The influence of the quantitative and specific composition of the microbiota of poultry houses on the prevalence of respiratory diseases and their prevention

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Abstract. The scientific article presents the results of research for 2023, conducted in poultry farms in the Kostroma region, to study the influence of the quantitative and specific microbial composition of the air on the prevalence of respiratory diseases in poultry of egg and meat production. In the course of the conducted research, it was found that the air of most poultry houses of poultry farms is polluted with bioaerosols containing a large amount of dust and microorganisms. The inhalation of such bioaerosol by a bird provokes the occurrence and development of an inflammatory process in the respiratory organs. An analysis of veterinary reporting data showed that in poultry farms, in the structure of diseases of non-infectious etiology, diseases of the digestive system account for 31%, respiratory diseases 29%, liver 11%, kidneys 9%. High load on poultry houses, limited areas, high planting density of broiler chickens, and technological disruptions are factors that lead to various diseases, primarily respiratory diseases, which dramatically reduce poultry productivity and safety.

1 Introduction

Microorganisms in the air of poultry houses are found in aerosols and can be adsorbed on the surfaces of liquid or solid dust particles [1]. Air flows transport these particles over considerable distances [2].

The main air pollutant in poultry farms is bird droppings, and the main source of microorganisms that enter and are accumulated in the air basin of poultry houses is the poultry stock that is kept there. In case of violations in technological and feeding programs, bacterial air pollution in poultry houses increases, and technological equipment, feed, and water are also exposed to bacterial contamination [2, 3, 4].

In industrial poultry farming, the highest dust content of the air basin of poultry houses is noted, a large amount of dust is formed during molting of poultry with the formation of a large amount of feather, down, and epithelial dust, and microorganisms that are released from the upper respiratory tract of poultry enter the air, the source of microorganisms can also be feces after their drying [5, 6].

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The dust of plant origin in the air is a consequence of the use of loose dry compound feed in poultry feeding. The dust of mixed feed may contain antibiotics, which lead to the appearance of antibiotic-resistant microorganisms. According to data from domestic and foreign scientists, dust in poultry farms contains up to 3-6% fiber, up to 70% crude protein, and 7 to 10% ether-extracted substances with the presence of large amounts of feathers, droppings, down, microscopic fungi, and microorganisms [7, 8, 9]. At the same time, it was noted that the highest concentration of respirable inhalation dust is observed at the end of 4-5 weeks of fattening during the rearing of broiler chickens [10, 11].

The air microbiota in poultry houses is mainly represented by bacteria, which can be found not only in the air, but also on the surface of enclosing structures, technological equipment, and care items. According to Russian researchers, in most cases, enterobacteria, streptococcus, and staphylococcus, pasteurella, enterococcus, pseudomonas aeruginosa, and less often representatives of other species and families are isolated in the air of poultry houses [12].

Microscopic fungi can also provoke the development of respiratory diseases, especially when the immune mechanisms of the mucous membranes of the upper respiratory tract are reduced. Under the influence of abiotic and biotic causes, the resistance of the mucous membranes of the respiratory tract decreases, the barrier function decreases, and the epithelial cells of the cilia reduce the production of mucociliary mucus, the protective properties of alveolocytes decrease, since there is a decrease in surfactant production and a decrease in phagocytic activity of alveolar macrophages, which, against the background of hypoxia and the occurrence of respiratory acidosis, leads to the development of pathophysiological and pathomorphological processes of respiratory tract [13, 14, 15].

The purpose of the research is to study the influence of the quantitative and specific microbial composition of the air on the prevalence of respiratory pathology in poultry during outdoor and in-cage maintenance in industrial poultry farms.

2 Materials and Methods of research

The research was carried out at poultry farms in the Kostroma region specializing in the production of commercial eggs and broiler meat. To achieve this goal, an assessment of the vaccination prevention schemes used at the poultry farm was carried out, materials from statistical veterinary reports of poultry farms on the incidence of poultry diseases of non-infectious etiology were summarized, information and analytical data from the Department of Veterinary Medicine of the Kostroma region were analyzed.

The degree of bacterial contamination of poultry houses in different periods of the year, various stages of technological cycles were performed by the sedimentation method (according to Koch).

