



Study the effectiveness of using a complex of disinfectants and probiotics in the presence of poultry

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Abstract

In the industrial production of broiler meat, optimal housing conditions are created to increase productivity and meat quality. To maintain the natural resistance of poultry, the technology of poultry must use probiotics and quality, safe disinfectants. This article deals with the discussion due to the research results on the integrated use of two probiotics and two disinfectants in raising broiler chickens. The scheme, modes, and terms of using probiotics and disinfectants for broiler chickens during their cultivation are offered. Doses and concentrations of the studied preparations are also generalized. The influence of the investigated preparations on hematological parameters, growth, and safety of poultry was analyzed. The results of the research showed that feeding with probiotics and disinfectants did not significantly influence the daily feed consumption of chickens but caused a 6.2 % increase in average daily gain and a decrease of 0.1 feed conversion rate in chickens of the experimental group. Production investigation has determined the modes of disinfection of poultry houses in the presence of broiler chickens when using a disinfectant, "Biolide", based on hydrogen peroxide, lactic acid, and lactic acid. The bactericidal effect of disinfection of walls, floors, and feeding troughs of the premises with aerosol use of disinfectant "Biolide" and spraying of probiotic powder "Biozapin" 2 days after treatment, at the rate of 10–30 g/m² 1 time in 2 weeks. There was an increase in the productivity of the studied poultry for feeding with probiotic feed "Biomagn" at the rate of 0.5 kg per ton of feed according to the scheme: from one day of age – seven consecutive days and 22 days of age – seven days in a row with constant water treated with disinfectant preparation "Diolide" based on chlorine dioxide, which made it possible to get quality products and cost-effective production. According to the research results, it is set that the optimal mode of aerosol disinfection of poultry houses in the presence of broiler chickens using 0.2 % disinfectant "Biolide" is 50 ml/m³ of the room at an exposure of 60 minutes. The safe and optimal concentration of the disinfectant "Diolide" during water treatment in the water supply system at a dose of 1.0 mg/l of chlorine dioxide corresponds to 0.0004 % concentration. The bactericidal effect of disinfecting the room's surface in the presence of poultry during its rearing after disinfection with the disinfectant "Biolide" and probiotic "Biozapin" was almost 100 %, which confirms its effectiveness. Under the action of the investigated preparations, a stimulating influence on the gas transport function of the blood of broiler chickens was revealed, especially in the older age of their rearing. In particular, at the age of 34 days, the concentration of hemoglobin was higher by 10.7 % (P < 0.05), and the number of erythrocytes at the age of 34 and 41 days – by 41.7 (P < 0.01) and 24.1 % (P < 0.01), respectively. At the same time, likely changes in the number of leukocytes and the ratio of their species in the blood of chickens of the experimental group concerning the control were not detected. These data indicate that aerosol treatment of premises in the presence of chickens is non-toxic and has no negative influence on the physiological state, confirmed by investigations of morphological indicators of poultry blood.

Keywords: broiler chickens, probiotics, chlorine dioxide, productivity, nonspecific resistance, hematological indicators.

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1. Introduction

The spread of antibiotic resistance is an emergency for animal and poultry health worldwide due to the increased rate of recovery of pathogens and their resistance to medi-

cines, which complicates the treatment of infectious diseases. The food chain is a critical way of transmitting antibiotic-resistant bacteria between animals and humans. Since lactic acid bacteria (LAB) act as a reservoir for the transfer of antibiotic resistance genes, LAB strains used in feed

additives should be monitored for safety. Our research shows that lactic acid bacteria can be a reservoir of antimicrobial resistance determinants, so the first and critical step in considering the use of lactic acid bacterial strains as feed additives should be to assess their antibiotic resistance and beneficial influence on the host. These results will help select the best strains of lactic acid bacteria for use as a feed additive (Jaimee & Halami, 2016; Feye et al., 2020; Stefańska et al., 2021; Mandal et al., 2021; Ma et al., 2021).

The intensive development of livestock and poultry farming depends on feed additives, guaranteeing results such as accelerating growth, protecting health from pathogenic infections, and improving other production indicators, such as digestion, feed quality, meat, milk, and eggs. There are high hopes for using probiotics, prebiotics, and synbiotics. They are used mainly to maintain the balance of intestinal microbiota of farm animals and poultry, which effectively combat pathogens that pose a danger to both animals and consumers (Mookiah et al., 2014; Markowiak & Ślizewska, 2017; Markowiak & Ślizewska, 2018).

Probiotics and disinfectants are potential alternatives to antibiotics used in poultry farming. However, there is no research on their integrated use in the technological process. This is especially true in the general scheme, i.e., preliminary disinfection of premises, the introduction of probiotics in the ration, disinfection in the presence of poultry, both disinfectant and probiotic spraying, and constant watering, which is treated with a bactericidal preparation (Salehimanesh et al., 2016; Tang et al., 2017). This is a new area that needs to be investigated and implemented in production in order to improve productivity and preserve poultry.

