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SUBSTANTIATION OF THE USE OF OZONE FOR CREATING AN OPTIMAL MICROCLIMATE ON LIVESTOCK FARMS

Abstract

The article considers the problems of creating an optimal microclimate, which directly affects the body's resistance, productivity and reproductive functions in conditions of high livestock concentration and dense placement of animals on farms. It is shown that ozone disinfection is a promising and environmentally safe method of ensuring sanitary well-being in livestock farming. One of the most important properties of ozone is its ability to inhibit the development of microorganisms up to their complete inactivation. Regular air ozonation reduces the risk of bronchopulmonary diseases in animals, reduces the negative impact of mycotoxins in feed and contributes to an increase in live weight gains. One of the directions of scientific work is the search for inexpensive, environmentally safe disinfectants that do not require the use of water. Such agents include ozone, which is an unstable substance, the molecules of which independently decompose into oxygen and a free oxygen atom. It is the presence of this atom that provides ozone with powerful oxidizing, disinfecting and deodorizing properties. The ozonation process requires small doses of the substance, is easy to use and economically beneficial. An important advantage of this method is that ozone is formed directly at the place of application from oxygen in the atmospheric air, and after disinfection is completed, it quickly decomposes without harming the environment.

***Keywords:*:** *animal welfare, microclimate, microflora, ozone, ozonation, animal health*

Introduction

At the present stage, issues of hygiene, sanitation, and are becoming increasingly important in the production of high-quality and safe food products. After Ukraine joined the World Trade Organization (WTO), the requirements for the competitiveness

of domestic milk and dairy products on both domestic and international markets significantly increased.

Analysis of recent studies and publications

One of the main conditions for the entry of Ukrainian dairy products into the markets of the European Union and WTO member countries is compliance with international safety and quality standards [1-5].

Modern livestock farms and complexes that use industrial production technologies are characterized by a complex interaction between animals and the environment. Under conditions of high livestock concentration and dense housing, the creation of a favorable microclimate becomes especially important, as it directly affects the immunity, productivity, and reproductive performance of animals. The amount of waste products, the level of bacterial contamination of the air, and other unfavorable factors directly depend on the number of animals kept in the facility. The negative influence of microclimatic factors causes changes in blood circulation, respiration, thermoregulation, gas exchange, and metabolic processes, which ultimately affect the health and productivity of animals [6, 7, 8].

Ozone can exist in all states of matter. Unlike ordinary oxygen, whose molecule consists of two atoms (O_2), ozone has a triatomic structure (O_3). Under normal conditions, ozone is a blue-colored gas. The mass of 1 liter of ozone is 2.1445 g. Its solubility in water at 0 °C is 0.394 g/L, which is approximately 15 times higher than the solubility of oxygen. Unlike O_2, ozone is unstable and can spontaneously decompose at high concentrations; the rate of this process increases with rising concentration and temperature. Ozone is considered one of the most powerful natural oxidizing agents. Ozone actively reacts with aromatic compounds, destroying their aromatic ring. These properties form the basis of technologies used for deodorizing rooms, various environments, and wastewater. In reactions with saturated hydrocarbons, ozone decomposes with the formation of atomic oxygen, which initiates chain oxidation processes.

At moderate concentrations, ozone affects the membrane of microorganisms by reacting with the double bonds of lipids. In addition, it disrupts the activity of cellular dehydrogenases, negatively affecting respiratory processes. Changes in cell membrane permeability and the conversion of closed DNA into an open form reduce the ability of bacteria to reproduce.

The sterilizing efficiency of ozone depends on its concentration, exposure time, temperature, humidity, type of microorganism, pH level, and the initial degree of microbial contamination. Low ozone concentrations (around 0.2 mg/m³) are insufficient for complete bacterial destruction, as bacteria may recover after treatment. Under such conditions, ozone mainly affects the cell surface and hardly penetrates inside. Complete inactivation of microflora requires higher concentrations and longer contact times. The bactericidal effect of ozone is enhanced by nitrogen oxides and strongly depends on air humidity: at humidity below 45%, its effectiveness is almost absent, while the best results are observed within the range of 60–80%.