To determine the total number of microorganisms in the samples, dilution was performed from 10^1 to 10^6, then inoculation was performed with MPA, Endo, Saburo media, followed by incubation in a thermostat. The colonies were recorded after 48 hours. The count of colonies of microorganisms was determined by V.L. Omelyansky. Morphological features of colonies were determined by microscopy of Gram-stained smears.

The morphological and biochemical parameters of blood were evaluated using generally accepted methods.

The processing of the obtained data was carried out by the method of variational statistics using the Student's reliability criterion.

3 Results and Discussions

When studying the microbial contamination of poultry farm air and the species composition of microbiota in poultry farms in the Kostroma region of egg and meat production, we identified the following microorganisms: *Escherichia Coli*, *Stahylococcus spp., Proteus spp., Enterobacter spp., Micrucoccus spp., Bacillus spp., microscopic fungi of the genera Aspergillus spp., Candida spp., Mucor spp.* (Table 1)

Table 1. Microflora isolated from the air pool of poultry houses, %.

Microorganisms	Productivity direction	
	Egg	Broilers
Escherichia Coli	43.3	46.1
Stahylococcus spp.	18.4	17.8
Proteus spp.	7.5	8.2
Enterobacter spp.	9.7	11.3
Micrucoccus spp.	2.8	3.4
Bacillus spp.	2.1	1.8
Aspergillus spp.	6.8	5.1
Candida spp.	5.5	4.2
Mucor spp.	3.9	2.1
Total	100	100

Among all the microorganisms isolated from the air basin of poultry houses, Escherichia Coli occupies the leading place, it occupies the largest share and accounts for 43.3% and 46.1% productivity in egg and meat farms, respectively.

The dominance of Escherichia Coli leads to a complication of the epizootic situation in farms, its belonging to the opportunistic microflora can serve as a springboard for the development of mixed infections.

The percentage of coccal microflora for poultry farms in the egg sector was 18.4% – in terms of the number of isolated staphylococci, 2.8% – in terms of the number of isolated micrococci; in poultry farms for broiler chickens, staphylococci were isolated in the amount of 17.8%, micrococci – 3.4%. Proteus was isolated in the amount of 7.5% and 8.2%, respectively.

The proportion of enterobacteria was 9.7% for poultry farms in the egg sector and 11.3% for poultry farms in the meat sector. Microorganisms of the genus bacilli were also isolated in small amounts in the amount of 2.1% and 1.8%.

In addition to the microflora of bacterial origin, pathogens of microscopic fungi of the genera Aspergillus spp., Candida spp., Mucor spp. were isolated in a number of farms, which were isolated in the amount of 6,8%,5,5%,3,9% in poultry farms of the egg sector, and 5.1%,4,2%, and 2.1% in poultry farms of meat direction that raise broiler chickens.

The amount of dominant microflora in a particular farm was different and varied depending on the epizootic situation, with respiratory diseases most often diagnosed in poultry.

An analysis of the structure of the incidence of non-communicable diseases in poultry in 2023 showed that diseases of the digestive system are registered in poultry farms in 1st place, respiratory diseases in 2nd place, which accounted for 31% and 29% in the structure of diseases, liver diseases – 9%, kidney diseases – 7%, other diseases make up 15% (Figure 1).

