



## Key indicators of beef safety and quality as important aspects of conservation

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### Abstract

Meat cattle breeding should develop in Ukraine as a priority and independent industry to meet beef needs. The meat industry has enormous potential and, as the most promising and attractive, will take a dominant place in the structure of the domestic food industry in the coming years. Beef is one of the most essential elements of the human diet. It contains complete proteins and animal fats, biologically active substances, mineral elements, and vitamins. The most important feature of food products is their quality and safety indicators, that is, the absence of substances harmful to the consumer's health and pathogens of infectious and invasive diseases. In this regard, veterinary and sanitary expertise and product safety control are of particular importance, as they are necessary to ensure the health of the population of Ukraine. Improving the quality of meat and meat products is a primary task in modern conditions. The implementation of this task depends not only on agricultural but also on processing enterprises. The article presents materials on the study of critical indicators of the safety and quality of beef. The study was carried out as part of the research work of the Department of Normal and Pathological Morphology, hygiene, and Expertise: "Monitoring the content of toxic substances in drinking water, feed and their impact on the body of cattle and the quality and safety of products", state registration number – 0120U101318. The material for the research was the slaughter products of domestic animals, such as cattle, which were supplied to enterprises in the city of Zhytomyr. Pre-slaughter inspection and veterinary-sanitary examination of carcasses and their slaughter products of cattle was carried out following the "Rules of pre-slaughter veterinary examination of animals and veterinary-sanitary examination of meat and meat products". The study aims to determine the safety and quality indicators of beef obtained in the conditions of meat processing enterprises of the Zhytomyr region. To achieve this goal, a comprehensive survey of beef safety and quality indicators was conducted. As a result of the tests, it was established that the pH level of the meat was 5.7–6.1. Carrying out the reaction with a 5 % solution of CuSO<sub>4</sub> in the broth showed that the broth was transparent. A positive response to peroxidase was also detected. The safety parameters corresponded to regulatory documents. Careful control of the safety and quality of beef at every stage of production, starting from the rearing of animals and up to the sale of the product, guarantees a high degree of consumer protection.

**Keywords:** domestic animal; beef; safety indicators; quality; pre-slaughter veterinary inspection; regulatory documents.

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## 1. Introduction

Animal husbandry is one of the essential branches of agricultural production, which plays a vital role in the formation of food security in Ukraine in the conditions of war and providing the population with nutritious types of food and food industry enterprises with raw materials (Lavruk, 2018; Hunich et al., 2021; Bashchenko et al., 2023). The natural and climatic conditions in the region are not favorable for the production of many types of animal husbandry products by agrarians, and animals are usually provided with feed for their output. Agricultural enterprises of Ukraine engaged in the production of livestock products have vari-

ous production lines and provide industrial enterprises with a variety of necessary food products for the population and valuable types of raw materials (Nitsenko & Meshcheryakov, 2019; Pepko et al., 2023; Mylostyvyi et al., 2023). In particular, animal husbandry ensures the production of a variety of dietary, vitaminized, and high-calorie (containing 30 % calories and 60 % protein of the daily ration) products of animal origin, which are used to feed the population and create promising export potential (Lavruk & Lavruk, 2022). Under the influence of extraordinary circumstances, the development of animal husbandry in military operations was characterized by a reduction in the number of cattle, an unbalanced fodder base, low productivity of animals, and a

decrease in the production of livestock products. The consequences of the processes of destruction of animal husbandry the aggravation of the problem of food security of the state, in particular, the decrease in the level of providing the population with quality products of animal origin, violation of the socio-economic and demographic situation in the region; the growth of negative processes in the use of natural agricultural resources, falsification of meat products by replacing one type of raw material with another (Oleksienko et al., 2020; Lavruk & Lavruk, 2022). It is essential to consider that the primary condition for the possibility of selling a food product remains its safety (Khimich et al., 2020). Unfortunately, according to most scientists, the level of food security in Ukraine is shallow. For a long time, despite the apparent urgency of the state's food security problems, Ukrainian legislation did not regulate a number of its essential components. Among them is the issue of residues of veterinary drugs in food products of animal origin, etc (Berezovska, 2020).