Under the influence of ozone, microbial contamination of air and equipment is significantly reduced. Ozone completely destroys Escherichia coli, Salmonella, staphylococci, and dysentery pathogens. In addition to disinfection, ozone eliminates unpleasant odors and enriches the air with oxygen [9, 10].

It has been proven that ozonation of premises, technological equipment, containers, and packaging in dairy enterprises improves sanitary and hygienic production conditions and extends the shelf life of products. Ozonation of refrigeration chambers also contributes to the longer preservation of freshness and nutritional value of food products. Ozone demonstrates the highest efficiency during the lag phase of bacterial development in the production and storage of products. Treatment of meat with ozone reduces moisture loss, improves sanitary conditions, and enhances the commercial appearance of products. The use of an ozone atmosphere combines well with other technological processes and is characterized by high efficiency. During the storage of semi-smoked sausages, changes in the lipid ratio are especially noticeable under ozonation conditions at ozone concentrations of 15–20 mg/m³.

The use of artificial air ozonation in livestock farming significantly reduces the spread of bronchopulmonary diseases. In animals kept in an ozonated environment, spontaneous pneumonia was practically not observed, whereas under normal conditions it occurred in approximately 40% of cases and could cause mortality in up to 20% of animals. Studies have also shown that ozonated air increases the body's resistance to sapronotic microflora and reduces the negative effects of mycotoxins in feed, contributing to a 5–10% increase in daily weight gain (Luchinkin S. P., 1986; Molochnikov V. V.,1980). During a two-hour daily treatment of pigsties with an ozone-air mixture containing 0.8 mg/m³ of ozone, microbial contamination decreased from 246,000 to 50,000 CFU/m³, while ammonia concentration dropped from 12 to 4 mg/m³. Long-term use of ozone at concentrations of 0.06–0.08 mg/m³ positively affected piglet growth: their live weight was 24% higher compared to the control group. The use of ozonated air also contributed to lower ammonia levels, improved growth, and reduced morbidity among young animals (Storchevoi V.F., 2010; Roschyna V.V., 2005). In poultry farming, ozone is used for disinfecting incubation and table eggs. Such treatment effectively disinfects eggshells from various types of microflora, including Salmonella. Unlike formalin, which is carcinogenic, or chlorine-containing agents that may cause side effects, ozone is considered one of the safest and most effective methods of egg disinfection (Ksenz N. V., 2010).

Ozone is widely used in drinking water treatment. The ozonation of contaminated water is a complex chemical and technological process that requires careful consideration of all factors influencing the efficient design of the treatment system. These factors include the nature of chemical reactions, the possibility of undesirable side effects, the transportation of the required amount of reactive substances, flow rates and retention time in the reaction zone, hydrodynamic conditions within different units of the technological scheme, as well as the energy parameters of individual system components.

Due to its strong oxidizing properties, ozone is considered one of the most effective agents for wastewater purification and disinfection. However, ozonation

should not be regarded as a universal standalone method capable of removing all possible contaminants. Instead, it represents only one stage of the overall water treatment process. Industrial-scale ozone treatment enables rapid and efficient purification regardless of the initial condition of the water. Worldwide, ozone-based water purification is recognized as one of the most environmentally friendly and versatile treatment methods. In addition, ozonation effectively neutralizes viral and spore-forming contaminants in both water and air.

This reliable and comprehensive method is also widely applied for the removal of iron and manganese from artesian well water. Ozonation is considered one of the most effective techniques for iron removal. Moreover, when iron and manganese are present in the form of organic compounds or colloidal particles (0.1–0.01 μm in size), water purification is possible only through ozone treatment, since preliminary oxidation of the organic compounds is required. In terms of disinfecting properties, ozone surpasses chlorine, chloramine, and chlorine dioxide.

