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INNOVATIONS IN SANITATION AND HYGIENE IN CATTLE BREEDING

Abstract

The article presents the results of determining effective regimens and developing methods for the use of three disinfectants, which, in various combinations, include quaternary ammonium compounds, polyhexamethylene guanidine hydrochloride, glutaraldehyde, and other substances. The research was conducted at the production facilities of the National Scientific Center "Institute of Experimental and Clinical Veterinary Medicine" (Kharkiv). The disinfectants were applied according to current guidelines and regulations. The proposed disinfection methods align with modern biosafety and biosecurity requirements in livestock production. They are user-friendly, environmentally safe, highly effective, and cost-efficient. The findings from this research provide valuable resources for planning and implementing sanitary and hygienic measures in livestock production. Future research aims to develop a comprehensive, science-based system of sanitary and hygienic practices specifically tailored for dairy farming.
Keywords: *disinfection, method, preparation, concentration, exposure.*

Presentation of the main material of the research. Disinfection has always been and continues to be one of the most effective measures in livestock production, aimed at preventing the emergence and spread of infectious diseases among productive livestock [2, 12]. Additionally, the organization of sanitary and hygienic measures, along with their prompt and high-quality implementation, is essential for obtaining safe animal products as well as for their storage and sale [3, 4, 15].

The range of available antimicrobial agents includes numerous products belonging to various chemical groups, each characterized by different properties [1, 11, 14]. However, it should be noted that not all disinfectants are suitable for use in livestock production. Some may cause resistance in the microbiota, while others can be toxic and pose environmental hazards [13, 19].

The large-scale introduction of disinfectants into production requires a preliminary study of their properties in the laboratory with confirmation of their effectiveness directly under production conditions [6, 16].

The effectiveness of sanitary and hygienic measures in livestock farms is significantly increased by rotating disinfectants and their alternate use [8, 10]. Good results were obtained with the combined use of several disinfectants [7]. At the same time, it is reported that in many farms and complexes (> 90%) disinfectants are used without proper adjustment of their application regimes. Also, the percentage of low concentrations or cases where no active substance was detected in disinfectants is about 50% [9]. Preliminary cleaning of animal facilities is key to the effectiveness of the disinfectant. However, in practice, these operations are carried out separately and only in 50% of cases are they effectively combined [17].

Determining effective cleaning and disinfection regimens for livestock facilities is critical to improving animal health and controlling animal diseases [5].

To develop scientifically based methods for sanitizing various animal facilities.

The research was conducted at the production facilities of the National Scientific Center “Institute of Experimental and Clinical Veterinary Medicine” in Kharkiv. Three complex antimicrobial agents containing various combinations of quaternary ammonium compounds, polyhexamethylene guanidine hydrochloride, glutaraldehyde, and other substances were evaluated for their effectiveness.

The disinfectants were applied according to the current recommendations and regulations [18].

After disinfection, bacteriological control of its quality was carried out by the isolation of sanitary-indicative microorganisms (bacteria of the Escherichia coli group). For this purpose, after disinfection, swabs were taken from 10 different areas of the room with an area of 10×10 cm using a metal frame stencil, which limits the required area. The samples, each separately, were washed in the same test tube by several immersions and squeezing of the swab. The squeezed swabs were removed, and the liquid was centrifuged for 20-30 minutes at 1500 rpm. The supernatant was carefully poured off, and an equal volume of sterile distilled water was added to the tubes. The precipitate was then shaken and centrifuged again for 20 to 30 minutes. After centrifugation, the supernatant was removed, and 0.5 cm^3 of the remaining sediment was inoculated onto nutrient media: meat-peptone broth (MPB) and meat-peptone agar (MPA). The cultures were incubated in a thermostat for 24 hours at 37.0 ± 0.5°C. The growth of the cultures was recorded after both 12 and 24 hours. The cultures grown on the media were examined under a microscope. The disinfection quality was considered satisfactory if microbial colonies were not grown in any of the samples.

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Based on research findings, innovative methods for disinfecting livestock facilities have been developed using highly effective disinfectants.