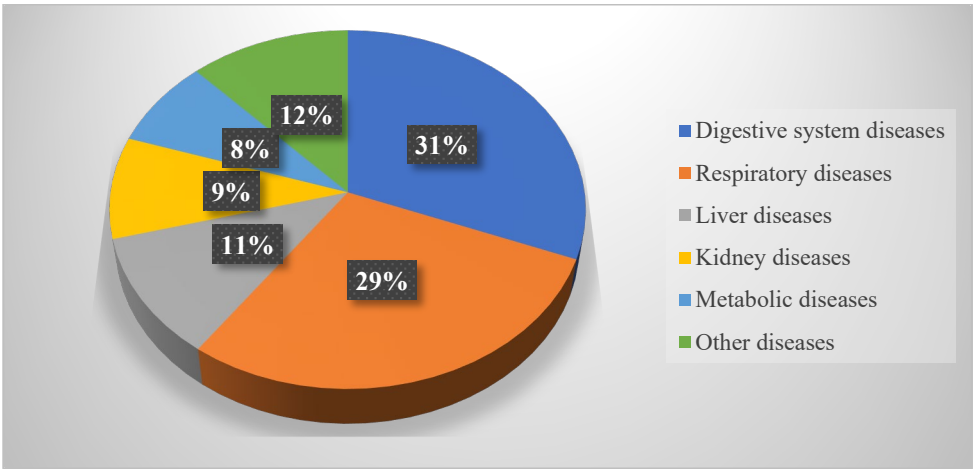

Fig. 1. The structure of the incidence of non-communicable diseases in poultry farms in the Kostroma region in 2023.

The use of various vaccination schemes helps to avoid the appearance of infectious diseases among poultry, as well as diseases associated with respiratory syndrome. It should be noted that under the influence of antigenic stimulations with virus vaccines, resistance against viral infections increases in poultry, adaptive restructuring occurs in the bird's body, nevertheless, such stimulations simultaneously lead to a decrease in the level of protection of the bird's body against bacterial infections, and especially conditionally pathogenic microflora caused by airborne poultry houses, which does not always avoid an outbreak of bacterial infections, including those provoked by intensive and numerous immunizations.

Thus, poultry farms specializing in the production of marketable eggs are immunized from 10 to 15 times during the growing period of young animals, which averages 110-120 days, depending on the epizootic situation. In enterprises specializing in meat production, broiler chickens are vaccinated from 6 to 8 times in the first 20 days of life during the technological rearing cycle until they reach 42 days.

In poultry farms, rhinitis, allergic rhinitis, allergic pulmonary alveolitis, rhinotracheitis, and bronchitis are more often reported among respiratory diseases of non-infectious etiology, causing enormous economic damage to poultry farming due to reduced productivity, reduced breeding and productive use of poultry, deaths, and low-quality products.

The widespread occurrence of respiratory diseases, manifested by respiratory syndrome, is facilitated not only by the action of biotic factors on the bird's body, but also by abiotic factors, and primarily by increased microbial contamination of premises. Biogenic factors do not constantly manifest their pathogenic potential, but under certain factors that negatively affect the bird's body and cause a decrease in the body's resistance.

With an increase in the maximum permissible concentrations (MPC) of microorganisms in the air of the poultry house, broiler chickens show a decrease in the humoral factors of natural resistance, which leads to a wide spread of diseases, primarily respiratory pathology.

The system of both cellular and humoral immunity participates in the protection of the respiratory tract from microorganisms. Damage to the mucous membranes of the upper respiratory tract in birds is caused by bacteria in the nasal cavity (commensals). As a rule, these are streptococci, staphylococci, enterobacteria, Enterococcus, Pseudomonas aeruginosa, as well as representatives of other families and species. Respiratory diseases can also be caused by microscopic fungi that enter poultry houses with contaminated litter and feed. Microorganisms enter the respiratory tract and its lower parts, lead to an inflammatory process in the nasal and bronchopulmonary regions, and cause increased migration of

neutrophils, lymphocytes, and macrophages. The metabolic activity of lymphocytes, which is influenced by bacteria, causes a decrease in the total number of cellular elements, and the number of neutrophils and macrophages in the mucous membranes of the respiratory tract decreases.

Bird inhalation of air containing higher than the maximum permissible concentrations of conditionally pathogenic microorganisms and their components leads to inflammation of the respiratory tract, leads to activation of the immune system, the action of allergens and antigens causes an allergic reaction, leads to allergic rhinitis, allergic pulmonary alveolitis, rhinotracheitis, bronchitis. The high density of poultry planting is an important abiogenic factor in the development of respiratory diseases, as it leads to an increase in its sensitivity to opportunistic pathogens.

A comparison of the microbial background of poultry houses by periods of the year when maintaining repair young birds shows that the greatest microbial air pollution was observed in the winter and spring periods of the year and amounted to 284±1.2 thousand CFU/m^3 in winter and 190±0.8 thousand CFU/m^3 in the spring period, which exceeded the standard indicator by 7.1 and 4.75 times, respectively. A similar dynamic was noted in the departments with the cellular content of the parent and industrial herds, and in the department of the parent herd in winter it was 327±1.9 thousand CFU/m^3 and 237±2.1 thousand CFU/m^3 in spring; in the department of the industrial herd in winter, 385±1.6 thousand CFU/m^3 and 430±2.2 thousand CFU/m^3 in the spring period, which also significantly exceeded the standard figure. In autumn and summer, there was a decrease in the level of microbial contamination of the air basin of poultry houses, but this indicator exceeded the standard values (Figure 2).

