

## REVIEW

of the official opponent, the candidate of technical sciences

**Sergii Verbytskyi**

on the dissertation by **Shang Feifei** on the topic:

**“Development of production technology of cooked sausages with the use of plant raw materials”,**

applied for the degree of Doctor of Philosophy

in specialty 181 “Food Technology”

**Relevance of the research topic.** Despite the proliferation in recent years of dietary patterns that avoid the consumption of meat and other animal products, meat from slaughtered animals and poultry is the most valuable source of nutrients essential for the normal functioning of the human body. However, for some categories of consumers a certain adjustment of the nutritional profile typical for meat products is necessary. For this purpose, numerous types of plant raw materials are used, which help reducing the risk factors for atherosclerotic cardiovascular diseases and coronary heart disease. In addition, plant raw materials are cheaper compared to meat, so the use of plant raw materials makes it possible to reduce the cost of meat products in wide demand and make them more accessible to the general population. It is widely practiced to add plant ingredients to cooked meat sausages. These ingredients are enriched with fiber, proteins, natural pigments and easily digestible fats, used instead of animal fats. In general, the involvement of plant components in the recipes of cooked sausages makes it possible to obtain valuable nutritious meat products with proper sensorial, physical, chemical, rheological, biological, microbiological and technological properties – products that fully comply with the principles of LEAN production.

So, the study of the physical and chemical mechanisms of the aggregation of food ingredients of animal and plant origin for the formulating cooked sausages, comprehensive studies of their structural-mechanical, biological and microbiological properties, as well as the use of the information obtained to create practical technological solutions for the production of cooked sausages is an urgent task, which in terms of volume and scientific load meets the requirements for a dissertation for the degree of Doctor of Philosophy in the specialty “Food Technologies”.

**The degree of validity of scientific statements, conclusions and recommendations formulated in the dissertation.** The study and analysis of the dissertation materials provided for review gives grounds to assert that the content of the dissertation properly corresponds to the formulated topic and objectives, and also reveals the purpose of the work, namely the scientific substantiation and development of technology for the production of cooked sausages from different types of meat, enriched with vegetable raw materials.

The assessment of the choice and object, subject, and research methods indicates that Shang Feifei is sufficiently oriented in the issues to which his work is devoted. The author is able to properly plan and conduct complex scientific research, and carry out a reasoned comparison of their results with information available in modern scientific and technical sources. On the other hand, the information provided in the work about scientific publications completed by the author indicates the ability to formulate the results of scientific research and join scientific discussions, that is, the proper scientific potential of the applicant. The conclusions he gives to the structural elements of the dissertation text fully correspond to the essence of the issues under consideration, the author's opinions regarding which are individual and balanced.

**The scientific novelty of the work** lies in the fact that the author was the first to scientifically substantiate and introduce natural plant raw materials in the form of taro paste into the recipe for cooked sausages made from pork and various types of poultry. The author of the dissertation also established that the combined oil mixes with granules of molten hot gelatin, forms a white emulsion and hides the unpleasant odor of gelatin. The application of the basic provisions of the developed technology for cooked sausages with a reduced amount of animal fat due to the addition of vegetable raw materials has also received further development.

There is no doubt about the validity of scientific statements, conclusions and recommendations, since they are based on a thorough analysis of a large array of professional scientific and technical literature, on diverse and significant scientific research. The results of our own research are properly reflected in professional scientific publications and tested at scientific conferences.

**Practical significance of the obtained results.** Based on the results of the work, new formulations and technology for the production of cooked sausages from different types of meat, enriched with vegetable raw materials with a reduced content of animal fats, have been developed. Regulatory and technical documentation has been developed and approved – TU U 10.3-04718013-008:2022 “Taro products, concentrated and dried. Technical specifications” (Ukraine) and two standards for “Poultry sausage with taro paste” Q/PLD-004S-1 and Q/ZFA-0001S-2022 (China). The technology has been tested in production conditions and implemented at the sole proprietorship “Klimenko L.O.” and sole proprietorship “Filon A.M.” (Sumy city), Guangxi Zhifu Agricultural Development Co., Ltd and Guilin PLANT Biotechnology Co., Ltd (Guangxi Province, China). In the Chinese province of Guangxi, 1.8 tons of cooked sausages with poultry and vegetable ingredients were produced and sold, in Ukraine – 180 kg.

The dissertator’s personal contribution consists of planning experiments, performing analytical and experimental work, analyzing experimental data, formulating conclusions, preparing materials for publication, and participating in the development of regulatory documentation.

**General characteristics of the dissertation.** The dissertation is a manuscript consisting of an abstract, 6 sections, conclusions, a list of sources used and annexes. The main text of the work is presented on 220 pages. The dissertation is illustrated with 22 figures and 67 tables. The list of used bibliographic sources consists of 253 titles.

**The first section** substantiates the characteristics, functions and use of poultry meat as raw materials for sausages, and also summarizes information about plant raw materials as sources of protein, dietary fiber, dyes, antioxidants, functional ingredients, etc. The section also analyzes traditional and modern technologies for the production of cooked sausages.

**The second section** describes the object, a list of materials and research methods, as well as a structural diagram reflecting the sequence of the main stages of research, are adduced. The section also describes the details of experimental research and practical testing of developments in China and Ukraine.

**The third chapter** defines technological regimes and analyzes the production process of taro paste, its nutritional composition, sensorial, physical and mechanical properties, and describes studies of the effects of different amounts of taro paste on the quality characteristics of cooked pork sausages. Experiments have proven that the amount of taro paste of 8% ensures minimal loss of weight and moisture of sausages during cooking, increases the protein content by 1.34 times, and reduces the amount of fat by 1.6 times compared to the analogue. It was proposed to replace part of the pork meat in sausages with duck meat in the amount of 40%, which provides the sausage product with better elasticity and reduces the cutting force by 1.26 times, contributing to the acquisition of a more intensive color.

