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Research paper

Improved-Efficiency Irradiation Facility for Poultry Farming

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Abstract

This article discusses the effectiveness of influence of irradiation lighting facility on the productivity and homogeneity of broilers. Irradiation lighting facility of increased efficiency is proposed. Its spectral composition of radiation sources corresponds to the function of relative spectral sensitivity of the organ of vision, and to the functions of relative spectral erythemal and bactericidal efficiency. The results of experiment in the influence of optical radiation, received from irradiation lighting facility, on an industrial herd of broilers are given in the article.

Keywords: *spectral sensitivity, efficiency, ultraviolet light sources, LED modules.*

1. Introduction

The State Program for the Development of Agriculture for 2013-2020 provides for the increase in production of the main types of agricultural products, and the level of profitability. It is known that artificial lighting and irradiation in agro-industrial complexes, including poultry farms, ensures the efficiency of poultry operation and increases the yield of the final product of poultry farming. In this case, the effectiveness of artificial lighting and irradiation depends on the characteristics of optical radiation sources, used in lighting and irradiation facilities.

The solution of task for optimization of technological lighting and irradiation for better meeting the physiological requirements of poultry for light is based on the development of technical means with improved spectral characteristics. Improvement of spectral composition with the purpose of positive influence on the bird organism is possible when taking into account the function of relative spectral sensitivity of the bird's organ of sight, with local maxima in the ultraviolet, blue, green, red spectral regions [3, 7], the function of the relative spectral erythemal efficiency with the maximum in the ultraviolet region of the spectrum at wavelength of 297 nm and less [6]. In addition, bactericidal irradiation with a spectrum, corresponding to the function of relative spectral bactericidal effectiveness, has a significant influence on the poultry environment [5].

The researches, carried out by the authors, made it possible to form the basic requirements for the spectral composition of irradiation facilities, proposed for poultry farms, when used in conjunction with existing lighting equipment.

2. Development of Irradiation Facility with Improved Efficiency for Poultry Farming

Based on the function of relative spectral sensitivity of the bird's organ of sight, the functions of relative spectral erythemal and bactericidal effectiveness, irradiation lighting facility (ILF) was developed. It includes the module of green and red LED strips, combined in one facility with ultraviolet (UV) lamps LE-15 (erythemal) and DB-15 (bactericidal). Bactericidal lamps are installed inside the case of irradiator, and that eliminates the direct hit of radiation flux to the poultry in the region of short-wave ultraviolet radiation from these lamps. In the proposed ILF, radiation from green and red LEDs provides for synchronization of birds' biorhythms. The radiation of erythemal lamps LE-15 in the UV spectral region with a maximum of radiation at a wavelength of 315 nm provides erythematous and anti-rachitic action on the organism of the grown bird, and also influences on synchronization of bird's biorhythms. The radiation of bactericidal lamps DBM-15 in the UV spectral region with a maximum of radiation at a wavelength of 254 nm ensures bactericidal action on microorganisms of the poultry's environment [1]. Thus, the proposed ILF is a facility with wide spectrum of effect.

Experimental model of the developed irradiation lighting facility is shown in Figure 1.



Figure 1: Irradiation lighting facility with wide spectrum of effect

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Investigation of the influence of optical radiation on poultry productivity was conducted in poultry houses of the Republic of Mordovia. Studies were carried out on the impact of spectral composition of the developed irradiation lighting facility on the productive characteristics of chickens in the conditions of their shelf keeping. Poultry was grown in a closed poultry house for optimal control over puberty. The installation with traditional lamps LB-40 was used in conjunction with the proposed facility. Shelve stand for keeping young birds had standard dimensions.

The conditions of the environment for poultry keeping in the control and test groups were the same, and were provided in accordance with the guidelines for the maintenance of chickens. In the dark, the intensity of illumination did not exceed 0.5 lux. In the control (basic) variant for general lighting, only luminescent lamps LB 40 were used. In the test variant, developed facility with ultraviolet lamps and LED strips was used in addition to fluorescent lighting. Doses of radiation and lighting were established in accordance with the recommendations on the use of ultraviolet radiation in livestock production and poultry farming. The irradiation regime was intermittent [2].

The irradiation regime was similar, as in the previous experiment: erythemal lamps were switched on once a day at 8:30 for 15 minutes until reaching 14 days of age; twice a day at 8:30 and 13:00 for 15 minutes, beginning from 14 days of age. Bactericidal lamps were turned on 2 times a day at 8:30 and 13:00 for 1.5 hours until reaching 14 days of age, and since the 14th day, the time of one irradiation was increased from 1.5 to 2 hours [4].

When illuminated by LEDs, the following mode was used: the 1st day – 24 hours; the 2nd day – 23 hours; the 4-10th days - 20 hours; the 11th day and further – 8 hours.

Using the analogy method, two groups were formed: control group (base) and test group. The conditions for keeping the control and experimental groups were the same.

Chickens were weighed weekly. According to the results of weight gain, homogeneity of the broiler stock was determined and culling was carried out.

The research was conducted in spring, during 42 days.

Illumination and irradiation of young birds, using the lighting facility, is shown in figure 2.



Figure 2: Illumination and irradiation of chickens with developed irradiation lighting facility

In the production studies on the influence of spectral composition of radiation sources on young birds, the following parameters were taken into account and determined: input parameters - dose and time of irradiation, output parameters - homogeneity of the poultry stock, liveability, live weight of birds, slaughter weight, weight of carcasses.

In the test group, young animals had good mobility, active feeding, and there was no bird noise.

The main results of the experiment are shown in Table 1.

Table 1: Results of the impact of optical radiation from ILF with wide spectrum of effect on the industrial poultry stock

Parameters	Units of measurement	Test results		The effectiveness of experimental group in comparison with control
		Control	Test	Test
The term of fattening	days	42	42	
Quantity	animals	81	81	
Weight gain	kg/animal	2,575	2,730	higher by 6%
Mortality	animals	2	2	
Livability	%	96	96	
Culling	animals	7	4	3 animals less
Slaughter yield	animals	72	75	
Slaughter yield	%	88	93	higher by 5%
Slaughter weight	kg/animal	2,881	2,921	
Slaughter weight of batch	kg	207,5	219,1	higher by 5,6%
Amount of feed	kg/animal	3,90	4,06	higher by 4,2%
Carcass weight	g	1707	1803	higher by 5,6%
Weight of carcasses in batch	kg	122,9	135,2	higher by 10%

3. Summary

As a result of comparative analysis of production tests, the conclusion is drawn, that in the experimental group the weight of carcasses in batch is higher by 10%, compared to the control group. The component of the increase in weight of carcasses in the test batch correlates with the decrease in quantity of chickens, culled by weight. It can be explained by the positive effect of optical radiation, received from irradiation lighting facility. The other component refers to an increase in the average carcass weight in the test group and correlates with an increase in feed in the same group, although this can be explained by increased appetite, due to the influence of radiation from the developed irradiator.

4. Conclusion

Thus, it can be stated that the developed irradiation lighting facility allows to perform the functions of lighting, erythemal and bactericidal irradiation, to increase the homogeneity of production herd in the process of raising chickens, to increase the yield of the final product of poultry farming, and, on the whole, to increase the efficiency of artificial lighting and irradiation of poultry farms.

Based on the studies carried out, it can be concluded that the proposed irradiation lighting facility for poultry farming is promising.

Conflict of Interest

The author confirms that the presented data do not contain a conflict of interest.

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