The aim of this study was the search for affordable and environmentally safe disinfectants that do not require large amounts of water. Ozone is one such agent widely used in dairy production and animal husbandry.

Materials and Methods

The microclimate varies in different parts of a room. Usually, the microclimate is monitored 3–4 times per month. During the studies, three measurements are taken at 6:00, 14:00, and 22:00. Measurements are carried out diagonally at three points: 1 meter away from the wall and in the center of the room. Measurements are also taken at three height levels: at the level of a lying animal, a standing animal, and 0.6 m below the ceiling. Different animals have different requirements for the indoor microclimate. This depends both on the species of the animal and on its stage of development. Currently, in Ukraine, the effectiveness of disinfection is assessed through visual sanitary inspection and bacteriological control. Veterinary laboratories analyze surface swabs to determine the total number of microorganisms, coliform titer, and the presence of pathogenic bacteria such as salmonella, enteropathogenic strains of Escherichia coli, and anaerobic microorganisms.

Presentation of the main research material

The microclimate plays an important hygienic role and can affect the organism both directly and indirectly. Excessively high air temperatures may lead to overheating and reduced productivity due to excessive stress on the thermoregulation system. Low temperatures, on the contrary, contribute to the development of colds, especially in young animals, and may also cause frostbite. Increased air humidity creates favorable conditions for respiratory diseases, intensifies heat loss during the cold season, and complicates body cooling in summer. Under such conditions, feed energy is mainly used to maintain body temperature rather than for growth and productivity. Permissible temperature and relative humidity of air in animal housing facilities are shown in the table 1.

Table 1

Permissible temperature and relative humidity of air in animal housing facilities

Facility	Temperature, °C	Relative Humidity, %
Barns for tethered and loose-box cattle housing	10 (8-12)	70
Barns for loose housing on deep litter	6 (5-8)	50-85
Maternity wards	16 (14-18)	70 (50-85)
Calf prophylactoriums (preventive care units)	18 (16-20)	70 (50-80)

Air pollution caused by dust and harmful gases also negatively affects animal health. High dust concentration often leads to bronchitis and other respiratory diseases. Excessive levels of ammonia, carbon dioxide, hydrogen sulfide, or carbon monoxide may cause intoxication of the organism. Special attention should be paid to seasonal climate changes and their impact on animals and the indoor microclimate, particularly when managing reproductive herds. Microclimatic parameters may differ significantly in various areas of livestock buildings; therefore, their monitoring is carried out several times a month. Measurements are usually taken at three points along the diagonal of the building — near the walls and in the central area — at different height levels: in the zones where animals lie and stand, as well as near the ceiling. Indicators are recorded at different times of the day to obtain an objective assessment of environmental conditions. Requirements for housing conditions vary depending on the animal species and stage of development.

An important component of the microclimate is the air microflora. Microorganisms contained in dust particles can remain suspended in the air for a long time and settle on surfaces. In livestock buildings, the concentration of bacteria is significantly higher than in atmospheric air. For example, in cowsheds, one cubic meter of air may contain from 12 to 86 thousand bacteria. Among them are saprophytic and opportunistic microorganisms, cocci, and mold spores. Through contaminated air, animals may become infected with dangerous diseases such as tuberculosis, brucellosis, anthrax, foot-and-mouth disease and others. These microclimate parameters are shown in the table 2.

Table 2

Microclimate parameters in the animal room

Type of Animal	Temperature, °C	Relative Humidity, %	Air Velocity, m/s	Number of Microbial Units per 1 m³ of Air	Dust Concentration, mg/m³ (season)	
					Winter	Summer
Cows, heifers, older young stock	8-12	40-85	0,3-0,5	70	0,8-1	1,2-1,5
Calves: Newborns	14-18	40-85	0,3-0,5	30	0,5	1,5
Calves:	12-18	40-75	0,1-0,5	50	0,5	1,5

1-4 months						
Calves: 4-12 months	8-16	40-75	0,3-1,0	50	0,8	1,5

According to numerous researchers, the quality of livestock products, especially milk, directly depends on the sanitary and hygienic conditions of animal housing and feeding [11, 12, 13].