It should be noted that the problem of beef production in Ukraine is quite urgent since its production has decreased significantly, and the share of beef in the structure of the meat balance has decreased dramatically. It should be noted that beef is an irreplaceable and unique product that forms a complete diet of the population due to the most effective transformation of roughage and pasture forage into high-quality protein, which is the basis of the structural elements of cells and tissues (Pidpala et al., 2019; Ohorodnichuk, 2022). The beef obtained is mainly represented by meat from slaughtering dairy cows and calves since farms are almost unengaged, raising young cattle for meat (Pankeev, 2022).

Nutrition is the most critical physiological need of the human body, and satisfaction largely determines a person's health and quality of life. Meat and meat are among the most essential food products (Monteiro et al., 2011; Albuquerque et al., 2022). The nutritional value of meat products is determined by their chemical composition and high organoleptic properties (Geiker et al., 2021; Juárez et al., 2021). Numerous physical and chemical processes occur under the influence of the environment and technological factors. In this regard, the quality of finished meat products depends on raw meat quality. Meat quality is a set of properties characterizing food and biological value, organoleptic, physicochemical, structural-mechanical, functional-technological, sanitary-hygienic, and other features of products, as well as the degree of their expression (Kitaeva et al., 2021).

The intensive technology of breeding dairy cattle breeds contributes to the formation of high meat productivity in animals. It shortens the duration of their fattening to commercial live weight at an earlier age. During the rearing period from birth to 13 months of age, bulls of the Holstein, Ukrainian black and red, and red-spotted dairy breeds of the control and experimental groups reached a live weight of 421.1–443.8 kg and 430.3–443.3 kg (Pidpala et al., 2019). There is a certain regularity in the formation of meat productivity. Including the chemical and morphological composition of carcasses in bulls during ontogenesis, which is more influenced by body weight and carcass weight than age (Kruk, 2015).

Meat is a collection of various tissues - muscle, connective, fat, bone, etc. (Geiker et al., 2021; Ederer & Leroy, 2023). Each tissue type consists of cells and non-cellular

structures that perform certain physiological functions (Mukund & Subramaniam, 2020). The structural elements of the cell are the membrane, the large nucleus, and the cytoplasm (Kim et al., 2022). The content of tissues in meat and its properties depend on the type of animal, its sex, age, fattening, and breed. The chemical composition and anatomical structure of different tissues are not the same, so the consumer properties of meat are determined by the ratio of tissues in the carcass, which depends on the species and breed of animals, sex, age, and fatness (Tkachik & Tkachuk, 2019).

All types of animals that enter meat processing plants as raw materials for obtaining meat and slaughter products are called slaughter animals. Healthy domestic animals and poultry are allowed for slaughter. Slaughter of sick animals or those suspected of having infectious diseases is allowed in cases provided for by the rules of pre-slaughter veterinary inspection of animals and veterinary-sanitary examination of meat and meat (Gorobei et al., 2018).

The situation with Ukraine's population's health is becoming dangerous due to the influence of many factors, including nutrition (Turchyn & Slyvka, 2010). At the current stage, the urgency of this problem has increased due to several factors: the deterioration of the ecological (Melnyk & Viserska, 2015), epizootic situation, non-communicable diseases (injuries to the skeleton's bones, pneumonia, mastitis, etc.) (Suprovych & Strojnovska, 2023), export and import of products of animal origin. All this causes the need to solve a whole set of tasks and becomes a prerequisite for creating a solid scientific basis for food products' quality and safety control.

Ensuring the safety and quality of raw materials and food products is a necessary condition that determines the health of the population and the preservation of its gene pool. Consumption of food products of low sanitary quality poses a danger to humanity. Therefore, improving the hygienic and nutritional quality of food products is of great importance. The most crucial measure in solving these problems is scientifically based veterinary and sanitary assessment of meat and other livestock products. The evaluation of the slaughter products of animals affected by various diseases and those treated with medicinal products deserves special attention (Overkovska, 2023).

The use of a wide range of veterinary drugs and feed additives due to the modern level of animal husbandry technology and the increase in the industrial load on the environment with toxic substances due to intensive economic activity requires strengthening control over the safety of products of animal origin (Kyrlyuk, 2019). Today, there is much talk about the need to reform the state control system in food safety (Danilyuk, 2020). The safety of food products and raw materials is one of the decisive components of the economic security of every state. It is determined by the country's ability to effectively control the production and import of safe and high-quality food based on universally recognized principles (Semich, 2020).