The main factors influencing poultry productivity, product quality, and health, including its immunity, are the full feeding of poultry and the providing quality drinking water.

It is known that water is involved in the body's metabolism and is responsible for regulating body temperature, digestion, and other vital processes. In the normal physiological state, poultry consumes more water than food, and in violation of the technology of retention, and stress, water consumption increases by 3–4 times (Kucheruk & Zasiękin, 2018). Insufficient water consumption causes dehydration, decreased appetite, and slows growth and development, leading to the mass death of poultry (Biben et al., 2017).

For poultry to break down proteins, fats, and carbohydrates in the digestive tract and for a balanced metabolism, water is necessary. Therefore, in industrial poultry, various medical preparations and other preparations needed to ensure high viability are added to the poultry water supply system. Therefore, in order to achieve high indicators and reduce costs, it is essential to pay due attention to the water treatment and water treatment system. One essential means to ensure water quality is chlorine dioxide and sodium chlorite. These active substances are the ingredients in many preparations used to fight against bacteria and fungi and preservatives and disinfectants. It is mainly used not only for disinfection of premises and equipment but also for water supply systems. Commercial, industrial, and medical uses include disinfection of ventilation systems, hard surfaces (e.g., floors, walls, and laboratory equipment), water supply systems, and food products (Smith et al., 2015; Ma et al., 2017; Praeger et al., 2018; Totaro et al., 2021).

Chlorine dioxide in the form of gas belongs to the 1st class of danger. Chlorine dioxide at room temperature is a

water-soluble yellow gas with a characteristic odor. It is a relatively stable free radical and very strong oxidant. When dissolved in water, SiO_2 has a decisive antimicrobial action. Chlorine dioxide when dissolved in water is not hydrolyzed and remains as a molecularly dissolved gas at $\text{pH} = 6\text{--}9$, which usually corresponds to the properties of drinking water. In an alkaline environment at $\text{pH} > 11$, the redox reaction begins with the formation of chlorites and chlorates. Chlorine dioxide is a relatively unstable gas; it does not compress or liquefy. Solutions of chlorine dioxide with concentrations of $20\text{--}30 \text{ g/dm}^3$ are unstable. However, after dilution to a concentration of 1 g/dm^3 , they show relative stability, depending on temperature, sunlight exposure, and pH . Chlorine dioxide actively oxidizes organic matter with the formation of organic oxygen-containing compounds (aldehydes, alcohols, ketones, etc.), but no organochlorine substances are formed. Chloramines are not formed in the presence of ammonia and ammonium salts; bromates are not formed in the presence of bromides. In the process of oxidation and disinfection of water, chlorine dioxide is reduced to chlorite-anion (ClO_2^-) and chloride-anion, with the possible formation of a small amount of chlorate-anion (ClO_3^-) and hypochlorite-anion (ClO^-) (Mokienko et al., 2006).

In a subchronic experiment on white rats, it was found that chlorine dioxide at a concentration of 1.35 mg/dm^3 in water does not cause significant changes in blood indicators, lipid peroxidation, structural and structural and functional changes in internal organs in adult animals, and offspring of females. Consumed water containing chlorine dioxide in the same concentration, except for the stimulation of spermatogenesis and NOS activity in the cellular elements of the spleen (Mokienko & Petrenko, 2008).

According to the WHO, the recommended concentration of chlorine dioxide in drinking water has not been set due to its rapid decomposition. The temporarily recommended value for chlorites (0.2 mg/dm^3) provides sufficient protection against the potential toxicity of chlorine dioxide: it was found that the threshold concentration of chlorine dioxide in terms of exposure to the smell of water is $0.45\text{--}0.40 \text{ mg/dm}^3$. The taste with an intensity of 1–2 points is detected at higher concentrations of this compound in water. In Ukraine, the maximum permissible concentration (from now on – MPC) of chlorite anions for water drinking and cultural and domestic water use is 0.2 mg/dm^3 , chlorate anions – 20 mg/dm^3 .

Chlorite anions that enter wastewater to natural reservoirs are rapidly reduced to chloride anions and are, therefore, safe for the environment. According to USA regulations (IBWA, FDA, EPA) for drinking water, the concentration of residual chlorine dioxide and chlorite anion should not exceed 1.0 and 0.8 mg/dm^3 , respectively, according to WHO recommendations (2004) residual concentrations of chlorite anion and chlorate anion should not exceed 0.7 mg/dm^3 .

In the general case, the dose of chlorine dioxide introduced into the purified water (pure water reservoir) should not exceed 0.5 mg/dm^3 .

