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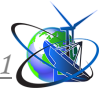
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**SANITARY AND HYGIENIC EVALUATION OF THE USE OF PREPARATIONS FOR PROTECTING POULTRY FROM PATHOGENIC MICROFLORA AND ENSURING THE PROPER QUALITY AND SAFETY OF POULTRY PRODUCTS****САНІТАРНО-ГІГІЄНІЧНА ОЦІНКА ЗАСТОСУВАННЯ ПРЕПАРАТІВ ЗАХИСТУ ПТИЦІ ВІД ПАТОГЕННОЇ МІКРОФЛОРИ ТА ЗАБЕЗПЕЧЕННЯ НАЛЕЖНОЇ ЯКОСТІ І БЕЗПЕЧНОСТІ ПРОДУКТІВ ПТАХІВНИЦТВА****Prylipko T.M. / Приліпко Т.М.,**  
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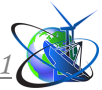
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**Abstract.** For efficient breeding of poultry, its maintenance must be arranged in such a way that it does not prevent the bird from fully realizing its genetic potential. At this stage of the development of poultry farming in Ukraine, two methods are used for keeping chickens - in cage batteries and floor keeping, but at the moment the most developed for growing, keeping and producing edible chicken eggs is cage keeping. As a result of the conducted research, a comparative assessment was made between the two- and three-tier keeping of chickens in cage batteries designed by Nizhynsilmas JSC and VO Techna LLC, which allows us to state that both one and the other method of keeping poultry in cage batteries allow for unhindered control of feeding processes, feeding, microclimate regulation, litter removal and egg collection. The author concluded that keeping chickens in two- or three-tier cage batteries has a positive effect and does not create a negative impact on the environment and on the laying hens themselves. Abroad, the maintenance of industrial flocks of chickens takes place in 2-3 tiered batteries on a mesh or slatted floor, which according to the laws of those countries meets all the requirements for keeping poultry. The equipment for keeping poultry must comply with the following technological processes, such as: storage of dry feed, feeding and distribution of feed, preparation of water, supply of water, removal of droppings from the place of keeping poultry and its removal outside the territory of the poultry house, collection of eggs from laying hens and parent stocks. Chickens should be kept and raised in poultry houses with a regulated microclimate. According to the data, an alternative to conventional cage batteries should be "improved" cage batteries, which are equipped with a nest, perch and bedding material, and provide each hen with 600 cm<sup>2</sup> of suitable area. Promising and relevant trends in industrial poultry farming will be the introduction of technologies that minimize the use of chemical synthesis drugs (antibiotics, productivity stimulants) during poultry breeding and food production and at the same time will be as close as possible to natural conditions where animals can fully realize their genetic potential.



**Key words:** poultry, cage keeping, antibiotics, genetic potential, chemical synthesis, cultivation

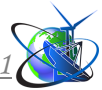
Currently, the production of edible chicken eggs, in addition to maintaining high production rates, must also ensure the proper level of maintenance of chickens. Conventional cage systems for keeping poultry were developed back in the 1930s, and began to be used in traditional poultry farming since the 1950s. These systems exist to this day, their application was aimed at increasing profits and productivity due to the possibility of keeping more chickens in a small area and higher production of edible eggs [ 5].

The relevance of proper sanitary and hygienic provision of the appropriate system of keeping animals, especially poultry, has been growing over the past few decades. Both researchers and consumers recognize that proper animal husbandry depends not only on the absence of disease, injury and inappropriate feeding. Animals must be comfortable, have their behavioral needs met, and have adequate feeding and housing systems. To achieve this goal, cage-free systems of laying hens are increasingly used, such as multi-tiered aviaries, which are most often used in industrial egg production in the last decade, as these systems provide a greater opportunity for free movement and the realization of the bird's natural behavior [ 6].

However, in Europe in the 1960s, poultry housing became quite important, and conventional cage housing was questioned on the grounds that such housing restricts the movement of the bird [2 ], and even to this day there is a difference of opinion about maintenance of laying hens in cage batteries [ 7].