Within the framework of the EU, the issue of the safety and quality of food products in the chain "from the field to the table" is regulated by numerous European directives, which must be introduced into the legislation of Ukraine to harmonize the regulatory framework. The adoption and constant updating of the food legislation of Ukraine significantly strengthens the European integration vectors of Ukraine.

## 2. Materials and methods

The material for the research was the carcasses and slaughter products of cattle, which came to enterprises in the city of Zhytomyr. Pre-slaughter inspection, slaughter, processing, and veterinary-sanitary examination of carcasses and slaughter products of cattle were carried out following the “Rules of pre-slaughter veterinary examination of animals and veterinary-sanitary examination of meat and meat products”. The study was carried out as part of the research work of the Department of Normal and Pathological Morphology, Hygiene, and Expertise: “Monitoring the content of toxic substances in drinking water, feed and their impact on the body of cattle and the quality and safety of products”, state registration number – № 0120U101318. The quality and safety of beef was investigated using the analysis of key characteristics:

- organoleptic (appearance, consistency, color, smell, taste of cooking);
- biochemical (determination of pH of meat, reaction with copper sulfate in broth, reaction to peroxidase, determination of volatile fatty acids);
- safety parameters: the mass proportion of pesticides, the presence of mycotoxins (aflatoxin B1), antibiotics (tetracycline group, zinc bacitracin), heavy metals (lead, cadmium, copper, zinc, mercury, arsenic, etc.), radionuclides (GOST 30178-96; DSTU EN 12393-1:2003; DSTU 7670:2014); the total number of mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM), CFU, the presence of bacteria of the *E. coli* group (ECBG); pathogenic microorganisms, including bacteria of the genus *Salmonella*, *Listeria monocytogenes* (GOST 30518-97; DSTU ISO 11290-1:2003; DSTU EN ISO 6579-1:2022).

## 3. Results and discussion

The quality indicators of meat and meat products depend on the composition and properties of raw materials, recipes, conditions, and technological processing and preservation regimes. An objective and comprehensive assessment of these dependencies is necessary to identify factors affecting product quality.

The production of meat products at Zhytomyr Enterprises complies with all norms and rules. The availability of FSSC 22000, ISO 22000:2005, HACCP, and FSSC 22000 certificates guarantees that all stages of meat production at Zhytomyr enterprises meet the standards.

Production at these enterprises is organized in compliance with the strictest norms and rules, from planning and procurement of raw materials to quality control of finished products.

All stages of production, from the reception of raw materials to the packaging and labeling of finished products, are carefully checked and meet international standards.

A comprehensive approach to ensuring the safety of food products ensures that at every stage of production, all necessary measures are taken to preserve the quality and harmlessness of products.

At meat processing enterprises, points are equipped to inspect carcasses and other slaughter products: heads, internal organs, carcasses, and final.

Processing animals at such enterprises is organized so that veterinary control is carried out at each stage.

During the pre-slaughter veterinary examination of animals, no animals suspected of infectious diseases or sick animals were found.

During the post-mortem inspection of cattle carcasses and slaughter products, cases of non-infectious diseases (mechanical injuries of the humerus, femur, lower leg, kidney cysts, pneumonia, mastitis) were revealed.

During the analysis of the organoleptic characteristics of beef, it was found that they correspond to fresh meat. As a result of the tests, it was established that the pH level of the meat was 5.7–6.1. Carrying out the reaction with a 5 % solution of CuSO<sub>4</sub> in the broth showed that the broth was transparent. A positive response to peroxidase was also detected.

All indicators of biochemical analysis testified to the high quality of the meat.

As is known from scientific sources (Zasekin, 2000; Shcherbakova & Maksymova, 2019), the primary sources of contamination of livestock products are pesticides, toxic substances used in agriculture, the use in livestock of growth stimulants, unauthorized preservatives, feed, preventive and therapeutic additives in increased doses, violations of sanitary requirements in the technology of production and storage of products, which leads to the formation of bacterial toxins, the use of dangerous dyes, preservatives, antioxidants, etc.

Studies have shown that beef's pesticides and heavy metals levels do not exceed the maximum permissible levels. The research results are presented in Table 1.