The dose of chlorine dioxide introduced at the stage of peroxidation is determined experimentally, depending on the quality of natural water. In the general case, residual concentrations:

- chlorine dioxide in water after 15–30 minutes of contact must have a value of at least 0.1 mg/dm^3 ;

- chlorine dioxide at all points of water distribution networks must be at least 0.05 mg/dm³;
- chlorites in the water supplied to consumers should not exceed 0.2 mg/dm³ according to DSanPiN 2.2.4-171-10.

The use of the mean is environmentally safe; the decomposition products of the mean, such as chlorites, are reduced to chlorides.

The only by-product of disinfection – chlorites – is easily controlled by a coagulant. Dioxide has many benefits; it is also called “green chemistry”, so its use is approved in the EU, listed in the WHO Drinking Water Quality Guide, and approved for use by the US Environmental Protection Agency.

The action on the pathogenic flora of ClO₂ during the reaction is due not only to the high content of released chlorine but also the formation of atomic oxygen. This combination makes chlorine dioxide a powerful disinfectant. The restraining factor in the use of this disinfectant until recently was the increased explosiveness, which complicated its production, transportation, and storage. However, modern technologies can eliminate this shortcoming by producing chlorine dioxide directly at the point of use (Mokienko et al., 2006).

Taking into account the scientists' research and the analysis of active substances for disinfectants, the subsequent development of the authors, was a new, environmentally safe, highly effective bactericidal preparation, “Diolide”, which includes sodium chlorite and sodium chloride. These components allow for effectively carrying out comprehensive sanitary treatment of objects of animal husbandry in the presence of animals and the sanitation of water supply (Ge et al., 2011; Ngwenya et al., 2013; Ma et al., 2017).

Antimicrobial ability and safety allow using means for disinfection of the room and water in the system of poultry watering. Thus, the disinfection stages are reduced, and the need for additional costs to purchase a different preparation for water purification is eliminated. After receiving positive results in previous investigations on laboratory animals, we decided to use the preparation developed by us in poultry farming.

The purpose of the work was to investigate in production conditions in the presence of broiler chickens the disinfectant preparations “Biolaid” for aerosol disinfection, “Diolaid” for water purification, the probiotic preparations “Biozapin” for spraying the room, and “Biomagn” as part of the feed on the hematological profile, growth, and viability of the poultry organism, which were developed by employees of the State Research Institute for Laboratory Diagnostics and Veterinary-Sanitary Examination.

2. Materials and methods

The research was conducted in one of the farms of the Lviv region on broiler chickens of the ROSS-308 cross, starting from 1 to 41 days of age. Chickens were kept in poultry houses with free access to feed and water and technological parameters of broiler breeding (temperature and light regime) in accordance with norms. For research, 2 groups of broiler chickens were formed: control and experimental groups, 100 heads in each. The premises were constantly kept clean. Before landing the poultry, the walls and floors were well-cleaned and washed. Feeders, waterers, lighting devices, and thermometers were also disinfected

before landing the poultry. Sawdust litter was used on the floor.

The experiment was carried out as follows: bactericidal control of the room before and after disinfection: washes from the walls, floor, and feeder. During the keeping of poultry, the rooms were disinfected once a week in their presence with the disinfectant “Biolide” at a concentration of 0.2 % for 60 minutes of exposure. Then, two days after disinfection, the probiotic “Biozapin” based on a mixture of probiotic bacteria *Bacillus subtilis*, *Bacillus amyloliquefaciens*, and aluminosilicate was evenly sprayed in the room at the rate of 10–30 g/m² once every two weeks.

The broilers of the control group were fed standard compound feed (SC) according to the existing norms recommended for the ROSS-308 cross.

The chickens of the experimental group were similarly fed with SC and the synbiotic preparation “Biomagn” at the rate of 0.5 kg per ton of compound feed. The specified preparation was used according to the following scheme: from the age of one day, they were fed for seven consecutive days (1–7 days), and at the age of 22 days, seven days in a row (22–28 days).

Along with this, the broilers of the research group were given a solution of the preparation “Diolide” with water throughout the experiment. For the disinfection of drinking water, the preparation “Diolide” was used for drinking broiler chickens and disinfection of the water supply system at a dose of 1.0 mg/l of chlorine dioxide, which corresponds to a concentration of 0.0004 %.

The disinfectant “Biolide” contains hydrogen peroxide, perlactic acid, and lactic acid. Disinfection was carried out by methods of aerosol treatment, wiping, irrigation, spraying, soaking, and immersion. The mean is intended for preventive, current, and final disinfection in the presence of animals and poultry. This preparation has high bactericidal, virucidal, and fungicidal properties.

