Part 2. Biosafety

UDC 614.31:637.524.04/.07 **DOI 10.36016/JVMBBS-2023-9-4-6**

MONITORING OF METHODS FOR IDENTIFYING RAW MEAT IN SAUSAGE PRODUCTS

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Summary. Despite the growing global interest in healthy lifestyles and nutrition, there is still a demand for ready-to-eat meat products. Sausage products are one of the traditional foods for Ukrainians. National standards (DSTU) provide requirements for the recipe, nutritional value, and physical and chemical parameters that each type of sausage product must meet. However, the high cost of raw materials, shortages, and the need for rational use of resources contribute to the falsification of these products. Modern researchers offer various analytical methods to identify and quantify the content of specific components in finished meat products. Despite their effectiveness, these methods are not yet standardized. As a result, the imperfections in the national legislative, methodological, and technical framework complicate the identification process, leading to an increase in falsification in sausage products

Keywords: falsification, quality, safety, control

Introduction. Providing the population of Ukraine with quality food is of paramount social and epidemiological importance. It is a matter of national health and sustainable development of society. However, the interest in quality and safe food is growing not only in our country but also around the world. Therefore, the demand for healthy food is increasing in developed countries. However, the trend towards healthy eating is often at odds with the need for convenience, leading many to buy ready-made meals and semi-finished products (Paliy et al., 2020; Khimych and Rodionova, 2021).

Meat and meat products are a source of many important nutrients in the human diet, the main one being protein (Qu et al., 2022; Moroz and Sydor, 2023).

Sausages are the most popular among the variety of meat products. For centuries, sausages have been consumed around the world and have become an important element of the gastronomic heritage of many countries. Their attractiveness to consumers is due to their good taste, high nutritional value, and the ability to be consumed without additional heat treatment (Halagarda, Kędzior and Pyrzyńska, 2018; Montowska and Spychaj, 2018; Paliy et al., 2020).

Meanwhile, an examination of the sausage market reveals a significant amount of falsification of sausage products. As per local specialists (Kotelevych and Larina, 2020; Khimych et al., 2020; Verkhivker et al., 2023), up to 80% of sausages sold in retail are falsified by one or more indicators. Controlling the safety and quality of meat and meat products remains an urgent problem today, considering such disappointing statistics (Bogatko, et al., 2017; Naaum et al., 2018; Visciano and Schirone, 2021; Miedico et al., 2022; Sangaré and Karoui, 2023).

The primary means of detecting falsification is through the identification procedure. This procedure confirms or denies whether the product-specific parameters and properties comply with those stipulated in the relevant technical and regulatory documentation (Zhornyk and Yanchenko, 2020; Bondarenko, 2021; Drychyk and Chorna, 2021).

The imperfections in the national legislative, methodological, and technical frameworks complicates the identification procedure, which contributes to the growth of falsification (Bondarenko, 2021; Verkhivker et al., 2023).

Therefore, analyzing the methodology and implementing modern, effective methods of identification is crucial in ensuring the quality and safety of sausage products.

The **aim of the study** is to monitor the methods of identification of meat raw materials in sausage products.

Analysis of literary sources. National standards (DSTU) for sausage products include requirements for the recipe, nutritional value, and physical and chemical parameters that each type of sausage product must meet. The same standards provide for verification of compliance of finished products with these requirements (Khimych et al., 2020; Bondarenko, 2021).

The standard procedure for the identification of sausage products involves the use of sensory (organoleptic) and laboratory (rheological, chemical and biochemical) methods (Montowska and Spychaj, 2018; Bondarenko, 2021).

Experts can use sensory analysis to determine indicators such as shape, appearance, color, texture, taste, smell, and type of minced meat in a cut to characterize the consumer properties of sausage products. This method is advantageous due to its accessibility, speed, and ease of implementation. However, it also has significant drawbacks, including a high level of subjectivity and low reliability. To ensure a reliable analysis, experts typically employ various analytical methods (Pospiech et al., 2019; Bandura et al., 2021; Zhang et al., 2023).

The nutritional value of meat products depends on the composition of raw materials and the appropriate ratio of individual components. This is also a key factor in determining the product's attractiveness to consumers (Halagarda, Kędzior and Pyrzyńska, 2018).

However, high prices, shortages, and the need for rational use of raw materials contribute to the spread of sausage product falsification. The emergence of new forms of counterfeiting with meat products is also attributed to the development of food technologies. The most common way to falsify meat products is by replacing meat components with lower-cost and lower-quality ones, which often results in a decrease in the nutritional value of the products (Naaum et al., 2018; Shehata et al., 2019; Hassoun et al., 2020; Verhivker et al., 2023).

Today, various methods and technical tools are available for identifying and quantifying the content of a particular component in a product (Pospiech et al., 2019).

Microstructural analysis is a standard and effective method for identifying raw materials used in sausage production (Ince and Özfiliz, 2018; Paliy et al., 2020; Nazarenko et al., 2022; Verhivker et al., 2023). The method aims to identify the structural components of sausage products, including those of animal, vegetable, and artificial origin. Microscopy of stained histological preparations enables clear and accurate differentiation of various tissue elements and cellular structures. This allows for qualitative and quantitative determination of the components of minced meat (Evstafieva et al., 2017; Tishkina, Lieshchova and Iesina, 2018; Guelmamene, Bennoune and Elgroud, 2018; Mokhtar et al., 2018).