Various disinfectants are used for air decontamination in livestock and poultry facilities, including chlorine-based products, hydrogen peroxide, organic acids, and other oxidizing agents. These substances are mainly applied through aerosol spraying. However, due to the high cost and certain disadvantages of chemical disinfectants, ozonation is becoming increasingly popular as an alternative method of disinfection [14].

Ozone is an unstable compound whose molecule decomposes into oxygen and a free oxygen atom. Due to this property, ozone acts as a powerful oxidizing agent with strong disinfecting and deodorizing effects. Ozone is produced from atmospheric oxygen using special ozone generators through the process of electrosynthesis. Ozonation is the treatment of air aimed at disinfection and elimination of unpleasant odors. In terms of oxidative capacity, ozone surpasses most disinfectants and is second only to fluorine and some free radicals. It rapidly destroys organic and inorganic contaminants, converting them into harmless substances.

One of the most important properties of ozone is its ability to inhibit the development of microorganisms up to their complete inactivation. Therefore, ozone is widely used for the purification of drinking water, food processing, and sanitary treatment of premises and equipment. In animal husbandry, ozone is used to disinfect buildings, equipment, containers, pipelines, animal skin, manure, and to eliminate unpleasant odors. In poultry farming, ozonation is applied to incubating and table eggs, which helps destroy pathogenic microflora and improve hatchability.

Despite its advantages, ozone must be handled carefully because excessive concentrations are toxic to humans and animals. In addition, ozone may cause corrosion of metal surfaces and oxidation of fats. In occupied premises, ozone concentration should not exceed 0.1 mg/m³. Before ozonation, the room must be sealed, and after treatment it should be thoroughly ventilated. Microclimate conditions also play a major role in animal health. Long-term exposure to favorable environmental factors promotes adaptation of the animal organism: thermoregulation mechanisms improve, the cardiovascular and nervous systems function more efficiently, and metabolism becomes normalized. Such adaptation increases disease resistance and positively affects productivity. Research has shown that milk productivity in dairy cows depends approximately 70% on housing conditions and only 30% on hereditary traits.

Modern livestock production requires effective disinfection systems because keeping animals in enclosed spaces leads to the accumulation of bioaerosols containing dust, organic particles, and pathogenic microorganisms. Disinfection methods are

generally divided into chemical and physical ones. Chemical agents possess strong bactericidal properties; however, they may pollute the environment, damage equipment, and contribute to the development of microbial resistance. For this reason, physical disinfection methods, particularly ozone and cold plasma technologies, are becoming increasingly important. Ozone destroys microorganisms by oxidizing proteins and lipids in the cell membrane. Cold plasma generates active radicals and photons that damage bacterial DNA and cell membranes. Ozone is also effectively used for grain and feed preservation to prevent the growth of bacteria, fungi, and mold. This improves product quality and reduces the risk of toxic substance formation. Studies indicate that ozone is capable of destroying up to 99% of bacteria and viruses, as well as effectively eliminating mold fungi and their spores.

Conclusions and future research perspectives

Practical studies confirm that regular air ozonation reduces the risk of bronchopulmonary diseases in animals, decreases the harmful effects of mycotoxins in feed, and contributes to increased live weight gain. The use of ozone-air mixtures significantly lowers microbial contamination and ammonia concentration in livestock buildings. Thus, ozone disinfection is considered a modern, effective, and environmentally friendly method of ensuring sanitary safety in livestock and poultry farming. Its application contributes to maintaining animal health, improving product quality, and reducing production losses.

