basis was provided by the requirements specified in Article 187 of the Act of July 20, 2018, Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended).

Basic information about the Author of the doctoral dissertation

Ms. Eng. Yolanda Victoria Rajagukguk is a graduate of the Faculty of Food Science and Nutrition at the Poznań University of Life Sciences. She completed her second-cycle studies in Food Technology and Human Nutrition in 2021, earning the professional title of Master of Engineering. In October of the same year, she was admitted to the Doctoral School of the Poznań University of Life Sciences.

She has led two competitively awarded research projects: (1) *Authenticity of berry seed oils from different extraction methods* (PRELUDIUM 22, funded by the National Science Centre, NCN) and *Physicochemical characterization of berry seed oils during storage using DSC and FTIR* (Young Scientist Research Grant by PULS).

She completed three research internships under the ERASMUS+ programme at Suranaree University of Technology in Thailand and at the University of Bologna in Italy. In 2024, she received a scholarship for young researchers from the Poznań scientific community, as well as awards in international competitions organized by IUFOST and IFT.

Formal evaluation of the thesis

The doctoral thesis submitted for review by Yolanda Victoria Rajagukguk, M.Sc., Eng., entitled “*Physicochemical, thermal, and spectroscopic characterisation of oils from berry seed by-products in terms of authenticity assessment*” comprises a 33-page study with an attached, thematically coherent collection of six scientific publications, five of which appeared in 2023-2025 in *Foods*, *Journal of Food Composition and Analysis*, *NFS Journal*, *Journal of Food Engineering*, and *LWT – Food Science and Technology*, while the last one was under review. The work submitted for review is therefore hybrid in nature. At the time of writing the review, the last publication appeared in the *Journal of Food Composition and Analysis*. The total number of points calculated according to the date of publication of the papers at the time of submission was 620 points according to the Ministry of Science and Higher Education, and the total IF = 24.4, and after taking into account the last published paper, it is 720 points and IF = 28.4.

All publications were written in English, and the doctoral student is the first author in all of them. The attached documentation contains statements from co-authors confirming the significant individual contribution of Yolanda Victoria Rajagukguk, M.Sc., Eng., to the development of the concept, the experimental part, and the analysis and interpretation of the research results presented in the above-mentioned scientific articles. I consider the doctoral student's acquisition of publishing experience in Q1-Q2 JCR journals to be very valuable and promising for her future scientific work.

The introductory study, written in English, has a typical layout for experimental works. It includes an abstract in English and Polish, an introduction, the objectives of the work and

research hypotheses, a chapter presenting the organization of the research, a discussion of the results, a description of the innovative nature of the research, a summary and conclusions, a bibliography of 33 items, and a list of tables and figures.

The structure of the work is clear and logically organized, forming a coherent whole. The language of the dissertation is characterized by appropriate precision and stylistic correctness.

Most of the research work covered by the dissertation was carried out as part of a project financed by the National Science Centre of Poland (NCN) under the OPUS (grant numer: 2018/31/B/NZ9/02762), headed by Prof. Jolanta Tomaszewska-Gras, as well as under the PRELUDIUM (grant numer: 2023/49/N/NZ9/00861), which was awarded to the doctoral student.

Justification of the research topic

I consider the research topic to be fully justified both from the point of view of current research trends in food analysis and the real needs of the market for high-quality products. Berries seed oils are a dynamically developing segment of the vegetable oil market, characterized by high economic value, limited availability of raw materials, and high quality variability resulting from botanical origin and processing technology. These factors make these products particularly vulnerable to adulteration and uncontrolled degradation processes, which clearly justifies the need to develop modern, reliable methods for their identification and quality assessment.