In European countries, there is great interest in raising poultry on the floor (free range). There is an opinion that the eggs of free-range chickens are of better quality than those obtained in caged chickens [6 ]. For efficient breeding of poultry, its maintenance must be arranged in such a way that it does not prevent the bird from fully realizing its genetic potential. At this stage of the development of poultry farming in Ukraine, two methods are used for keeping chickens - in cage batteries and floor keeping, but at the moment the most developed for growing, keeping and producing edible chicken eggs is cage keeping. As a result of the research conducted , a comparative assessment was made between the two- and three-tier keeping of chickens in cage batteries of the design of Nizhinsilmash JSC and VO Techna LLC, which allows us to assert that both one and the other method of keeping poultry in cage batteries allow unhindered control drinking, feeding, microclimate regulation, litter removal and egg collection processes. The author concluded that keeping chickens in two- or three-tier cage batteries has a positive effect and does not create a negative impact on the environment and on the laying hens themselves. Abroad, the maintenance of industrial flocks of chickens takes place in 2-3 tiered batteries on a mesh or slatted floor, which according to the laws of those countries meets all the requirements for keeping poultry [ 8].

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poultry houses with a regulated microclimate. According to, an alternative to conventional cage batteries should be "improved" cage batteries, which are equipped with a nest, perch and bedding material, and provide each hen with 600 cm<sup>2</sup> of suitable area. Such "improved" cages must be equipped with feeders with a feeding front of 10 cm per hen, automatic feeders, the height of the cage cell must be from 45 cm in the upper part to 35 cm in the lower part.

Depending on the natural and economic conditions, different methods of keeping livestock are used in poultry farms and poultry farms: cage, floor (on a deep litter or on a mesh floor), free-range, aviary or combined.

Cage keeping is practiced in poultry farms and in specialized farms that produce edible eggs in the breeding of repair young, broilers and fattening young. Poultry are placed in single-tiered or multi-tiered cages. Since January 2012, the directive of the Council of the European Union 1999/74/EC [prohibiting the keeping of laying hens in cage batteries] came into force in Europe, but they are still used today, as they can accommodate a large number of chickens at the same time and provide better sanitation premises [ 1].

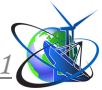
Aviary keeping of laying hens is used in regions with a mild climate [3 ]. With this method, the bird is housed in light-type buildings without a front wall, combined with an aviary - a small area surrounded by a net with a mesh or slatted floor. This allows the bird to move over greater distances, thereby enabling it to behave naturally. Therefore, aviary breeding has significant advantages over breeding chickens in cages.

In studies [5 ], it was noted that free-range poultry has a positive effect on the growth and activation of the hypothalamus-pituitary-adrenal axis, and the bird becomes calmer. When kept on the floor, the bird is kept in large-sized aviaries without or with walks. This method is used for industrial flocks of chickens in small poultry farms, in specialized farms and commercial farms. Poultry is kept on unchanged bedding or on a mesh or slatted floor [6 ].

Free-range housing is used mainly in breeding poultry farms, poultry farms, for parent stock of poultry farms and breeding farms. A free-range bird is in constant motion in the fresh air and under the influence of sunlight, which has a positive effect on its health, increases the hatching quality of eggs and the preservation of chickens during their rearing. Combined housing is used for young birds in poultry farms and large commercial farms, where chickens are kept in cages for up to 60 days, and later in camp conditions.

Different systems of keeping laying hens continue to cause controversy among researchers, producers, ecologists and consumers. The priority is the impact of these systems on the health of the birds and their freedom to exhibit natural behavior. However, it is not easy to assess whether a poultry housing system provides health and basic ethological and behavioral needs. These systems directly or indirectly affect not only the behavior, productivity and health of the bird, but also the quality of its eggs [ 7].

In recent years, organic farming has become increasingly popular in Europe, including Poland. There is a return to traditional ways of keeping poultry with access to open space, fresh air and sunlight, as well as feeding based on natural and



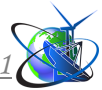
minimally processed feed [ 8]. However, obtaining products (including chicken eggs) using certified methods is much more expensive than using traditional methods. This is due to factors such as longer growing period, higher feed consumption, lower productivity and lower fertility. In the economically developed countries of Western Europe, organic breeding of laying hens accounts for 10% of the total production of edible eggs. In Poland, it still has a marginal value and does not exceed 1%. Egg production in Poland is mainly based on cage keeping of hens. Many studies have shown that this is the most economical way to produce quality eggs. However, Council Directive 1999/74/EC states that the sale of eggs laid by hens kept in conventional cage systems will be restricted or even prohibited from 1 January 2012. The producers of Polish egg are making an intensive effort to extend the use of conventional cages for 5 years and to prevent discrimination against food products produced in cages. Research is ongoing on the development of environmentally friendly production technologies that meet the expectations of middle-class consumers, while combining the safety and quality of animal products with moderate prices [5 ].