References

1. Law of Ukraine (2020). *On State Control over Compliance with Legislation on Food, Feed, Animal By-Products, Animal Health and Welfare*. https://zakon.rada.gov.ua/laws/show/2042-19
2. Vlasenko, V. V. (2006). Quality and safety of milk in Ukraine and the EU and 125 current state and prospects for development. *Effective livestock farming*, 3. 32–34.
3. Demchuk, M. V. & Tkachuk, V. A. (2004). Influence of microclimate on cow productivity and sanitary quality of milk. *Veterinary Medicine of Ukraine*, 4. 29–32
4. Verkhovna Rada of Ukraine. (2006). On protection of animals from cruelty (Law № 3447-IV, February 21, 2006). Vidomosti Verkhovnoi Rady Ukrainy, 27, Art. 230. URL: https://zakon.rada.gov.ua/laws/show/3447-155.
5. Ministry for Development of Economy, Trade and Agriculture of Ukraine. (2021). On approval of general requirements for the welfare of farm animals during their keeping (Order №. 224, February 8, 2021). URL:https://zakon.rada.gov.ua/laws/show/z0206-216.
6. Kosianchuk, N. I. & Tiutiun A. I. (2011). Vplyv deiakykh faktoriv dobrobutu tvaryn na yakist miasa. *Naukovyi visnyk LNUVM ta B. im. S. Z. Hzhytskoho*. Vol. 13, 2 (48), 245-249.
7. Tetiana Pushkar, Lilia Kremenchuk & Ihor Petrov (2026). Animal welfare - history of development and its significance. *Agrarian Bulletin of the Black Sea Littoral*. 118. 296-304
8. Neja W., Piwczynski D., Krezel-Czopek S., Sawa A. & Ozkaya S. (2017). The use of data mining techniques for analysing factors affecting cow reactivity during milking. *Journal of Central European Agriculture.* № 18 (2). P. 342–357.
9. Roshchina V. V. & Roshchina V. D. (2003). Ozone and Plant. Cell, Kluwer : Dordrecht
10. Norman D. A. & Kanarev P. M. (2004). Enerqy balance of fusion processes of the ozone molecule. *Journal of Theoretics.* Vol. 6–1. Feb-March, 5 – 18.
11. Yakubchak, O. M., Khomenko, V. I. & Melnychuk, S. D. (2005). Veterinary and sanitary examination with the basics of technology and standardization of livestock products. Kyiv: Bioprom LLC.

12. Kovbasenko, V. M. (2005).Veterinary and sanitary examination with the basics of technology and standardization of livestock products: Textbook in 2 volumes. Kyiv: Inkos Company. T.1
13. Kozak, V. L. (2001)/ Fundamentals of veterinary and sanitary examination and quality assessment of livestock and crop products. Ternopil: Textbooks and manuals
14. Mericam-Bourdet, N. (2012). Effect of voltage waveform on dielectric barrier discharge ozone production efficiency. *Eur. Phys. J. Appl. Phys*. 57. 1–10.

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ОБҐРУНТУВАННЯ ЗАСТОСУВАННЯ ОЗОНУ ДЛЯ ФОРМУВАННЯ ОПТИМАЛЬНОГО МІКРОКЛІМАТУ НА ТВАРИННИЦЬКИХ ФЕРМАХ

Анотація

У статті розглянуто проблеми створення оптимального мікроклімату, який безпосередньо впливає на стійкість організму, продуктивність і репродуктивні функції в умовах високої концентрації поголів'я та щільного розміщення тварин на фермах. Показано, що озонова дезінфекція є перспективним і екологічно безпечним методом забезпечення санітарного благополуччя у тваринництві. Однією з найважливіших властивостей озону є його здатність пригнічувати розвиток мікроорганізмів аж до їх повної інактивації. Регулярне озонування повітря знижує ризик бронхо-легеневих захворювань у тварин, зменшує негативний вплив мікотоксинів у кормах і сприяє збільшенню приростів живої маси. Одним із напрямів наукової роботи є пошук недорогих, екологічно-безпечних дезінфектантів, що не потребують використання води. До таких засобів належить озон, який є нестійкою речовиною, молекули якої самостійно розкладаються на кисень і вільний атом кисню. Саме наявність цього атома забезпечує озону потужні окиснювальні, дезінфікуючі та дезодоруючі властивості. Процес озонування потребує невеликих доз речовини, є простим у використанні та економічно вигідним. Важливою перевагою цього методу є те, що озон утворюється безпосередньо на місці застосування з кисню атмосферного повітря, а після завершення дезінфекції швидко розпадається, не завдаючи шкоди навколишньому середовищу.