Aerosol disinfection of the air in the poultry house was carried out with a 0.2 % solution of the preparation “Biolide” in the period before the landing of the poultry and processing every seven days in the period from 6 to 42 days of growing broilers, using an aerosol generator of cold fog “Dyna-Fog Tornado” (model 2897, construction type – ULV electric sprayer, the manufacturing company “Curtis Dyna-Fog, Ltd.”, USA) in a dose of 50.0 cm³ per 1 m³ for exposure of 60 minutes. Bacteriological studies of sanitary and hygienic washes were performed in accordance with EN 1656:2009, IDT.

To carry out washings, tampons were made on wire rods mounted in a cotton-gauze plug, which was used to close a test tube with distilled water previously poured into it in a volume of 2.0 cm² and sterilized in an autoclave at a pressure of 0.5 atmospheres for 30 minutes (Harkavenko et al., 2020).

A sampling of wash samples from the surfaces of technological equipment and inventory was carried out from an area of 100 cm² using a metal frame stencil measuring 10×10 cm, which limited the required area.

Before each overlay on the surface of the investigated object, the frame stencil was flambéed in the flame of alcohol still. When the area was limited to 100 cm² with a swab on a rod soaked in distilled water, the test surface was wiped and put back into the test tube.

The preparation “Biomagn” is a mixture of probiotic bacteria: *Bacillus subtilis*, *Bacillus licheniformis*, *Bacillus*

coagulans, *Enterococcus faecium*, and dried fermentation products of microorganisms: *Lactococcus Lactis*, *Bacillus subtilis*, *Bacillus licheniformis*, as well as magnesium chloride, chitosan, xylanase, protease, cellulase, meal milk thistle, acidity regulator, betaine and emulsifier.

Together with the experimental group's broilers, they drank a solution of the preparation "Diolide" with water, where the main active substances are sodium chlorite and sodium chloride. For drinking water disinfection, the preparation "Diolide" was used at a dose of 1.0 mg/l per chlorine dioxide. Diolide is added through medicators; the mother liquor is previously diluted to a concentration that ensures its submission by the mediator following its technical characteristics.

For hematological investigations, blood was taken from chickens at different age periods: 10-, 27-, 34-, and 41-day-old. In heparin-stabilized blood, the number of erythrocytes and leukocytes was determined by counting in the Goryaev chamber, the hemoglobin content by the hemoglobin cyanide method, the ratio of individual forms of leukocytes based on the counting and differentiation of 100 cells in blood smears stained by the Romanovskyj-Giemza method (Vlizlo, 2012). During the period of rearing poultry, attention was paid to body weight, death, and development according to standard methods (Vlizlo, 2012).

All interventions and slaughter of poultry were carried out in compliance with the requirements (International guiding principles for biomedical research involving animals, 1985, 2012) with the permission of the bioethics commission of the State Research Institute for Laboratory Diagnostics and Veterinary-Sanitary Examination.

The *Excel* program (*Microsoft, USA*) analyzed the experimental data. The significance of the experimental data was processed using a one-way analysis of variance. A difference of $P < 0.05$ was considered significant.

3. Results and discussion

Results

The main feature of the effective action of the complex preparation use of "Biolide", "Biomagn", "Biozapin", and "Diolide" is the absolute refusal of antibiotics in the experimental group and, as a result, increased preservation of livestock, improvement of the immune system, and increased productivity. These are the results obtained during the production experiment with the broilers of the experimental group.

After hatching, a chick with normal development still retains part of the unused nutrients in its yolk sac, and the intestine of the hatched chick is sterile. However, from the first day, it is populated with microflora from the environment. Usually, the yolk sac has a yellowish-orange color, and a well-developed vascular network can be seen on it, and its size actively decreases from the first hours after hatching and disappears within a few days. This residual nutrient is the primary source of nutrition for the chick during the incubation period and may retain this function during the first week of its life. To avoid colonization of the intestines of chickens with an unfavorable microbial background, antibiotics were injected in the control group during the first eight days. As a result, the development of a general immunodeficiency of the organism occurred.

When keeping broiler chickens in the control group on the general scheme of poultry farming, general inhibition, a

decrease in feed consumption, the formation of unstable immunity was observed, and the death of poultry was observed to be greater than in the experimental group.

In the experimental group, when using the probiotic preparation "Biomagn" as part of the feed for seven days, starting from the first to the 7th day and from the 22nd to the 28th day, drinking with a water solution "Diolide" during the experiment period in the general scheme of vaccination of chickens and carrying out the scheme according to the treatment of the premises in the presence of poultry with the preparation "Biolide" and "Biozapin" showed a very high preventive effect on diseases of the gastrointestinal tract in the first and following days of the poultry's life. There were no cases of cloacitis ("cloaca sticking"), the poultry was active and mobile, the litter became dry, the intensity of feed consumption was increased, and the broilers' clinical condition was better than in control. The research group recorded a decrease in the death of chickens at the main stages of their rearing and a decrease in the number of forcibly slaughtered livestock.

