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### **Review of the doctoral dissertation**

Charles'a Odilichukwu R. Okpala, MSc

Thesis title: „*The effect of marination process on meat quality in relation to the relevance of quality management in the agrifood sector*”

Faculty of Food Science and Nutrition

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Supervisor: Dr hab. inż. Małgorzata Korzeniowska, Prof. UPWr,

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The basis for this review was the resolution of the Council of the Food and Nutrition Technology Discipline of the University of Environmental and Life Sciences in Wrocław of July 19, 2023, in which I was assigned as the reviewer of this doctoral thesis.

### **The structure and layout of the work**

Meat quality, which also includes its health safety, concerns all stages of the food chain. The quality characteristics of meat of relevance to consumers are improved not only by production factors, but to a large extent by processing techniques, including marination and heat treatment. Consumer interest in convenience foods is also linked to an increase in demand for marinated meat. However marinating processes have been researched for many years, there is still space for scientific work to determine the selection of marinade ingredients and

marinating conditions to meet consumer expectations. These processes should be carried out in accordance with good manufacturing and hygiene practices. Staff knowledge in this regard is crucial. For the above-mentioned reasons, the research issue undertaken in the PhD thesis of Charles'a Okpala, MSc, concerning the improvement of the process of marinating meat for heat treatment on a grill in relation to the importance of quality management in the agri-food sector is important, and its implementation has practical significance. The PhD student's research is in accordance with current trends related to a comprehensive approach to ensuring the quality and safety of produced food and the recognition of the possibilities of projecting them.

The construction of the work is typical of doctoral theses based on the already published results. The doctoral thesis by MSc Charles'a Okpala was prepared as a series of eight works, which were published in the years 2020-2023 (one of them has been accepted for publication). The presented thesis consists of the following chapters: *Introduction, Research hypothesis/problem statement, Overall aim and specific objectives of the study, Research methodology, Reflections on published works, Summary and recommendation for future studies, References*. The references cited in the dissertation includes 70, appropriately selected literature positions. The work begins with a 2-page *Summary*. This part of the doctoral thesis covers 64 pages. The next part consists of the publications of the doctoral dissertation together with statements signed by the PhD student and co-authors. Both Charles Okpala, MSc and the other co-authors specified their contribution to the research and preparation of the publication.

Publications of the doctoral dissertation have been published in recognised scientific journals: *Food Science and Technology, Frontiers in Nutrition, Food Reviews International, Foods, International Journal of Food Properties, Peer J., Processes*. The total IF value for the publications is 35.273, the total score is 620 points. The publications comprising the series that is a basis of the dissertation are one-authors (1), two-authors (2), three-authors (1), four-authors (1), five-author (1), six-authors (1). In all publications, the MSc Charles Okpala is first author and correspondence author. Publications comprising the series are carefully prepared and include properly selected graphic documentation.

### **Formal aspects and substantive assessment of the doctoral thesis**

The Ph.D. thesis presented by MSc Charles'a Okpala meets the formal requirements for this type of work presented in the procedure for the doctoral degree, is experimental and contains chapters typical of this type of work and it indicates a good orientation of the Author in the area of the issues raised. The Author focuses on research related to the optimization of

the meat marinating process in relation to the relevance of the quality management in the agri-food sector. The subject discussed in the thesis is interesting both in cognitive and applicational aspect. The conclusion arising from research into the formation of meat quality traits allows action to be taken to ensure food quality and safety throughout the food chain.

In the *Introduction* section, the doctoral student presented the importance of quality in the agri-food industry, quality formation and quality management in relation to meat processing technology, and optimization of the meat marinating process in relation to the importance of quality management in the agri-food sector. This part of the work provides justification for the way the Doctoral student formulated the dissertation subject. In the *Research hypothesis / problem statement* section, the Author emphasized that the knowledge of quality and its formation is crucial in the entire food supply chain, including meat. He indicated, the need to complete the scientific information on the dissertation topic, resulting from the review of both experimental work and literature.