Wheat bran in an amount of 1.2 kg was used to enrich cooked sausages with dietary fiber and protein. This ensured the structural stability of the protein scaffold, due to the gelling property, in combination with the protein tissue framework.

The section also substantiates and defines the temperature-time parameters of heat treatment of cooked sausages with vegetable raw materials: cooking temperature – 74-82°C, duration – 60-80 minutes.

**In the fourth section**, using the orthogonal modeling method, the optimal formula for recipe indicators is derived: taro paste – 16 kg, wheat bran – 1.5 kg, phosphate complex – 0.3 kg. The section also evaluates the effect of dosing efficiency of dyes such as fermented rice (0.3%), red beets (0.2%), antioxidants such as ginger-onion juice (5%), sodium isoascorbate (0.2%) and animal fat substitutes – oil gelatin emulsion (3%) on the course of physical, chemical, biochemical, microbiological processes and on the rheological, sensorial characteristics of cooked sausages using various types of poultry meat as raw materials. It was revealed that technological additives ensured a characteristic red color; elastic and delicate consistency contributed to the inhibition of oxidative processes and provided the highest rating in sensorial research.

**The fifth section** substantiates innovative technologies for cooked sausages with different types of meat and vegetable raw materials: pork meat, taro paste, wheat bran and natural dye; from pork meat, duck meat, taro paste, wheat bran and natural dyes; made from duck meat, chicken meat, taro paste, wheat bran, gelatin-oil emulsion, antioxidants

and natural dyes.

**The sixth chapter** substantiates the socio-economic effect of the development and implementation of the technology of cooked sausages from different types of meat with the addition of taro paste. New technology has made it possible to carry out complex processing of Areca taro root crops, which has reduced production costs and made the technological process more efficient.

**Completeness of presentation of the main results in published works.** The main scientific results and provisions of the dissertation are set out in Based on the materials of the dissertation work, 17 printed works were published, including: 4 articles – in scientific publications included at the date of publication in the list of scientific specialized publications of Ukraine; 4 articles – in periodical scientific publications indexed in the Scopus database; 1 article – in a periodical scientific publication of a country of the European Union; 8 abstracts of reports – at scientific, scientific-practical and international conferences. The requirements of the Ministry of Education and Science of Ukraine regarding the required number of articles in scientific publications have been met.

**Absence (presence) of violation of academic integrity.** Shang Feifei's dissertation showed no signs of violation of academic integrity. The research results and hypotheses of other authors are accompanied by appropriate links to relevant sources therefore, the work does not contain elements of plagiarism.

#### **Discussion questions and comments.**

1. Partition 1.1 which abounds with the references of different literature sources characterizing the use of plant raw materials used to formulate meat products lacks any examples of using namely taro and its derivatives in sausages or other meat or meat containing products.

2. The denominations of the equipment used do not exactly correspond to authentic denominations given in operation documentation of the manufacturers of the said equipment: the appliance TA.XTPLUS is not a “Physical Property Tester” but a “Texture Analyzer”; CR-400 is not a “Chromometer” but a “Chroma Meter” or “Colorimeter” (Partition 2.3.1).

3. The TPA Analysis is usually used to analyze the ready food products as the said analysis imitates the mastication activity of the human organs. Why was the TPA Analysis used to characterize the taro paste – a transitory stuff not to be consumed as it is (Partition 3.1.2.3)?.

4. The Partition 4.3 states that antioxidant activity was determined according to the method described by Yang Y.F., Luo M.N., Hu Q.H. et al. (2022) where three methods of accelerated lipid oxidation are given, namely: high-temperature heating, repeated freezing and thawing, as well as ultraviolet (UV) irradiation. What was the method used in the course of experiments and what were the reasons for the choice made?

5. The Partitions 4.4.4 and 5.3.2 contain the results of evaluating of the organoleptic parameters but the method used cannot be found to be specified in the dissertation.

6. The experimental formulation No. 3 of the sausage contains onion and ginger juice as the mixture of natural antioxidants. The antioxidant properties of the said substances are known as well as their astringent flavor. Haven't the onion and ginger juices deteriorated the taste characteristics of the sausages made in the course of experiments?

7. The Partition 5.3.3 states that the microbiological parameters shall confirm with the “regulatory documentation Zrf” but the said documents are not referenced in the dissertation.

**Conclusion on the compliance of the dissertation with the requirements in force.** Shang Feifei's dissertation on the topic: “Development of production technology of cooked sausages with the use of plant raw materials” is a completed scientific research, which is characterized by the relevance of goals and objectives, scientific novelty and practical value, and represents a significant contribution to the development of modern technologies for the production of cooked sausages. The content of the work corresponds to the topic, reveals the problem and ways to solve it.

The work is prepared in accordance with the requirements of the order of the Ministry of Education and Science of Ukraine “On approval of the Requirements for the

preparation of a dissertation” dated January 12, 2017 No. 40, meets the requirements of the “Procedure for awarding the degree of Doctor of Philosophy and canceling the decision of a one-time dissertation council of a higher education institution, scientific institution on awarding a degree Doctor of Philosophy”, approved by Resolution of the Cabinet of Ministers of Ukraine No. 44 of January 12, 2022, and its author deserves to be awarded the degree of Doctor of Philosophy from the field of knowledge 18 “Production and Technology” in specialty 181 “Food Technologies”.

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