Paying attention in the experimental group to the yolk sac of young chickens (it is the easily soluble fats of the yolk residue that regulate the development of the digestive system of young poultry, as well as stabilize its energy exchange during the initial period of development), better and faster development of the poultry than in the control group was noted. The yolk reserves of chickens in the experimental group were used faster than in the control group, indicating the experimental group's ability to assimilate nutrients fully.

In the poultry that was in the control group until the end of the first week, a large part of the yolk sac was still preserved; this not only indicates a poor development of the digestive system but also indicates a source of general internal toxicosis for the poultry due to the presence in the container of metabolic products, half-decomposed fats, and other toxins. This process of intoxication significantly slowed down the growth and development of the young in the control group.

The preservation of the young was better in the experimental group than in the control group.

From the moment of hatching, the chicken is conditionally free from microflora, so it is unnecessary to additionally destroy it with antibiotics. Instead, antibiotics were used in the control group, which led to the corresponding consequences. The use of a complex of these preparations, thanks to their bactericidal, probiotic, and immunomodulatory properties, not only neutralized the negative microflora at the level of antibiotics but also contributed to the strengthening of the poultry's immunity without burdening the poultry's body.

From the got data, it can be seen that the use of environmentally safe probiotic preparations with immunomodulatory properties "Biomagn" and "Biozapin" and bactericidal preparations "Biolide" and "Diolaid" during the entire period of poultry farming under this scheme had a positive influence on the increase in live weight of broiler chickens.

The purpose of the next stage of the work was to find out the influence of the investigated probiotic preparations with immunomodulating properties "Biomagn" and "Biozapin" and bactericidal preparations "Biolide" and "Diolide" on the hematological parameters of the organism, growth, and survival of broiler chickens during their rearing period. As you know, hematological investigations help to determine

the influence of certain factors on the mechanisms of metabolic homeostasis of the body's internal environment. The analysis of the results showed that the concentration of hemoglobin in the blood of broiler chickens of the control group gradually increased with age (Table 1). At the same time, changes in the number of erythrocytes in the blood of chickens of this group during the research period were expressed to a lesser extent. Using the complex of researched preparations to broiler chickens caused an increase in the

concentration of hemoglobin in the blood and an increase in the number of erythrocytes. Thus, at the age of 34 days, the concentration of hemoglobin was higher by 10.7% ($P < 0.05$), and the number of erythrocytes at the age of 34 and 41 days – by 41.7% ($P < 0.01$) and 24.1% ($P < 0.01$), respectively. They got data to testify to the stimulating influence of the investigated preparations on the intensification of providing oxygen to the main vital systems of the poultry's organism.

Table 1
Hematological profile of the investigated broiler chickens ($M \pm m$, $n = 5$)

| Indicators | Groups | Periods of research | | | |
|-------------------|--------|-----------------------|-----------------------|-----------------------|-----------------------|
| | | 16 th -day | 27 th -day | 34 th -day | 41 st -day |
| Hemoglobin, g/l | C | 87.59 ± 2.16 | 92.89 ± 1.27 | 95.18 ± 1.13 | 98.23 ± 3.51 |
| | E | 90.18 ± 1.22 | 95.68 ± 2.95 | 103.19 ± 3.11* | 106.88 ± 2.77 |
| Erythrocytes, T/l | C | 3.28 ± 0.51 | 3.11 ± 0.14 | 3.21 ± 0.09 | 3.58 ± 0.11 |
| | E | 3.87 ± 0.41 | 3.59 ± 0.41 | 4.61 ± 0.36** | 4.27 ± 0.18** |

Note. In this and the following tables: * – statistically significant differences between the investigated indicators in the experimental group chickens compared to the control group: * – $P < 0.05$; ** – $P < 0.01$; *** – $P < 0.001$

It is known that determining the total number of leukocytes in the blood is of important diagnostic value. At the same time, a complete assessment of morphological changes in poultry blood can be obtained only by differential calculation of the ratio of individual types of blood leukocytes. From the data presented in Table 2, we can see that the total

number of leukocytes in the blood of broilers of the control group increased with age, which corresponds to physiological norms. At the same time, no significant changes in the number of pseudoeosinophils, eosinophils, lymphocytes, and blood monocytes were detected in the chickens of the control group during the research period.

