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Kraków, 11.02.2026

Review

of doctoral dissertation entitled: „*Authentication of selected game species in food products based on nuclear markers and qPCR*” under the supervision of prof. Dr hab. Magdalena Montowska

1. Formal and Legal Basis for Preparing the Review

The review was prepared at the request of the Chair of the Scientific Council of the Discipline of Food Technology and Nutrition at the Poznań University of Life Sciences, Professor Dorota Cais-Sokolińska, DSc, PhD (resolution of 11 December 2025). The legal basis for the review consisted of the requirements specified in Article 187 of the Act of 20 July 2018 – Law on Higher Education and Science (consolidated text: Journal of Laws of 2020, item 85, as amended).

The submitted dissertation was carried out at the Department of Meat Technology, Faculty of Food Sciences, Poznań University of Life Sciences, under the supervision of Professor Magdalena Montowska, DSc, PhD. The dissertation constitutes part of the research project entitled “*Comparative Peptidomic and Genetic Analysis of the Authenticity of Food of Animal Origin*” (No. 2020/37/B/NZ9/00082), funded by the National Science Centre. The doctoral proceedings were initiated in the field of agricultural sciences, within the discipline of food technology and nutrition.

2. Presentation of the Doctoral Candidate’s Profile

Ms. Bukola Adenuga, MSc, completed her studies in Biostatistical Data Analysis at the University of Abeokuta (Nigeria) in 2014 and obtained a master’s degree in Biological Data Modeling at the University of Ibadan (Nigeria). Her academic output includes eight publications in which she is the

first author or a co-author. She has presented the results of her research at five international conferences.

Ms. Bukola Adenuga's research interests focus on molecular genetics, particularly on studies related to the authentication of meat species using DNA-based techniques. She is also a member of the following professional associations: the American Dairy Association, the Genetics Society of America, the Nigerian Institute of Animal Science, and the Biotechnology Society of Nigeria.

3. Evaluation of the Choice of Dissertation Topic

Despite considerable consumer interest, the consumption of game meat in Poland remains consistently low. This is primarily due to its price and limited availability, as well as a lack of consumer knowledge and skills related to the preparation of game meat dishes. Consequently, this type of meat remains within the category of premium products. A significant proportion of game meat obtained in Poland is exported. However, offers of farmed game meat, originating for example from New Zealand, have begun to appear on the domestic market. This further increases the expectations of informed consumers regarding the possibility of verifying the authenticity of meat products.

Regardless of their origin, meat products are usually supplied in the form of cuts that are packaged, which prevents reliable visual identification. Even greater difficulties arise in the case of processed meat products. The need for reliable food labeling and for increasing transparency in the trade of all types of food products necessitates the implementation of methods for authenticating the source of origin, or more broadly, the quality of food. In other cases, the identification of meat components may be required due to the presence of protected animal species or species that are carriers of diseases harmful to humans.

Therefore, the ability to identify meat species is not solely a matter of interest for more affluent consumer groups, for whom confirmation of product origin is important, but also for less affluent societies, for whom traceability is often a matter of health and even life. The doctoral candidate also addresses these aspects in her review articles (P1 and P2). DNA-based methods belong to the group of tools used for this purpose; however, extensive data are required to build a comprehensive knowledge base that will support the work of inspection and control authorities, among others.

Taking the above into account, I assess the choice of the dissertation topic positively.

4. Formal Evaluation of the Dissertation

The dissertation submitted for review is a collection of five published and thematically related scientific articles under the common title “*Authentication of Selected Game Animal Species in Food Products Based on Nuclear Markers and qPCR*”. The dissertation consists of a List of Publications, a Summary in Polish and English, a List of Frequently Used Abbreviations, an Introduction, Research Hypotheses and Objectives, Materials and Methods, Results and Interpretation, a General Discussion, Conclusions, a References section, Co-authors’ Declarations, and a collection of copies of the published articles.

The adopted structure of the dissertation is appropriate, and the work meets the requirements set for doctoral dissertations.

5. Substantive Evaluation of the Dissertation

The presented cycle of publications demonstrates high scientometric value. The total Impact Factor (IF) of the publications amounts to 27.4, and the total number of points according to the list of journals of the Ministry of Science and Higher Education (MNiSW) dated 5 January 2024 is 620. All publications have an international reach, which further emphasizes the innovative character of the research and its high scientific value. The doctoral candidate is the first author of all publications submitted for evaluation.

The first two publications (P1 and P2) are review articles. Publications P3, P4, and P5 concern studies on deer, roe deer, and wild boar meat, respectively.

In the first review article (P1), the doctoral candidate addresses the situation of the meat market in Nigeria. The paper discusses issues related to meat quality and safety, legal regulations, and institutions supervising this market. It also introduces the topic of meat identification and the potential application of analytical methods that could support the authentication of meat and meat products. The paper is interesting and valuable. However, in my opinion, it should not constitute part of the doctoral dissertation submitted for evaluation. The reference to game meat is marginal, and the issues related to the use of advanced identification methods appear, in the context of the situation in Nigeria described in the article, to be the last tools that should be implemented to improve consumer safety.

Supposingly, the doctoral candidate intended to refer to her country of origin in the dissertation, or maybe there were other reasons for including this publication in the cycle. I would like to ask for a brief comment on this issue.