Substantive assessment of the work

The series of six publications that make up the dissertation has been planned in a thoughtful and logical manner, and each of the works pursues a clearly defined research objective, while fitting into a coherent concept of the whole, divided into three main stages. The doctoral student systematically examines the thermal, spectroscopic, and volatile profiles of oils from berry seeds using differential scanning calorimetry (DSC), Fourier transform infrared spectroscopy (FTIR), UV/Vis spectroscopy, and flash gas chromatography with an E-nose detector, supported by multidimensional data analysis. The transition from basic characterization to practical applications in authenticity screening and shelf life prediction is clear and well-reasoned.

In the first publication, the author focused on the fundamental characteristics of berry seed oils using raspberry seed oil as an example, which should be considered a necessary and correctly executed preliminary stage. The thermal and spectroscopic profiles obtained allowed the natural

variability of the oils studied to be determined and created a reference point for further comparative analyses.

The second publication expanded the scope of research to include the issue of testing the authenticity of oils depending on their origin (based on material obtained in the laboratory and from the market) using thermal (DSC) and spectroscopic (UV/Vis and FTIR) methods. The use of chemometric methods made it possible to demonstrate that oils that are seemingly similar in terms of lipid composition can be effectively distinguished on the basis of comprehensive analytical profiles. This work significantly confirmed the validity of a holistic approach to the analysis of oil authenticity and constitutes an important element of the scientific novelty of the entire cycle.

In the third publication, the author addressed an issue of practical importance related to the determination of changes occurring in cold-pressed oils from berry seeds during storage and the identification of factors that determine the thermal and oxidative stability of this group of oils. She showed that raw material factors related to the composition of oils (including the content of compounds with antioxidant properties) significantly shape the recorded analytical signals, which has direct consequences for the interpretation of results in the context of the authenticity and quality of market products. This work demonstrates the ability to take a critical approach to the problem of the storage stability of the analyzed group of oils.

The fourth publication was devoted to the issue of oxidative stability and changes occurring in oils during storage using gas chromatography (electronic nose) in combination with chemometrics. The author convincingly demonstrated that the analytical techniques used enable effective monitoring of degradation processes, and the results obtained are important for assessing the shelf life and quality safety of oils. This work broadens the cognitive value of the cycle, going beyond strictly identification issues.

The fifth publication is clearly application-oriented and concerns the development of predictive models for assessing the authenticity of oils from berry seeds using non-standard methods (thermal and spectroscopic). Particularly noteworthy is the correct use of chemometric tools and the attempt to translate data from non-targeted analytical methods into a practical control tool. This publication demonstrates the ability to use basic research results to solve practical problems.

The sixth publication serves as a synthesis and verification of the usefulness of the proposed approach in conditions close to real life. The assessment of oil authenticity depending on the

extraction method (cold pressing, extraction using a solvent or supercritical gas) and the possibility of their rapid screening thanks to the use of data fusion and the creation of a new “DSC-FTIR” dataset should be considered a particularly valuable element of the entire cycle. This work confirms the consistency of the research concept and the validity of the analytical strategy adopted.

One of the main advantages of the dissertation is the methodological approach used. The doctoral student effectively uses non-targeted methods, analyzing complete “fingerprints” of analytical data instead of relying on individual parameters. The use of chemometric tools such as PCA and PLS (including PLS-DA and regression models) is appropriate and technically correct. Model validation strategies have been correctly implemented, and the author demonstrates a good understanding of issues related to natural sample variability, model overfitting, and model robustness. The inclusion of samples from different batches, different suppliers, and stored at different times increases the practical value of the results obtained.

The work makes a significant original contribution to the development of the discipline. In particular, it expands knowledge on the quality assessment of berry seed oils and demonstrates the practical usefulness of DSC melting profiles, FTIR spectra, and volatile profiles in the rapid assessment of the authenticity and quality of this group of oils. The results obtained can be directly applied in quality control laboratories and industrial practice, and can also be used by legislative bodies establishing rules for testing adulteration of this group of products.