The first utility model is based on developing the method of pre-launch disinfection of livestock facilities. This process includes thoroughly cleaning and mechanically cleaning the facilities, followed by disinfection using a specific preparation. To ensure the effectiveness of the disinfection, bacteriological quality control is implemented. The disinfectant used contains alkyl dimethyl benzyl ammonium chloride, dodecyl dimethyl ammonium chloride, polyhexamethylene guanidine hydrochloride, N,N-bis (3-aminopropyl)-dodecylamine, functional additives, and water, with a recommended exposure time of 5 hours.

Before the pre-launch disinfection, the room is thoroughly cleaned and mechanically scrubbed to remove building materials, debris, and other contaminants. The floors, ceilings, and walls are washed using pressurized water. After the water has been removed from the room, wet disinfection is carried out using a designated preparation:

Method 1: alkyl dimethyl benzyl ammonium chloride – 0.065 %, didecyl dimethyl ammonium chloride – 0.007 %, polyhexamethylene guanidine hydrochloride – 0.025 %, N,N-bis(3-aminopropyl)-dodecylamine – 0.02 %, functional impurities – 0.025 %, water – 99.858 %.

Method 2: alkyl dimethyl benzyl ammonium chloride – 0.13 %, didecyl dimethyl ammonium chloride – 0.014 %, polyhexamethylene guanidine hydrochloride – 0.05 %, N,N-bis (3-aminopropyl)-dodecylamine – 0.04 %, functional impurities – 0.05 %, water – 99.716 %.

Method 3: alkyl dimethyl benzyl ammonium chloride – 0.195 %, didecyl dimethylammonium chloride – 0.021 %, polyhexamethylene guanidine hydrochloride – 0.075 %, N,N-bis(3-aminopropyl)-dodecylamine – 0.06 %, functional impurities – 0.075 %, water – 99.574 %.

The effectiveness of the proposed method is shown in Table 1.

Table 1

Method of pre-launch disinfection of livestock facilities

The proposed product		Microflora growth	
Composition	%	Before disinfection	After disinfection
alkyd dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride polyhexamethylene guanidine hydrochloride N, N-bis (3-aminopropyl)-dodecylamine functional impurities water	0.065 0.007 0.025 0.02 0.025 99.858	+	+

alkyd dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride polyhexamethylene guanidine hydrochloride N, N-bis (3-aminopropyl)-dodecylamine functional impurities water	0.13 0.014 0.05 0.04 0.05 99.716	+	–
alkyd dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride polyhexamethylene guanidine hydrochloride N, N-bis (3-aminopropyl)-dodecylamine functional impurities water	0.195 0.021 0.075 0.06 0.075 99.574	+	–

Note: "+" – growth of microorganisms; "–" – no growth of microorganisms.

Table 1 shows that catalase-positive and oxidase-negative staphylococcus, Escherichia coli, mono- and diplococci were isolated from the swabs taken from the objects of the livestock premises before disinfection. When the product is used according to Method 1, it does not cause complete destruction of microorganisms, as evidenced by the growth of staphylococcal colonies on the nutrient medium. No growth of microorganisms was observed in any of the swabs taken after the application of the product by methods 2 and 3 at an exposure time of 5 hours.

The next two utility models are based on the task of developing methods of preventive disinfection. Thus, the first developed method includes mechanical cleaning of livestock premises, their disinfection with a product, and bacteriological quality control of the disinfection by using a disinfectant containing alkyl dimethyl benzyl ammonium chloride, didecyl dimethyl ammonium chloride, glutaraldehyde, isopropanol, turpentine and water at an exposure time of 1 hour.

Preventive disinfection of livestock facilities begins with the mechanical removal of manure, feed residues, and bedding. Feeders, drinkers, partitions, purulent channels, walls, and floors are mechanically cleaned using water under pressure. After removing the water from the premises, wet disinfection is carried out with the product:

Method 1: alkyd dimethyl benzyl ammonium chloride – 0.0853 %, didecyl dimethyl ammonium chloride – 0.039 %, glutaraldehyde – 0.0537 %, isopropanol – 0.0732 %, turpentine – 0.01 %, water – 99.7388 %.