In the next section *Overall aim of the study*, the Doctoral student formulated the main objective of the dissertation, which is the enhancement of marinated oven grilled meat processing in relation to the relevance of quality management in the agri-food sector and three specific objectives including:

1. To review the literature data determining how the quality of animal products are enhanced by combining plant – based marinades and thermal processes, to what makes quality management relevant in the agri-food sector;
2. To conduct experimental studies, in order to evaluate: the effect of various marination receipts on the culinary quality of different meat types including chicken breast, pork neck and beef entrecôte; the effect of grilling process on the physicochemical properties, antioxidant power and sensorial acceptability;
3. To conduct field studies, which surveyed supply chain stakeholders associated with the meat industry, specially butchers as well as food retail managers/supervisors, and relate with their knowledge of quality and its utilization.

However, I think that scientific nature of the dissertation, the Doctoral student should formulate not only the dissertation objectives, but also the research hypotheses.

In the section 4 - *Research methodology*, the Author clearly presented a graphic diagram of the research layout and described the stages of the conducted research in the form of three parts relating to the specific objectives of the dissertation. To aim the purpose of the work, the Doctoral student used research tools and methods, verified for the purpose of his own research.

In the section *Reflection of published works*, the Doctoral student presented the main results of his research given in the published works presented in three parts in relation to the established specific objectives of the dissertation.

Publications 1, 2 and 3 related to dissertation objective 1 are a review. Due to the scientific nature of the dissertation, they are introduction to the research work. In the publication: *Okpala, C.O.R., Imamou Hassani, M., Korzeniowska, M., & Guiné. R.P.F. (Accepted for publication). Enhancing the quality of animal meat products by combining plant – based marinades and thermal processes: A treatise. Food Sci. Technol.* the Doctoral student presented ways to project the quality of meat by optimizing its marinating and thermal processing. He gave examples and properties of plants used in the preparation of marinades, the way they are prepared and used, and discussed thermal processes used in the treatment of marinated meat products. For the preparation of this part of the work, the Doctoral student used a rich source literature. The presented description of this part is an introduction to the area of research undertaken by Charles'a Okpala, MSc, in the experimental part. In the next publication (*Okpala, C.O.R., & Korzeniowska, M. 2020. Concept, Content, and Context Perspectives of Quality of Agrifood Products: Reflections on Some Consumer Decision – Making – Purchase Scenarios. Front. Nutr.*) the Doctoral student discussed the concept, content and context of quality of agri-food products. This part of the dissertation is interesting due to the simultaneous analysis of the mentioned aspects of quality in relation to consumers' purchasing decisions, however, it is the least related to the main overarching goal of the dissertation. In publication 3 of a review nature, based on 319 items of literature, the Author discussed fundamental aspects related to quality management and food safety, such as ethical considerations related to quality, good practices (production, hygiene, agricultural, storage, food service, laboratory, sales, transportation), safety standards related to food quality, fundamentals and implementation of HACCP and control systems related to QA and other related quality standards (*Okpala, C.O.R., & Korzeniowska, M. 2023. Understanding the relevance of quality management in agro – food product industry: From ethical considerations to assuring food hygiene quality safety standards and its associated processes. Food Rev. Int.*).

In my opinion, particularly valuable are the summaries in Tables 2 and 4 containing studies conducted by other authors on good practices and the HACCP system, hygiene, food safety and quality at various stages of the food chain in various sectors of the agro-food industry, along with the specific objectives of the studies. Due to the basic nature and subject matter of publications on quality management not only in meat production, but in the entire agri-food sector, this work should be the first in the series of publications included in the dissertation.

However, in this part of the dissertation, I lacked a closer connection between the marinating process and quality management in relation to meat industry practices.