In summary, the dissertation is an original and carefully executed study that makes a significant contribution to food science research, particularly in the area of authenticity determination. The doctoral student has demonstrated independence, good methodological preparation for conducting research, and the ability to publish high-quality scientific research results. I conclude that the dissertation meets the formal and scientific requirements necessary for the award of a doctoral degree.

Questions:

- Can the proposed models be directly implemented in routine quality control? What conditions would need to be met?
- What possibilities do you see for applying the proposed research methods to the analysis of other oils or fatty products?

- Can the analytical methods used support the sensory analysis of oils?

Final conclusion

The doctoral thesis of Ms. Yolanda Victoria Rajagukguk, M.Sc., entitled “*Physicochemical, thermal, and spectroscopic characterisation of oils from berry seed by-products in terms of authenticity assessment*” completed at the Poznań University of Life Sciences, Faculty of Food Science and Nutrition, in the discipline of food technology and nutrition, is a thematically coherent series of six scientific publications published in 2023-2025 in renowned JCR-listed journals. The dissertation meets all the requirements specified in Art. 187(1)-(4) of the Act of July 20, 2028, Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended), as well as the formal requirements for the award of a doctoral degree in the discipline of food technology and nutrition. I hereby declare that the dissertation by Yolanda Victoria Rajagukguk, M.Sc., Eng., is an original, independent scientific study of high cognitive and applicative value, and that the research results obtained significantly expand the current state of knowledge in the field of quality analysis and authenticity determination of oils from berry seeds using non-targeted analytical methods such as DSC and FTIR, and my assessment of the thesis is positive.

I hereby request the Scientific Council of the Food Technology and Nutrition at Poznań University of Life Sciences to admit Yolanda Victoria Rajagukguk, MSc, to the next stages of the doctoral program.

Application for distinction of doctoral dissertation

The doctoral dissertation by Yolanda Victoria Rajagukguk, M.Sc., stands out for its exceptional conceptual coherence, methodological maturity, and cognitive contribution in the field of innovative application of thermal and spectroscopic methods for quality analysis and authenticity testing of fruit seed oils.

The dissertation consists of a series of six high-quality scientific articles published in renowned international journals, which clearly exceeds the standard doctoral requirements. The candidate addresses a complex and important research problem concerning food authenticity by developing and verifying non-targeted analytical methods in combination with advanced

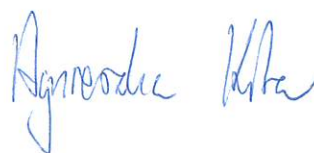
chemometric analysis. The work is very well prepared in terms of methodology, innovative, and in line with current scientific and industrial needs.

A particular strength of the thesis is the original and systematic use of full analytical fingerprints, including DSC melting curves, FTIR spectra, and volatile profiles, rather than simplified or targeted parameters. This approach reflects a high level of scientific independence and conceptual maturity. The candidate not only correctly applies advanced techniques, but also critically evaluates their strengths, limitations, and practical usefulness.

The research also has clear practical significance, particularly in the areas of quality control and authenticity testing. The methods developed are rapid, non-destructive, and environmentally friendly, making them suitable for routine screening. This direct applicability of the tested methods outside of scientific research further confirms the exceptional value of the dissertation.

The dissertation is characterized by consistency, clarity of scientific argumentation, and strong integration of results across multiple analytical platforms. The candidate demonstrates the ability to design complex experiments, manage large data sets, and interpret results at a high scientific level.

In summary, the dissertation by Yolanda Victoria Rajagukguk, M.Sc., significantly exceeds the standard doctoral dissertation. It stands out for its high scientific quality and innovation, as well as the practical potential of the results obtained. Therefore, I request that the Scientific Council of the Food Technology and Nutrition Discipline at the University of Life Sciences in Poznań award a distinction to the doctoral dissertation of Ms. Yolanda Victoria Rajagukguk, M.Sc.

A handwritten signature in blue ink, appearing to read "Agnes Kuba".