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ENHANCING ENERGY EFFICIENCY IN BROILER CHICKEN PRODUCTION USING ELECTRICAL TECHNOLOGIES

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Abstract.*This paper explores the impact of electrical technologies—particularly LED lighting systems—on the energy efficiency and productivity of broiler chicken farming. Drawing upon experimental research and comparative analysis from leading Russian poultry science publications, as well as relevant global literature, the study evaluates the effectiveness of various lighting programs and technologies in improving production indicators, reducing energy consumption, and increasing economic efficiency. The findings demonstrate that modern energy-saving lighting programs can significantly enhance broiler productivity and reduce operational costs, making them a critical component in sustainable poultry farming practices.*

Keywords: *broiler chickens, energy efficiency, LED lighting, lighting programs, poultry farming, electrical technologies, sustainability, production optimization*

1. Introduction. Modern broiler production faces mounting pressure to improve energy efficiency while maintaining high productivity and meeting growing global demand for poultry meat. Lighting, along with ventilation and heating, accounts for a significant portion of the energy costs in poultry farming. The advancement of solid-state lighting technologies, particularly light-emitting diodes (LEDs), presents a promising opportunity to meet these challenges through precise environmental control, energy savings, and improved zootechnical outcomes. In addition to electricity savings, proper lighting programs can enhance broiler growth rates, reduce mortality, and improve feed conversion ratios (FCR), thereby increasing profitability.

Research worldwide has underscored the relevance of efficient lighting programs in broiler production. Studies have shown that spectral composition, light intensity, photoperiod, and mode of delivery (e.g., continuous, intermittent, pulsed) can significantly influence physiological and behavioral responses in broilers. This paper reviews major findings from Russian and international studies and discusses the application of electrical technologies to create optimized lighting environments in broiler houses.

2. Methods. This paper integrates findings from multiple empirical studies:

- Fisinin et al. (2011) investigated LED lighting configurations with warm and cold white spectrums in cage systems and their effect on production efficiency.

• Buyarov & Balashov (2013) tested various lighting programs—including pulsed and rhythmically variable lighting—on broiler performance in cage and floor systems.

• Buyarov & Buyarov (2013) evaluated technological innovations and energy efficiency strategies in the Russian poultry sector within the framework of WTO conditions.

• Additionally, global studies such as Rozenboim et al. (2004) and Deep et al. (2010) on spectral lighting effects, and Lewis & Morris (2006) on lighting in poultry systems, provide broader context.

The methodology involved analyzing variables such as live weight, feed conversion, mortality, muscle yield, energy usage, and economic indicators like European Production Efficiency Factor (EEF). Lighting programs assessed included continuous lighting (23C:1T), intermittent lighting (e.g., 4C:4T), and pulsed regimes using green spectrum light.

3. Results

3.1 **Zootechnical Performance**

Warm-spectrum LED lighting in localized configurations led to superior results in Fisinin et al.'s trials. Birds exposed to 3000 K lighting achieved earlier sexual maturity, higher egg mass yield (up to 17.7% more), and lower feed consumption per unit output. Localized lighting above feeders ensured uniform light intensity, improving bird comfort and reducing stress-related mortality.

In the experiments by Buyarov and colleagues, lighting programs influenced broiler weight gain, muscle-to-fat ratio, and safety rates. The use of pulsed lighting like (4C:4T)*3 and (5C:1T)*4 enhanced live weight by 5.24%, improved daily weight gain, and decreased feed cost by 11.76%. Furthermore, these programs increased the proportion of muscle tissue in carcasses and improved meat quality.

3.2 **Energy Efficiency and Sustainability**

Modern LED systems reduced energy consumption by up to 85% compared to incandescent lighting, as observed in both Russian and international contexts. LED fixtures also generate less heat, reducing the need for additional cooling and maintaining optimal thermal comfort. Systems like the Gasolec Orion used in the Russian studies showed clear advantages when installed with programmable timers.

The economic analysis from Buyarov (2013) indicated that cage systems equipped with KP-8L batteries and LED lighting had a 4–6% higher profitability margin than floor systems. When using programmable lighting programs with green-spectrum lamps (520–560 nm), the European Efficiency Factor reached up to 342, outperforming control groups by up to 67 points.

4. Discussion

The growing integration of electrical technologies in agriculture is a clear response to both economic and environmental pressures. In broiler farming, lighting is not merely an operational necessity but a strategic tool that influences growth performance and profitability. This is especially critical in large-scale operations where incremental improvements in feed efficiency or live weight translate into substantial economic gains.

Lighting regimens tailored to different broiler types (e.g., portion-type for frying, medium for filleting, or large for processing) allow farms to meet market-specific demands. Continuous lighting maximizes early-stage growth, whereas intermittent or pulsed lighting improves physiological development and welfare outcomes in later stages. In the long run, such programs reduce stress, enhance immune response, and improve meat quality.

From a sustainability perspective, the use of electrical technologies like LED lighting and smart sensors can align broiler production with global climate targets. Lower energy usage translates into reduced greenhouse gas emissions and operational costs, contributing to the economic and environmental sustainability of the poultry sector.

Additionally, integration with other technologies—such as automated ventilation, temperature regulation, and sensor-based feeding systems—can form part of an intelligent broiler production ecosystem. These advancements promise increased data-driven decision-making, enhancing both animal welfare and farm profitability.

5. Conclusion

Electrical technologies, particularly advanced LED lighting systems, offer considerable potential for enhancing energy efficiency and productivity in broiler chicken production. The evidence supports the adoption of tailored lighting programs that consider spectral quality, intensity, and timing as critical factors in broiler management.

By reducing electricity usage, optimizing zootechnical performance, and improving economic returns, these innovations provide a sustainable path forward for poultry producers. Policymakers and industry stakeholders should promote wider adoption of such technologies, supported by incentives and further research into precision agriculture solutions.

Future directions should include the development of fully integrated lighting and environmental control systems using real-time sensors and AI-based optimization algorithms. Such systems would represent the next step in energy-smart and animal-centric poultry farming.

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