Chicken egg is considered one of the most valuable and basic food products for humans . Consumers are increasingly interested in the quality of eggs, which means ensuring the proper quality of poultry products is becoming increasingly important. As societies in many countries become increasingly affluent and health conscious, food quality will continue to be a focus for consumers and producers, as well as a challenge for science. For this reason, in an era of competition, efforts are being made to create premium products that guarantee quality and safety. This can be achieved by providing the animals with optimal housing conditions and high-quality feed containing all the necessary nutrients that guarantee high productivity and good egg quality [ 6].

Thus, technologies that minimize the use of chemical synthesis drugs (antibiotics, performance stimulators) during poultry breeding and food production and at the same time will be as close as possible to natural conditions where animals can fully realize their genetic potential.

For the general production of egg products, according to various studies, more than 75% of chickens are raised in cages, but there are more and more new conditions for keeping laying hens in conditions more favorable for animals. They are focused on improved conditions for keeping birds and their free natural behavior. First of all, the quality of eggs is an important factor that affects the purchase and demand of eggs among consumers. Recently, consumers prefer to buy eggs with a larger size, with a dense protein and, accordingly, the appropriate quality [ 7 ]. In particular, the internal and external quality of eggs is primarily influenced by environmental factors, and the poultry housing system also plays an important role.

In studies [ 4 ], it was proved that eggs with a greater mass and better protein quality were obtained when keeping free-range chickens compared to caged ones. Also, according to the data of other researchers [ 6], it was concluded that the weight of eggs increased and the evaluation of their quality criteria by Hau units was higher for cage keeping than for walking. Therefore, we can conclude that the methods of keeping poultry affect not only the internal content of eggs, but also the quality and



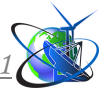
structure of the eggshell [5 ], which depends on the storage conditions and safety of egg products [ 1 ].

The housing system of laying hens is an important factor affecting the quality and safety of edible chicken eggs, as evidenced by a large number of studies in recent years. They showed a decrease in the number of eggs laid per day, as well as a decrease in egg weight in free-range and floor systems compared to eggs of chickens that were kept in cage batteries [ 3 ]. On the other hand, under the floor system of keeping laying hens, eggs are more contaminated and have a lower mass compared to eggs laid by laying hens raised in cage batteries. An important factor in the influence of mechanical damage on eggshell quality of laying hens is not the system of maintenance or production, but the diet and genetic potential of the bird.

Equally important is the factor affecting the quality and safety of edible eggs, such as bacterial risk assessment. Ways of infection through the shell and infection of the viable egg were investigated with a number of bacterial strains: *Staphylococcus warneri*, *Acinetobacter baumannii*, *Alcaligenes sp.*, *Serratia marcescens*, *Carnobacterium sp.*, *Pseudomonas sp.* and *Salmonella enteritidis*, which are isolated from a viable egg. During 3 weeks of storage at 20°C and 60% relative humidity, the penetration of bacteria through the eggshell into the contained eggs was regularly monitored. It has been proven that such characteristics of the eggshell as its area, thickness and number of pores do not affect the penetration of bacteria into the eggshell. For each individual bacterial strain, mean cuticle penetration was lower for penetrated eggshells compared to non-penetrated ones. For a single strain of *Carnobacterium sp.* and for the overall results of all strains, this difference was statistically significant. Total microbial contamination of eggs was not influenced by either eggshell area or eggshell porosity. Research results indicate that gram-negative, motile and non-aggregating bacteria most often penetrated the eggshell: *Pseudomonas sp.* (60%) and *Alcaligenes sp.* (58%) were the primary contaminants, followed by *S. enteritidis* (43%). All selected strains of microorganisms were able to penetrate the eggs. Penetration was observed most often after 4-5 days of egg storage. In particular, *S. enteritidis* was the main contaminant of whole eggs: the shell and/or contents of 32% of whole eggs. Penetrated eggshell and infected whole eggs showed significantly higher bacterial contamination of eggshell compared to non-penetrated eggshell and uninfected whole eggs, respectively. The effect of the age of hens on the penetration of bacteria into the eggshell and the contamination of the egg contents was not significant [ 2 ].