Method 2: alkyl dimethyl benzyl ammonium chloride – 0.1706 %, didecyl dimethyl ammonium chloride – 0.078 %, glutaric aldehyde – 0.1073 %, isopropanol – 0.1463 %, turpentine – 0.02 %, water – 99.4778 %.

Method 3: alkyd dimethyl benzyl ammonium chloride – 0.2559 %, didecyl dimethyl ammonium chloride – 0.117 %, glutaraldehyde – 0.161 %, isopropanol – 0.2195 %, turpentine – 0.03 %, water – 99.2166 %.

The results of the effectiveness of the proposed method are shown in Table 2.

Table 2

Method of preventive disinfection in animal husbandry

The proposed product		Microflora growth	
Composition	%	Before disinfection	After disinfection
alkyl dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride glutaraldehyde isopropanol turpentine water	0.0853 0.039 0.0537 0.0732 0.01 99.7388	+	+
alkyl dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride glutaraldehyde isopropanol turpentine water	0.1706 0.078 0.1073 0.1463 0.02 99.4778	+	–
alkyl dimethyl benzyl ammonium chloride didecyl dimethyl ammonium chloride glutaraldehyde isopropanol turpentine water	0.2559 0.117 0.161 0.2195 0.03 99.2166	+	–

Note: "+" – growth of microorganisms; "–" – no growth of microorganisms.

From Table 2, it can be seen that the disinfectant according to Methods 2 and 3 can be used for preventive disinfection of livestock facilities with an exposure time of 1 hour.

The following utility model provides for the use of a disinfectant containing didecyl dimethyl ammonium chloride, dioctyl dimethyl ammonium chloride, octyldecyl dimethyl ammonium chloride, alkyl dimethyl benzyl ammonium chloride, glutaraldehyde, water with an exposure time of 1 hour.

Preventive disinfection of livestock facilities begins with mechanical removal of manure, feed residues, and bedding. Feeders, drinkers, partitions, sewers, walls, and floors are mechanically cleaned with pressurized water. After the water is removed from the premises, wet disinfection is performed using a disinfectant:

Method 1: didecyl dimethyl ammonium chloride – 0.00375 %, dioctyl dimethyl ammonium chloride – 0.00375 %, octyl decyl dimethyl ammonium chloride – 0.0075 %, alkyl dimethyl benzyl ammonium chloride – 0.01 %, glutaraldehyde – 0.0125 %, water – 99.9625 %.

Method 2: didecyl dimethyl ammonium chloride – 0.009375 %, dioctyl dimethyl ammonium chloride – 0.009375 %, octyl decyl dimethylammonium chloride – 0.01875 %, alkyl dimethyl benzyl ammonium chloride – 0.025 %, glutaraldehyde – 0.03125 %, water – 99.90625 %.

Method 3: didecyl dimethyl ammonium chloride – 0.01875 %, dioctyl dimethyl ammonium chloride – 0.01875 %, octyl decyl dimethyl ammonium chloride – 0.0375 %, alkyl dimethyl benzyl ammonium chloride – 0.05 %, glutaraldehyde – 0.0625 %, water – 99.8125 %.

The results of the effectiveness of the proposed method are shown in Table 3.

Table 3

Method of preventive disinfection

The proposed product		Microflora growth	
Composition	%	Before disinfection	After disinfection
didecyl dimethyl ammonium chloride	0.00375	+	+
dioctyl dimethyl ammonium chloride	0.00375		
octyl decyl dimethyl ammonium chloride	0.0075		
alkyl dimethyl benzyl ammonium chloride	0.01		
glutaraldehyde	0.0125		
water	99.9625		

didecyl dimethyl ammonium chloride dioctyl dimethyl ammonium chloride octyl decyl dimethyl ammonium chloride alkyl dimethyl benzyl ammonium chloride glutaraldehyde water	0.009375 0.009375 0.01875 0.025 0.03125 99.90625	+	–
didecyl dimethyl ammonium chloride dioctyl dimethyl ammonium chloride octyl decyl dimethyl ammonium chloride alkyl dimethyl benzyl ammonium chloride glutaraldehyde water	0.01875 0.01875 0.0375 0.05 0.0625 99.8125	+	–

Note: "+" – growth of microorganisms; "–" – no growth of microorganisms.