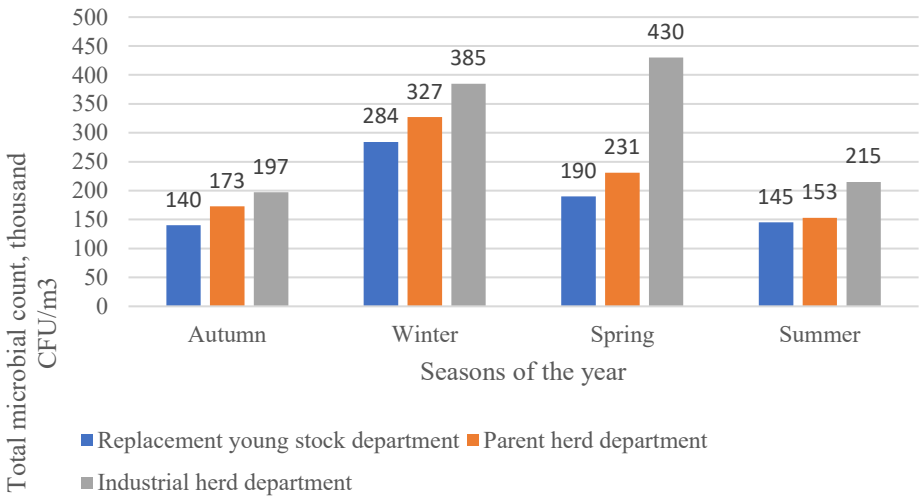

Fig. 2. Dynamics of the total microbial number of aviary air by periods of the year.

When raising broiler chickens at different times of the technological cycle, it was found that the total microbial number of the air in the poultry house varies depending on the maintenance period of broiler chickens. The maximum contamination of the air basin of poultry houses with microorganisms is observed on days 22-28, while the total microbial number is higher in winter and spring, while decreasing in spring and autumn (Figure 3).

When studying the dynamics of total microbial contamination in the rearing of broiler chickens, considering the timing of the technological cycle, it was found that the microbial

contamination of the air environment of the poultry house increases significantly with the age of the bird.

An analysis of the incidence of respiratory diseases in poultry by period of the year shows that respiratory diseases are more often registered in the winter and spring periods of the year, which has a direct relationship and is associated with an increase in the number of opportunistic pathogenic microflora in the air of poultry houses during these periods of the year, the formation of stagnant areas (stasis), especially in the spring and winter periods of the year, as well as an increase in temperature and relative humidity, a high content of harmful gases in the air (carbon dioxide, ammonia, hydrogen sulfide), which leads to overexpression of the mucous membrane of the respiratory system and creates a favorable environment for the development of diseases accompanied by respiratory syndrome.