The next specific objective of the dissertation was to evaluate the effect of various marination receipts on the culinary quality of different meat types and the effect of grilling process on the physicochemical, antioxidant and organoleptic properties. In order to achieve second goal of the dissertation, the Doctoral student conducted experimental research, the results of which are presented in publications 4, 5 and 6 (*Foods*, 2022; *Int. J. Food Prop.*, 2023; *Peer J*, 2023). In the study, three different marination variants were used (0.5%, 1% and 1.5% concentrations of BS, CP, GP) with fixed parameters of the oven grilling process (temperature 180°C; time 5 min). The research material consisted of chicken breast (Publication 4), pork neck (Publication 5) and beef entrecôte (Publication 6). After heat treatment, antioxidant properties (ABTS and DPPH), ferric reducing ability (FRAP), pH and the thiobarbituric acid test (TBARS) were analyzed. Physical characteristics of the samples were also evaluated by heat-treated weight loss, L\*a\*b\* color coordinates and cutting strength. The meat was also subjected to organoleptic evaluation of appearance, flavor, taste, tenderness and texture (chewiness, gumminess, grittiness, graininess, greasiness and hardness sensation). In the experimental research, the Doctoral student used a wide range of research methods, which demonstrates his extensive experience and high skills in conducting experimental research, and as a result, he is well prepared to carry out the tasks set out in the objectives of the work. All the methods as well as the preparation of samples and marinades were discussed in the methodological sections of the published works. The Doctoral student has shown that the technology of marinating meat for grilling can be improved with regard to specific meat products and their quality characteristics, i.e. color and texture.

The results of the research related to the third dissertation objective are included in publications 7 and 8 (*Foods*, 2021; *Processes*, 2023). A field study was conducted that surveyed and statistically analyzed data obtained from supply chain stakeholders associated with the meat industry in Nigeria and Poland regarding quality knowledge and application. The Doctoral student pointed to the link between laboratory results and the effective use of good practices in meat hygiene and storage, as well as food retailing, and the assurance of high food quality. A definition of “cleaner food production” as: “*the effective and efficient utilization of good practices to deliver high quality food retail products through environmental – friendly as well as sustainable processes*” was suggested in this section of the dissertation.

On the basis of the literature review, experimental and scientific studies, in the section *Summary and recommendation for future studies* the PhD student descriptively summarized

the results of the research and, what is particularly important, indicated the future directions in which the research should be continued. However, the Author did not formulate specific conclusions indicating the most important achievements of the work. It would have been appropriate to formulate a scientific conclusion indicating what the research contributes to the science of the meat marinating process in the context of the importance of quality management in the agri-food sector. I think that if the Doctoral Student had formulated research hypotheses in the section of the work - *The purpose of the work*, it would have been easier to provide supporting conclusions.

After reviewing the submitted dissertation, the following questions occurred to me, which I would like to ask PhD student for an answer:

- On what assumptions the selected ingredients and concentrations of marinades used in the experimental were chosen?
- Is there any known scientific information on the antimicrobial activity of CP, GP, BS and AF, IM? The scope of the work did not include microbiological studies, but the PhD student rightly stated that further research needs to determine the microbiological efficacy of marinated meat products under different packaging and storage conditions;
- Would it be possible to state which of the concentrations used (0.5%, 1% and 1.5%) of CP, GP and BS in the meat samples was the best evaluated in the sensory evaluation perceived overall acceptability;
- Would it be possible to provide an application conclusion resulting from the research conducted?

To summarise, in my opinion the doctoral dissertation of Charles'a Okpala, MSc is of high scientific and application value to the food industry and contributes valuable knowledge to the science of the marinating process and food quality. It should be noted that the results were published in the renowned, international high ranked journals which confirms their scientific significance. Due to the above aspects, the elements of originality, and all mentioned above, the wide scope and comprehensive approach to ensuring food quality, the extensive and properly conducted research experiments, and the interpretation and discussion of results give me the right to conclude that the dissertation of MSc Charles'a Okpala entitled: „*The effect of marination process on meat quality in relation to the relevance of quality management in the agri-food sector*” meets all the requirements for doctoral dissertations specified in Art. 187 (1-4) of the Act of July 20, 2018, Law on Higher Education and Science (Journal of Laws of 2023,

item 742) and I recommended that the Council of the Discipline: Food and Nutrition Technology, Wrocław University of Life Sciences should admit Charles'a Odilichukwu R. Okpala, MSc for the subsequent stages of the doctoral proceedings.

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