Table 3 demonstrates that the product effectively disinfects the treated surfaces when applied using methods 2 and 3 for an exposure time of one hour.

As a result of this research, several disinfection methods have been developed and patented in Ukraine as utility models. These include: No. 91983 “Method of Preventive Disinfection in Livestock Production,” No. 96490 “Method of Pre-launch Disinfection of Livestock Facilities,” and No. 99630 “Method of Preventive Disinfection”.

The findings enhance the existing system of sanitary and technological measures in animal husbandry by introducing innovative, science-based approaches to the selection and application of disinfectants.

The successful and sustainable development of livestock farming relies heavily on the timely and effective implementation of sanitary and hygienic measures. These measures are crucial for preventing infectious diseases in farm animals and eliminating sources of infection. Additionally, adhering to these sanitary measures and hygiene standards is essential for producing high-quality and safe livestock products [16, 20].

As livestock farming becomes more intensive and specialized, with a significant concentration of productive animals in limited areas, the importance of sanitary and hygienic measures increases. These measures play a crucial role in the technological processes within industrial complexes, as the production of high-quality products cannot occur without strict adherence to scientifically established norms and rules of veterinary sanitation and hygiene [1, 18].

Disinfection is a key and effective strategy for preventing and controlling various diseases in farm animals. The effectiveness of physical and biological methods is often limited by factors such as the lack of specialized equipment and the high resistance of microorganisms to these methods [2, 10, 14].

There has been a recent shift in understanding and addressing disinfection challenges. This change is largely due to the introduction of new biocidal agents, the recognition of resistant strains of microorganisms to many disinfectants, and a modern perspective on the environmental implications of using antibacterial drugs [15, 20, 21].

Chemical disinfection is currently the most effective method; however, the range of available chemical products does not fully meet market demands. Currently, there is a lack of disinfectants that fully meet all the necessary criteria for effectiveness, safety, and cost-efficiency. It has been demonstrated that a universal disinfectant cannot be completely effective across all situations.

Conclusions and prospects for future research. Maintaining the health of livestock and ensuring the safety of animal-derived products is impossible without the proper implementation of a comprehensive set of sanitary and hygienic measures. We have identified effective protocols and developed methods for using three disinfectants, which show promise for application in production settings. The results obtained from implementing these methods in practice will enable us to propose new and effective protocols for preventive disinfection.

This article is dedicated to the blessed memory of the notable scientist and talented organizer of educational and scientific processes, Doctor of Agricultural Sciences, Professor Andrii Palii.

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ІННОВАЦІЇ В САНІТАРІЇ ТА ГІГІЄНІ В СКОТАРСТВІ

Анотація

У статті представлено результати визначення ефективних схем та розробки методики застосування трьох дезінфекційних засобів, які в різних комбінаціях включають четвертинні амонієві сполуки, полігексаметиленгуанідину гідрохлорид, глутаровий альдегід та інші речовини. Дослідження проводились на виробничих потужностях Національного наукового центру «Інститут експериментальної та клінічної ветеринарної медицини» (м. Харків). Дезінфікуючі засоби були застосовані відповідно до чинних інструкцій та правил. Запропоновані методи дезінфекції відповідають сучасним вимогам біобезпеки та біозахисту у тваринництві. Вони зручні у використанні, екологічно безпечні, високоефективні та економічно вигідні. Результати цього дослідження надають цінні ресурси для планування та впровадження санітарно-гігієнічних заходів у тваринництві. Майбутні дослідження спрямовані на розробку всеосяжної, науково обґрунтованої системи санітарно-гігієнічних практик, спеціально розроблених для молочного тваринництва.

Ключові слова: *дезінфекція, метод, підготовка, концентрація, експозиція.*

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