The second review article (P2) is an extensive analysis of research related to the traceability of wild game meat worldwide and of a range of methods used for the authentication of meat and meat products. The doctoral candidate discussed the techniques applied, indicating their advantages and limitations, and provided examples of their use by other researchers in specific cases involving both single-species meat products and mixtures of different meat species. The broad scope of the topic and the in-depth analysis of a large number of publications confirm the doctoral candidate's good preparation for the subject matter undertaken. The fact that the article was published in a journal with a high Impact Factor and the maximum possible number of points according to the MNiSW evaluation system also attests to the high value of the paper.

My attention was drawn to the statement in publication P2 (Section 3.2.1) that buffalo meat is one of the most commonly consumed types of meat. I would like to ask for a comment on this.

The first chapter of the dissertation, intended to justify the chosen research topic, presents in a highly condensed form the issues addressed in publication P2. However, I would like to point out two shortcomings in this part of the dissertation. On page 16, prices of individual meat types are provided; in my opinion, they should be expressed as values per unit of mass, e.g. per 1 kg. Furthermore, on page 19, the name of the Agricultural and Food Quality Inspection is given in English, whereas the abbreviation in parentheses is derived from the Polish name. In my assessment, this should be consistent.

I also consider the inclusion of information contained in publications P1 and P2 in the section presenting the research results (*Results*) to be unnecessary. It should be included in the Introduction part.

Research Hypotheses and Objectives

The doctoral candidate formulated the following hypothesis: "*Roe deer, deer, and wild boar possess specific DNA sequences that can be considered nuclear markers for testing food authenticity.*" The verification of this hypothesis was planned through the implementation of six specific objectives using real-time qPCR based on nuclear markers. Both the hypothesis and the specific objectives have been formulated correctly.

Research Material and Methods

The doctoral candidate provided a clear and substantive description of the types of samples analyzed, as well as the rationale for including other animal species and plant raw materials in the study. She also explained the necessity of preparing and analyzing model meat products. The amount of material

examined in the dissertation is impressive, and an additional advantage is the inclusion of products originating from two different European countries, which highlights the international relevance of the results obtained. The doctoral candidate employed advanced research techniques, introduced innovative approaches and methodological modifications, as well as appropriate validation methods, which demonstrates her scientific maturity as a researcher.

Description of Research Results and Achievements

In her research, the doctoral candidate planned an analysis of the meat of three different wild animal species, obtained in significant quantities in Poland. These are among the more popular types of meat commonly referred to as game. A substantial quantity of wild boar products appears on the market, whereas roe deer and deer meat are more often sold fresh or frozen. The candidate also included processed meat products available on the market, meat outside the scope of the study (for method verification), and non-meat raw materials.

For each of the three studied animal species, model meat products were prepared to serve for calibration and to simulate potential adulteration. Additionally, the effect of heat treatment on DNA integrity was taken into account. At this point, a question arises: could you explain why different sterilization parameters were applied for roe deer and deer versus wild boar (115°C/30 min and 120°C/20 min, respectively)?

The doctoral candidate applied a similar research scheme for all three meat species. For each, a specific characteristic marker was used. The results were correctly presented and discussed. Of particular note is the innovative approach and development of a new, effective methodological procedure. Another strength of the work is the demonstration of a significant incidence of adulteration in products containing game meat, indicating a clear need to introduce such verification studies into routine controls. Considering the high price of game meat, such methods could serve as a powerful tool for protecting consumer interests.

Moreover, the doctoral candidate conscientiously indicated the limitations of the developed methods and the potential difficulties in implementing them into routine control procedures. In this context, a question arises: which methods, if any, could be applied for regular monitoring to ensure that producers are aware of the potential for rapid detection of fraud? I would like to ask for a comment on this matter.

All results obtained within the dissertation submitted for evaluation are universal and internationally relevant, contributing a substantial body of new knowledge to the discipline of food technology and nutrition.

The doctoral candidate demonstrated extensive theoretical knowledge in the field of meat authenticity research, applied methods, and previous studies. She introduced new methods for detecting specific nuclear markers in the genetic material of roe deer, deer, and wild boar, which enabled the analysis of products in which producers declared the presence of meat from these species.

6. Summary and Final Conclusion

The doctoral dissertation submitted for review constitutes a valuable contribution to the development of the discipline of Food Technology and Nutrition. In accordance with the requirements of the law, the doctoral candidate undertook the task of addressing a research problem involving the development and validation of methods for detecting nuclear markers based on qPCR for deer, roe deer, and wild boar meat. The results obtained provide new knowledge to the discipline of Food Technology and Nutrition.

The doctoral candidate demonstrated theoretical knowledge in the discipline and the ability to conduct independent scientific research. **The dissertation meets the conditions specified in Article 187 of the Act of 20 July 2018 – Law on Higher Education and Science (consolidated text: Journal of Laws of 2020, item 85, as amended).** Therefore, I recommend to the Council of the Discipline of Food Technology and Nutrition at the Poznań University of Life Sciences that Ms. Bukola Adenuga, MSc Eng., be admitted to the next stages of the procedure for awarding the degree of Doctor of Agricultural Sciences.

I also recommend that Ms. Bukola Adenuga's dissertation be awarded distinction. The research methods applied, the development of innovative methodology, the international scope of the study, and publications in journals with a high Impact Factor (27.4) demonstrate the doctoral candidate's above-average scientific abilities.

Dr hab. Inż. Marzena Zajac, prof. URK