Eggs from two different production systems, i.e., free-range and caged chicken systems, were also analyzed. Twenty-one and twenty-two types of microorganisms were identified on the surface of eggs from caged and free-range chickens, respectively. In both cases, Firmicutes was the dominant phylum (representing about 50% of the total number of phyla), and families such as Clostridiaceae, Ruminococcaceae and Lachnospiraceae were frequently found in the intestinal microbiota of chickens. In addition, this work also identified other types and families of microorganisms not previously described during the eggshell study [ 8].

In 1998, microbiologist William Wightman suggested that the earth's surface is home to more than five trillion individual bacteria. Most of these bacteria are



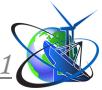
environmental or normal flora that do not cause disease in humans and animals. However, in the bacterial evaluation of the species, their number reached 1030 worldwide (Schloss, Handselman), it is important, especially from the point of view of medicine and public health, to differentiate and identify those species that are pathogenic. Differentiating pathogenic from non-pathogenic bacteria is particularly important in the food industry, as some level of bacteria in food is normal and many routes of contamination are unpredictable. However, food contamination by pathogenic bacteria such as *E. coli* or *Salmonella* can cause serious foodborne illness in humans. The importance of bacterial strain detection in the egg industry is most evident during outbreaks of foodborne illness in humans, particularly when associated with bacterial contamination of chicken eggs with pathogens such as *Salmonella* and others. In fact, the consumption of eggs and egg products has often been linked to outbreaks of human food poisoning due to their contamination with pathogenic bacteria [9]. Shell eggs can be contaminated with many types of microorganisms [7], including pathogens, and thus pose a risk of foodborne illness transmission to consumers [5].

The best-known bacterial contaminant of chicken eggs is *Salmonella*. These are rod-shaped gram-negative bacteria of the *Enterobacteriaceae* family. In addition, *S. enterica* is a ubiquitous species worldwide both in the environment and among warm-blooded animals, whereas *S. bongori* is common in cold-blooded animals. Any type of these microorganisms can cause serious food-borne illness in humans due to contamination of edible chicken eggs. Although *Salmonella* often exists as normal flora in chickens, it can be a pathogenic species in humans. Although other bacterial pathogens can infect chicken eggs, *Salmonella* is responsible for the majority of documented cases of human illness.

In addition, bacteria from chicken eggs, which are usually not pathogenic for humans, were isolated. These include *Aeromonas hydrophilia* (commonly found in water, thought to contaminate eggs during washing), *Bacillus cereus* (commonly found in soil, potential probiotic for poultry), *Campylobacter* (commonly isolated as normal flora in the reproductive tract of animals), *Listeria monocytogenes* (a common foodborne pathogen found in soil) and *Staphylococcus aureus* (natural flora of many animals, often opportunistic pathogens). Although these bacteria have been reported as frequent contaminants of chicken eggs, the diversity of contaminating microorganisms has not been sufficiently investigated, especially considering the different methods of their production [8].

The predominant routes of contamination of edible eggs by microflora can be classified as vertical and horizontal. Vertical contamination – infection of the egg occurs during its formation in the oviduct of chickens. This happens when laying hens are carriers of pathogens and transmit them through eggs. While horizontal contamination, which is more common, refers to contamination of the surface of the eggshell after the eggs are laid. It occurs when the eggshell comes into contact with a contaminated surface. In fact, droppings, water, cages and nesting materials, insects, staff hands, broken eggs, dust on egg bands, blood, and soil are the most common sources of eggshell contamination [1,2,4]. Changes that occur during the packaging and storage of eggs can also contribute to the contamination of eggs by affecting their





defense system. These changes can cause protein liquefaction and destruction of the yolk membrane and chalazae. Despite all the efforts made throughout the egg production process, from farm to table, the risk of contamination of consumers with pathogenic or opportunistic microorganisms is extremely common.