Table 2
Blood leukogram of broiler chickens, % ($M \pm m$; $n = 5$)

| Age/ groups | Leukocytes, g/l | Basophils | Eosinophils | Pseudoeosinophils | | Lymphocytes | Monocytes | |
|----------------|-----------------|-------------|-------------|----------------------|---------------------------|-------------|-------------|------------|
| | | | | Granular granulation | Stick-visible granulation | | | |
| 16 | C | 21.6 ± 0.88 | 2.5 ± 0.65 | 2.2 ± 0.37 | 1.3 ± 0.33 | 29.0 ± 0.71 | 62.4 ± 1.50 | 3.6 ± 0.68 |
| | E | 22.0 ± 1.69 | 1.3 ± 0.33 | 2.4 ± 0.51 | 2.0 ± 0.58 | 28.2 ± 1.16 | 63.0 ± 1.30 | 4.4 ± 0.75 |
| 27 | C | 24.0 ± 1.39 | 2.33 ± 0.33 | 2.2 ± 0.58 | 1.7 ± 0.33 | 28.2 ± 1.36 | 63.4 ± 1.57 | 3.8 ± 0.97 |
| | E | 25.7 ± 1.78 | 2.0 ± 0.58 | 3.0 ± 0.71 | 1.3 ± 0.33 | 27.0 ± 1.00 | 64.0 ± 1.38 | 4.0 ± 0.84 |
| 34 | C | 26.9 ± 1.38 | 2.8 ± 0.37 | 3.2 ± 0.37 | 0.8 ± 0.2 | 28.4 ± 1.12 | 61.0 ± 3.25 | 3.4 ± 0.32 |
| | E | 28.1 ± 1.79 | 2.6 ± 0.51 | 3.2 ± 0.37 | 0.8 ± 0.2 | 25.0 ± 2.84 | 65.4 ± 3.50 | 4.0 ± 0.44 |
| 41 | C | 30.1 ± 1.88 | 2.6 ± 0.4 | 2.8 ± 0.86 | 1.4 ± 0.24 | 26.6 ± 2.18 | 60.2 ± 3.91 | 4.0 ± 0.49 |
| | E | 32.8 ± 1.78 | 2.6 ± 0.51 | 2.4 ± 0.51 | 1.6 ± 0.24 | 23.6 ± 2.95 | 65.3 ± 2.0 | 4.8 ± 0.51 |

In all investigated periods, the total number of leukocytes in the blood of broiler chickens of the research group tended to increase concerning this indicator in the poultry of the control group. As for the ratio of different types of leukocytes, it should be noted that in the chickens of the experimental group, compared to the control group at the age of 34 and 41 days, a tendency to an increase in the relative number of lymphocytes and monocytes in the blood and a decrease in pseudoeosinophils with rod-shaped granulation was revealed. These data indicate a positive influence of the investigated preparations on the organism's immune function. After all, the ability of the immune system to perform

protective functions depends on several properties of its cells. In particular, a prominent place belongs to lymphocytes and monocytes, as the leading immunocompetent cells of the organism.

The intensity of growth of broilers, as you know, depends on many factors: species, age, sex, quality of feed, level of metabolism in the organism, etc. The analysis of the research results showed (Table 3) that the use of complex researched preparations on chickens positively influenced the intensity of their growth. This is evidenced by the greater mass of broiler chickens in the experimental group compared to the control group in all research periods.

Table 3
Growth intensity of broiler chickens, g ($M \pm m$; $n = 30$)

| Age of broiler chickens, days | Groups | |
|-------------------------------|---------------|------------------|
| | C | E |
| 16 | 621.2 ± 1.59 | 650.8 ± 1.69*** |
| 27 | 1816.9 ± 1.72 | 1881.3 ± 2.99*** |
| 34 | 2419.4 ± 4.81 | 2572.4 ± 2.80*** |
| 41 | 3402.4 ± 1.78 | 3612.6 ± 2.16*** |

At the same time, the highest weight was recorded in broilers of the research group at 41 days of age. In particular, according to this indicator, they exceeded the analogs of the control group by 210.2 g ($P < 0.001$). These data indicate the stimulating influence of the investigated prepara-

tions on the intensity of growth of broiler chickens of the experimental group. This is also indicated by the research results using the investigated preparations in broiler chickens (Table 4).

Table 4

Effectiveness of the use of the investigated preparations to broiler chickens

| Groups of chickens | Body weight, g | The average daily increase compared to the control, % | Feed conversion | Saving, % |
|--------------------|----------------|---|-----------------|-----------|
| Control | 3402 | | 1.91 | 96 |
| Experiment | 3612 | 6.2 | 1.80 | 97 |

From the data presented in Table 4, we can see that the average daily growth of broiler chickens treated with the investigated preparations was, respectively, 6.2 % higher than that of poultry in the control group. At the same time, feed conversion improved by 0.11 compared to the control group and poultry preservation.

Therefore, the results of the conducted research indicate the effectiveness of the complex use of the investigated

preparations for broiler chickens to increase the intensity of their growth and preservation. The preparations contributed to better assimilation of feed nutrients, which positively influenced their growth and viability.

When disinfecting the premises in the presence of broiler chickens with a 0.2 % Biolide solution and spraying the surfaces with the probiotic Biozopin, the total bacterial contamination decreased by 99.9 % (Table 5).