**Table 1**  
Content of pesticides and heavy metals in beef

Indicator	Permissible levels, mg/kg, not more	Result, mg/kg
Content of pesticides		
Mass fraction of DDD, mg/kg	0.1	<0.076
Mass fraction of DDE, mg/kg	0.1	<0.084
Mass fraction of DDT, mg/kg	0.1	<0.079
Mass fraction of hexachlorocyclohexane gamma isomer, mg/kg	0.1	<0.089
The content of heavy metals		
Mass fraction of mercury, mg/kg	0.03	<0.001
Mass fraction of lead, mg/kg	0.1	<0.07
Mass fraction of cadmium, mg/kg	0.05	<0.02

Mycotoxins are life products of microscopic fungi, which belong to the group of biologically active substances of different chemical nature, which have a general plasma effect on living cells. Many researchers believe that toxins have a lot in common with antibiotics, both in terms of their specific impact on the body's metabolic processes and the conditions of their formation by the producing fungi. Mycotoxins, as a rule, are multi-component, and their components have a different chemical nature – organic acids, glucosides, steroids, terpenes, peptides, and furans, so they have different effects on the body (Kutsan et al., 2009; Petrov et al., 2019).

The following results were negative in research on the content of mycotoxins (aflatoxin B1) and antibiotics (tetracycline group, zinc bacitracin).

It should be noted that residents' diet of radioactively contaminated territories mainly includes food products ob-

tained from their subsidiary farms. <sup>137</sup>Cs contamination of soils on which plant products are grown, and cattle are grazed leads to the accumulation of the radionuclide in food products through the migration of <sup>137</sup>Cs in the food chain. Consumption of radioactively contaminated food leads to internal irradiation of the body (Romanchuk et al., 2019).

The content <sup>137</sup>Cs and <sup>90</sup>Sr during the research complied with regulatory documents. The results of the research are presented in Table 2.

During bacterioscopy, single cocci were found, which corresponds to regulatory documents. An indicator such as KMAFAM was also within acceptable levels. The beef studied is safe because ECBG and pathogenic m/o, including *Salmonella* and *L. monocytogenes*, were not detected in it (Table 3).

**Table 2**  
Content of mycotoxins, antibiotics, and radionuclides in beef

Indicator	Acceptable levels, no more	Result
<b>Antibiotics</b>		
Mass fraction of antibiotics of the tetracycline group, units/g	Not allowed <0.01	Not detected <0.01
Mass fraction of zinc bacitracin, units/g	Not allowed <0.02	Not detected <0.02
<b>Mycotoxins</b>		
Aflatoxin B <sub>1</sub> , mg/kg	<0,005	<0,0015
<b>Radionuclides</b>		
Content <sup>137</sup> Cs, Bq/kg	200	6.0 ± 0.32
Content <sup>90</sup> Sr, Bq/kg	20	1.3 ± 0.39

**Table 3**  
Microbiological indicators of beef

Indicator	Acceptable levels	Result
Smears-imprints	Microflora is absent, or single cocci or rods are present	single cocci (1-3 cells)
KMAFAM, CFU in 1 g	5×10 <sup>5</sup>	8,4×10 <sup>3</sup>
Salmonella, in 25 g	Not allowed	Not highlighted
ECBG, in 0,01g	Not allowed	Not highlighted
<i>L. monocytogenes</i>	Not allowed	Not highlighted

Beef complies with regulatory documents regarding the content of toxic elements, pesticides, mycotoxins, antibiotics, and microbiological and radiological indicators.

#### 4. Conclusions

As a result of the conducted research, it was established that the animals for slaughter came to the meat processing enterprises of Zhytomyr from specialized enterprises for the production of beef and personal peasant farms in the regions of Ukraine. The production of meat products at enterprises in Zhytomyr complies with all norms and rules. Availability of FSSC 22000, ISO 22000:2005, HACCP, and FSSC 22000 certificates guarantees that all stages of meat production at Zhytomyr enterprises meet the standards.

Organoleptic, biochemical indicators, and safety parameters of beef corresponded to regulatory documents. Cases of non-infectious diseases were detected during the post-mortem veterinary examination of cattle carcasses and slaughter products.

*Prospects for further research.* Further scientific research will be aimed at determining the quality and safety indicators of pork.

#### Conflict of interest

The authors claim no conflicts of interest.

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