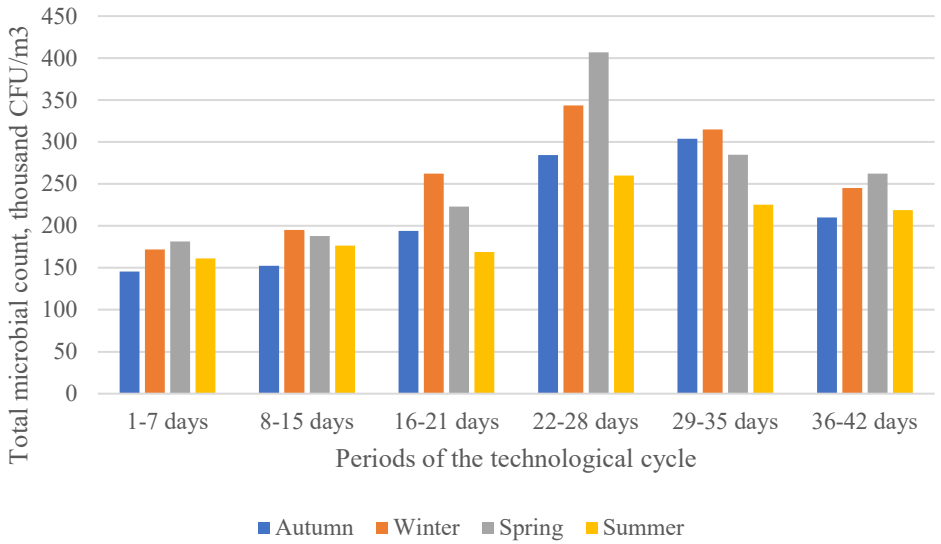

Fig. 3. Dynamics of the total microbial number of poultry house air at different times of the technological cycle of broiler chicken rearing.

An assessment of hematological and biochemical parameters of chicken blood in different periods of the year shows that in the winter and spring periods of the year, when there was an increase in the incidence of respiratory diseases in chickens, there was a significant decrease in the number of red blood cells, an increase in the level of white blood cells, with a decrease in monocytes, segmented and stab neutrophils ($P<0.05$). There was a significant increase in the number of lymphocytes in the winter and spring periods of the year.

When assessing the overall body resistance of chickens over the periods of the year, a reduced neutrophil activation index was found in the stimulated HCT - test in winter and spring.

When preventing respiratory diseases of poultry, their multifactorial nature should be considered, the prevention of respiratory tract diseases should be based on a strict integrated approach, and should consider and combine the entire range of technological, veterinary, sanitary, and special measures. The conditions of keeping a bird should exclude the effects of biogenic and abiogenic factors on its body. When keeping broiler chickens outdoors, strictly observe the standards of livestock placement, avoid overcrowding, violation of these standards leads to the accumulation of adverse factors, an increase in pathogenic and conditionally pathogenic microflora in the air of poultry houses, which contribute to the development of respiratory diseases, rapid over-infection of poultry during outbreaks of viral

or bacterial diseases. Compliance with the necessary parameters of the microclimate is important for both cage and outdoor poultry. Predisposing abiogenic factors contributing to the occurrence of respiratory diseases, exceeding the standard values of air velocity, hypothermia in violation of temperature conditions, the absence or conduct of irregular technological disinfection.

The prevention of respiratory diseases should primarily be aimed at increasing the nonspecific (natural) resistance of the bird's body with the use of vitamin-mineral and immunotropic preparations, as well as air sanitation to improve its sanitary and microbiological parameters. Carrying out aerosol disinfection in the presence of animals allows not only to improve the microbiological background of the air pool of poultry houses, but also to thoroughly disinfect the surface of enclosing structures, technological equipment and inventory, as well as the skin of poultry, and the upper respiratory tract. For sanitation, it is necessary to use modern disinfectants that do not have a toxic effect on the bird's body and have good disinfecting properties. For these purposes, solutions of modern disinfectants are used – Virocide, Katril – Dez – Vet, Dixam, Cryodesis and other preparations in low concentrations. If it is not possible to carry out aerosol treatment, it is necessary to use aerosol disinfection using the distillation method using aluminum iodide, various gas bombs.

4 Conclusions

Thus, the air of poultry farms is a bioaerosol consisting of a large number of pollutants, and the concentration of these pollutants is significantly higher than the maximum permissible values. The air of poultry houses contains a large amount of opportunistic microflora, harmful gases, and dust, which creates a favorable environment for the passage of microorganisms, leading to a high incidence of respiratory diseases in poultry.

Respiratory diseases of poultry are polyethological, while the disease develops due to a variety of causes, according to the type of associated or mixed infection.

Outbreaks of respiratory diseases are recorded more often in winter and spring, with sharp fluctuations in air temperature and relative humidity, and in the closed rooms of poultry houses during these periods, conditions are created that contribute to the accumulation of harmful gases in the air – carbon dioxide, ammonia, hydrogen sulfide, increased bacterial contamination of the air pool of poultry houses.

Mandatory preventive measures in poultry farms for the prevention of respiratory diseases should include measures aimed at increasing the natural nonspecific resistance of the bird body, regular disinfection measures, including aerosol disinfection in the presence of animals, filtration and air conditioning of the air pool of poultry facilities.

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