However, this method also has significant drawbacks. The process of making and examining a histological preparation is time-consuming, laborious, and requires a high level of expertise. Additionally, specific preparation is necessary during the sample processing, which affects the morphology of the sample. For instance, fat inclusions may be damaged or washed out during the preparation process (Łaszkiewicz, Szymański and Kołożyn-Krajewska, 2019).

Furthermore, advancements in food technology, including the development of new food additives and improvements in the production of mechanically deboned meat, have contributed to the continuous evolution of means and methods of falsification. As a result, standard quality assurance methods may not be sufficient (Łaszkiewicz, Szymański and Kołożyn-Krajewska, 2019; Sangaré and Karoui, 2023).

Recent scientific research demonstrates new analytical methods for identifying the composition of meat products and, in particular, sausages. These methods are based on total reflection X-ray fluorescence (Dalipi et al., 2018), sample irradiation combined with electron spin resonance (Tomaiuolo et al., 2019), X-ray microcomputed tomography (Pospiech et al., 2019), ion chromatography combined with electrical conductivity (Iammarino et al., 2021), ultrasonic analysis (Wieja et al., 2021), inductively coupled mass spectrometry (ICP-MS) (Miedico et al., 2022), nuclear magnetic resonance (NMR) (Sangaré and Karoui, 2023). Raman spectroscopy (Wubshet et al., 2019; Qu et al., 2022) and near-infrared (NIR) spectroscopy (Kademi, Ulusoy and Hecer, 2019; Beć, Grabska and Huck, 2022) have also been proposed for the detection of mechanical deboning in meat products.

Most of these methods have been tested only on certain types of meat (e. g., minced meat, sausage, etc.), so although they are useful as 'screening' methods, they need further testing and improvement (Miedico et al., 2022). It should be noted that none of the above methods can be used to determine the species identity of tissues of animal origin. Species identification is further complicated by the special processing conditions (heat or pressure) of sausage products (Bandura et al., 2021).

Therefore, the development of new and sophisticated methods for establishing food authenticity is becoming increasingly necessary due to growing consumer concerns about food quality and safety (Spink et al., 2019; Alaiz-Rodriguez and Parnell, 2020).

The most effective current methods for species identification are protein-based enzyme-linked immunosorbent assay (ELISA) (Perestam et al., 2017) and DNA-based assays such as polymerase chain reaction (PCR) (Shehata et al., 2019) and peptide biomarker analysis using high-performance liquid chromatography (HPLC) and mass spectroscopy (MS) (Prandi et al., 2019).

It has been proven that methods based on DNA analysis are more reliable, as DNA is more stable than proteins during the technological processing of sausage products (Perestam et al., 2017; Naaum et al., 2018).

Scientists (Montowska and Spychaj, 2018) have developed and proposed for implementation unique peptide markers specific to certain species of commercial animals and game, which allows to distinguish not only between different types of meat, but also other less valuable additives, such as connective tissue, blood plasma or dairy products, even in meat products that have been heavily processed.

It is worth noting that DNA-based analysis provides quantitative determination of the types of raw meat, which is very important for establishing the fact of intentional species replacement (Naaum et al., 2018; Shehata et al., 2019).

Another effective method of identification is laser-induced spectroscopy (LIBS), an innovative optical spectroscopy method. LIBS allows for quick analysis of the stable components of protein biomarkers, specifically their elemental composition, which remains constant during production. This provides significant advantages, particularly when monitoring and analyzing element variability in the sample structure. The technique is based on recording element-specific emission radiation emitted during the cooling phase of the plasma formed in the sample, caused by a powerful laser source, using a spectrometer. The LIBS method can be used for both qualitative and quantitative analysis (Sezer et al., 2022).

Domestic scientists (Prylipko and Koval, 2023) propose to use optical pattern recognition methods for identification. To do this, it is necessary to identify and classify specific features of a particular type of sausage product using pattern recognition theory and software tools.

However, currently, none of the above analytical methods for identifying sausage products are standardized by the relevant national regulations. Therefore, it is not possible to accurately identify the quantitative composition and species of meat components of the raw materials used by sausage manufacturers (Bondarenko, 2021; Sangaré and Karoui, 2023).

Thus, the problem of the effectiveness of their control remains unresolved.

Conclusions. 1. The examination of sausage products in Ukraine is regulated by the National Standards of Ukraine (DSTU). This involves the use of sensory and laboratory research methods, including rheological, chemical, and biochemical analysis.

2. The spread of falsification of meat raw materials in sausage products is facilitated by a shortage of high-quality raw materials due to the decline in livestock production, as well as the high cost of additional ingredients in the recipe.

3. In order to provide the Ukrainian nation with high-quality and safe food, in particular sausage products, it is necessary to additionally determine the species of animal tissue included in the formulation using enzyme-linked immunosorbent assay (ELISA), polymerase chain reaction (PCR), laser-induced spectroscopy (LIBS), high-performance liquid chromatography (HPLC) and mass spectroscopy (MS) during veterinary and sanitary examination.

The prospect of further research is to test the analyzed European methods for the identification of meat raw materials in sausage products in order to determine their effectiveness in detecting the presence of mechanically deboned meat in meat products and to improve the DSTU in order to ensure effective inspection of meat and meat products.

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