Table 5

Effectiveness of disinfection of premises in the presence of broiler chickens with the disinfectant of 0.2 % Biolide and probiotic Biozopin, thousand/cm², $M \pm m$, $n = 5$

| Disinfection facilities and microbial test-cultures | Bacterial contamination of the surface, CFU/cm ² | | |
|---|---|--------------------|-------------------|
| | Before disinfection | After disinfection | % decontamination |
| The surface of the room | | | |
| Wall | 2.4 ± 1.25 | <10* | 100 |
| Floor | 5.2 ± 1.25 | 30 | 99.9 |
| Feeding troughs | 3.4 ± 1.25 | 0 | 100 |

Note: * – $P \leq 0.05$ – against initial indicators

As a result of industrial experiments to investigate the effectiveness of using Biolide for preventive and forced disinfection of premises and equipment in the presence of broiler chickens, it was set that it can be used in a concentration of 0.2 %, with a solution consumption of 200 ml/m².

So, according to the research results, it was found that the disinfectant Biolide and the probiotic Biozopin have an effective bactericidal action in the presence of poultry.

Discussion

Using disinfectants based on organic acids such as lactic acid, perlactic acid, and others makes it possible to disinfect premises effectively. Also, organic acids and their salts are considered safe (GRAS) and approved by most EU member states for feed additives in poultry and livestock. It has been found that using organic acids protects chickens by improving the utilization of nutrients and increasing productivity due to the efficiency of feed assimilation (La Ragione & Woodward, 2003). Organic acids in a non-dissociated (non-ionized, more lipophilic) form can penetrate the bacterial cell wall and disrupt the normal physiology of some types of bacteria (Dhawale, 2005). In addition to antimicrobial activity, they reduce the pH of the digestive tract, increase the secretion of the pancreas, and have a trophic effect on the mucous membrane of the gastrointestinal tract (Dibner & Buttin, 2002). Organic acids have contributed significantly to the profitability of poultry farming and have provided people with healthy and nutritious poultry products (Ricke, 2003; Moharrery & Mahzonieh, 2005). It is reported that acidification with various organic acids reduces the production of toxic components by bacteria and the colonization of

pathogens on the intestinal wall, thereby preventing damage to epithelial cells, and also improves the digestibility of proteins, calcium, phosphorus, magnesium, and zinc, and also serves as substrates in intermediate metabolism (Adil et al., 2010; Ibrahim et al., 2021; Zhu et al., 2021; Kumar et al., 2022).

To date, it has been proven that the stabilization of normal microflora in the intestines of chickens lasts up to 30–40 days of life, according to various data. It follows from this that the healthiest population of broiler chickens and the avoidance of immunodeficiencies can be achieved under the condition of stimulation of the organism's resistance, reduction of post-vaccination complications (Guarner et al., 2008; Boiko et al., 2016), the constant balance of the quantitative composition of the ecosystem of microorganisms and the conditions for its stable existence, which becomes possible when using ecologically safe probiotic preparations with immunomodulating properties “Biomagn” and “Biozopin” and bactericidal preparations “Biolide” and “Diolide” during the entire period of poultry growing from 1 for 42 days of life under this scheme.

Growing broilers is problematic because, in 45 days (and in some farms in 42 days), the organism of chickens intensively goes through all stages of growth and development, which are biologically determined for at least 120 days. With this in mind, every day in the life of broilers can be critical. There are clearly defined critical immunodepressive periods in the life of broiler chickens. The first period is 3–5 days of life, associated with the increased use of protective factors from the egg under the influence of the environment. The second period falls on 12–15 days of life due to the

further use of transovarial factors and the immature immune system of chickens of this age. The third period is 42–45 days of the life of broiler chickens. During these periods, it is necessary to pay special attention to the creation of effective immunity.

With this in mind, in our research, we aimed to determine the influence of the complex of investigated preparation on the hematological profile and indicators of immune protection of the poultry's organism. Carrying out morphological and biochemical investigations showed that in the age dynamics of broiler chickens of the control group, the increase in the number of erythrocytes in the blood and the increase in hemoglobin concentration attract attention, which is caused by physiological changes in the poultry's organism during its growth and development. These changes were expressed to a greater extent by the end of the experiment. It is known from the literature that significant changes in hematological indicators occur during the early stages of poultry development. In our research, it was also stated that with age, the hemoglobin concentration in the poultry's blood increased, and the number of erythrocytes increased. An increase in the hemoglobin content in the blood of broilers of older age groups may be due to a higher level of mineral metabolism and hemoglobin formation. Many authors (Zhang et al., 2003; Zhang et al., 2012; Shevchenko, 2013) note that the increase in the concentration of hemoglobin in the blood of poultry of older age groups is associated with the formation of the immune system and the end of the formation of hematopoietic organs.