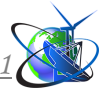
Hygiene and sanitation play an important role in controlling poultry diseases in poultry houses. One of the important requirements to promote hygiene and sanitation is that all birds in the same facility must belong to the same age group, along with limiting each establishment to one type of housing or type of bird. Premises and buildings for poultry production must meet the requirements for isolation from the environment and strict adherence to the principles of hygiene and disease prevention (for example, restrictions on the movement of personnel, equipment and vehicles). The poultry house must be properly prepared for the arrival of each new batch (disposal of poultry, litter and manure; fight against disease vectors and rodents; dry and wet cleaning; disinfection; fumigation). Attention should be paid to terminal sanitation of buildings and equipment after depopulation (physical and chemical cleaning, pressure washing, disinfection, fumigation). Special care should be taken before carrying out sanitary procedures after an outbreak of an infectious or invasive poultry disease. Immediate disposal of dead and sick birds is an important and effective means of preventing the spread of any infectious or invasive disease. Disposal methods include the use of landfills, tanks, burial in trenches, incineration and composting of waste. Regular visual inspection of livestock and poultry together with routine microbiological monitoring testing is very effective in checking the effectiveness of cleaning and disinfection. Special care should be taken before carrying out sanitary procedures after an outbreak of the disease in poultry farms [3,5].

Thus, the production of edible chicken eggs depends on many factors, which often have a certain uncertainty and unpredictability, which requires the development of reliable control and the introduction of a system for the prevention of poultry diseases and the safety of edible eggs at all stages of their production.

One of the effective means of prevention of infectious and invasive poultry diseases is the use of new drugs developed on the basis of nanotechnology, which require research into the effectiveness and safety of both productive poultry and edible chicken eggs.

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**Анотація.** Для ефективного вирощування птиці її утримання має бути облаштовано таким чином, щоб не заважало птиці повністю реалізувати свій генетичний потенціал. На даному етапі розвитку птахівництва в Україні для утримання курей використовують два способи – в кліткових батареях та підлогове утримання, але на даний період найрозвиненішим для вирощування, утримання та виробництва харчових курячих яєць є кліткове утримання. В результаті проведених досліджень зроблено порівняльну оцінку між двох-трьохярусним утриманням курей у кліткових батареях конструкції ВАТ “Ніжинсільмаш” та ТОВ “ВО Техна”, яке дозволяє стверджувати, що як один, так і інший спосіб утримання птиці в кліткових батареях дозволяють безперешкодно контролювати процеси напування, годівлі, регуляції мікроклімату, видалення посліду та збору яєць. Автор зробила висновок, що утримання курей в двох-трьохярусних кліткових батареях має позитивний ефект та не створює негативного впливу на навколишнє середовище і на самих курей-несучок. За кордоном утримання промислових стад курей відбувається в 2-3 ярусних батареях на сітчастій або планчастій підлозі, що за законами тих країн відповідає всім вимогам щодо утримання птиці. Обладнання для утримання птиці має відповідати наступним технологічним процесам, таким як: зберігання сухого корму, подача та роздавання корму, підготовка води, подача води, видалення посліду з місця утримання птиці та виведення його за територію пташника, збір яєць від курей-несучок та батьківського поголів'я. Кури повинні утримуватися та вирощуватися у пташниках з регульованим мікрокліматом. Відповідно до даних, альтернативою до звичайних кліткових батарей мають бути “удосконалені” кліткові батареї, які обладнані гніздом, сідалом та підстилковим матеріалом, і надають кожній курці 600 см<sup>2</sup> відповідної площі. перспективними і актуальними напрямками у промисловому птахівництві будуть запроваджуватися технології, які мінімізують використання препаратів хімічного синтезу (антибіотиків, стимуляторів продуктивності) під час вирощування птиці та виробництва харчових продуктів і одночасно будуть максимально наближатися до природних умов, де тварини можуть повноцінно реалізувати свій генетичний потенціал.

**Ключові слова:** птиця, кліткове утримання, антибіотики, генетичний потенціал, хімічний синтез, вирощування



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