Ключові слова: *добробут тварин, мікроклімат, мікрофлора, озон, озонування, здоров'я тварин*

Список використаних джерел

1. Закон України «Про державний контроль за дотриманням законодавства про харчові продукти, корми, побічні продукти тваринного походження, здоров'я та благополуччя тварин» [Електронний ресурс]. 2020. Режим доступу до ресурсу: https://zakon.rada.gov.ua/laws/show/2042-19.
2. Власенко В. В. Якість та безпека молока в України та ЄС і 125 сучасний стан і перспективи розвитку. *Ефективне тваринництво*. 2006. № 3.С. 32–34.
3. Демчук М. В. Вплив мікроклімату на продуктивність корів і санітарну якість молока *Ветеринарна медицина України*. 2004. № 4. С. 29–32.
4. Про захист тварин від жорстокого поводження : Закон України від 21.02.2006 № 3447-IV (зі змінами). Відомості Верховної Ради України. 2006. № 27. Ст. 230. URL: https://zakon.rada.gov.ua/laws/show/3447-15
5. Про затвердження Загальних вимог до благополуччя сільськогосподарських тварин під час їх утримання : наказ Міністерства розвитку економіки, торгівлі та сільського господарства України від 08.02.2021 № 224, зареєстрований у Міністерстві юстиції України 22.02.2021 за No 206/35828. URL: https://zakon.rada.gov.ua/laws/show/z0206-21
6. Кос'янчук Н. І., Тютюн А. І. Вплив деяких факторів добробуту тварин на якість м'яса. *Науковий вісник ЛНУВМБ ім. С. З. Гжицького*. 2011. Т. 13. № 2 (48), Ч. 2. С. 245-249.
7. Тетяна Пушкар, Ліля Кременчук, Ігор Петров. Добробут тварин — історія розвитку та його значення. *Аграрний вісник Причорномор'я*. 2026, № 118, С. 296-304
8. Neja W., Piwczynski D., Krezel-Czopek S., Sawa A. & Ozkaya S. The use of data mining techniques for analysing factors affecting cow reactivity during milking. *Journal of Central European Agriculture.* 2017. № 18 (2). P. 342–357.
9. Roshchina V. V., Roshchina V. D. Ozone and Plant. Cell, 2003. Kluwer : Dordrecht. 312 p.
10. Norman D. A., Kanarev P. M. Enerqy balance of fusion processes of the ozone molecule. *Journal of Theoretics.* Vol. 6–1. Feb-March, 2004. 5 – 18.
11. Якубчак О. М., Хоменко В. І., Мельничук С. Д. Ветеринарно-санітарна експертиза з основами технології і стандартизації продуктів тваринництва. К.: ТОВ «Біопром», 2005. 799 с.
12. Ковбасенко В. М. Ветеринарно-санітарна експертиза з основами технології і стандартизації продуктів тваринництва: Навчальний т посібник в 2. К.: Фірма «Інкос», 2005. Т.1. 416 с.
13. Козак В. Л. Основи ветеринарно-санітарної експертизи та оцінки якості продуктів тваринництва і рослинництва. Тернопіль: Підручники і посібники, 2001. 240 с.
14. Mericam-Bourdet N. Effect of voltage waveform on dielectric barrier discharge ozone production effi ciency. *Eur. Phys. J. Appl. Phys.* 2012. № 57. P. 1–10.

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