The analysis of the got data showed that the use of the specified investigated preparations caused an increase in the number of erythrocytes in the blood of broiler chickens of the experimental groups compared to the control group at 34 and 41 days of age. Similar changes were also detected in the investigation of hemoglobin concentration. These data indicate the stimulating influence of the investigated preparations on the oxygen transport function of the blood, and these changes were especially pronounced in the blood of older poultry. These changes in the blood of broiler chickens of the experimental groups are related to the complex additive action of the investigated preparations on the hematological parameters of the poultry's organism. As you know, hematological investigations help to determine the influence of certain factors on the mechanisms of metabolic homeostasis of the organism's internal environment. Under the influence of the investigated preparations in the blood of broiler chickens, no significant changes in the number of blood leukocytes were detected. At the same time, at the end of the experiment, at the age of 34 and 41 days, a tendency to increase in the number of lymphocytes and monocytes and a decrease in pseudoeosinophils with rod-shaped granulation was recorded. Since the quantitative and qualitative composition of peripheral blood is maintained at a certain level and reflects the physiological or pathological state of the organism, the degree of reactivity and resistance of animals and poultry to the action of exogenous factors (Zhang et al., 2012; Shevchenko, 2013), accordingly got results to indicate the absence of violations in the functioning of homeostatic systems in the organism of broiler chickens due to the actions of the investigated preparations. At the same time, the stated trends indicate the strengthening of protective functions in the organism of broiler chickens due to the action of the investigated preparations. It is known that monocytes are the precursors of immunocompetent cells,

they take part in the processes of phagocytosis, and lymphocytes are essential cells for performing the organism's immune function. These results are partially consistent with data available in the literature on the stimulating influence of probiotic preparations on the processes of erythropoiesis and hemoglobin synthesis of the organism on the processes of cell proliferation and differentiation (Klaenhammer et al., 2012).

In general, the conducted investigations showed that the use of the specified investigated preparations in broiler chickens positively influenced hematological parameters, which contributed to strengthening immunity and increasing their growth rate. From these points of view, a complex approach in the use of investigated preparations can be considered a new promising direction for increasing broiler chickens' immune potential, viability, and growth. In order to get the expected weight of broiler chickens, special rations, vaccinations, and revaccinations are provided for poultry: broilers on the farm are vaccinated at one day and ten days old (vaccines were complex). All this is an additional load on the unformed adaptive and compensatory capabilities of young broilers, which leads to a decrease in productivity, preservation, and profitability of this industry (Kovalenko et al., 2010; Stoianovskiy et al., 2012; Kurtiak & Romanovych, 2015).

The use of antibiotics in the breeding of broilers allows for solving several problems of infectious pathology in poultry houses. However, their unregulated use leads to violations of the intestinal microbiocenosis to the appearance of strains of microorganisms that differ in their resistance to antibacterial preparations. In such conditions, restoring the microflora of the gastrointestinal tract of chickens is the primary guarantee of getting an estimated profit and producing dangerous products (Tsaruk, 2017).

The intensity of growth can be based only on the appropriate provision of nutrients to the young. An important role is played here by ensuring the appropriate transition from yolk nutrition to feed consumption.

4. Conclusions

A positive influence of the complex of investigated preparations on the gas transport function of the blood of broiler chickens, especially at an older age of their rearing, was stated. In particular, at the age of 34 days, the concentration of hemoglobin was higher by 10.7 % ($P < 0.05$), and the number of erythrocytes at the age of 34 and 41 days – by 41.7 % ($P < 0.01$) and 24.1 % ($P < 0.01$), respectively. At the same time, likely changes in the number of leukocytes and the ratio of their types in the blood of chickens of the experimental group compared to the control group were not detected.

Thus, the theoretically grounded concept of increasing the economic efficiency, the profitability of intensive cultivation, and the possibility of simultaneous cultivation of safe and high-quality broiler poultry found its clear reflection and confirmation in research using ecologically safe disinfectant preparations “Biocide” for aerosol disinfection in 0.2 % concentration and “Diocide” for water purification in 0.0004 % concentration, probiotic preparations “Biozapin” for spraying the room at the rate of 10–30 g/m² 1 time for two weeks and “Biomagn” in the composition of feed at the rate of 0.5 kg per ton of compound feed. Their complex action consists in using and mobilizing the “organism's

forces” of the animal, its immune system, which must fight and resist bacterial and viral infections, pathogenic fungi, poisoning, etc. The developed scheme of drinking and feeding broiler chickens from the period of life in industrial conditions provided optimal protection of the organism against various pathogenic factors by 100 % without antibiotics, increased immunity, and improved production indicators during broiler breeding.

Prospects for further research. The next stage of the work is to determine the quality and safety of poultry farming products after using disinfectants and probiotics preparations.

Conflict of interest

The authors declare that there is no conflict of interest.

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