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THE IMPACT OF NON-IONIZING RADIATION ON THE QUANTITATIVE AND QUALITATIVE INDICATORS OF CHICKEN MEAT PRODUCTS

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Abstract. *The growing interest in non-ionizing radiation and its potential biological effects has stimulated research into its application in animal husbandry. This article examines the impact of non-ionizing radiation, specifically extremely low-frequency pulsed electromagnetic fields (ELF-PEMF), on the productive indicators of dual-purpose chickens of the Dominant D959 crossbreed. Changes in the mass of eviscerated carcasses and selected internal organs were analyzed under the influence of different levels of extremely low-frequency non-ionizing radiation. Particular attention was paid to the qualitative characteristics of the meat – the content of crude protein in hydrolysates of breast muscle proteins in the experimental chickens. The study revealed no pathological changes in the internal organs of chickens after exposure to ELF-PEMF, confirming the biological safety of the applied irradiation modes regardless of the protein content in the diet. The results indicate that statistically significant changes in the examined parameters occur under certain exposure conditions. In particular, a reliable increase in the mass of the eviscerated carcass was observed under a 30-minute daily irradiation regimen over 150 days, with the chickens being fed diets either 15% higher or lower in protein content. The research suggests a potentially positive role of periodic ELF-PEMF exposure as an adaptogenic factor that helps maintain or even increase protein content in muscle tissue, especially under conditions of moderate stress and adaptive protein deficiency. At the same time, constant electromagnetic exposure under nutrient-deficient conditions was found to suppress protein metabolism. The data obtained support the prospect of using ELF-PEMF as a growth-promoting factor for chicken muscle mass, with constant exposure appearing more effective than periodic exposure. The mode of electromagnetic field exposure should be considered a significant regulator of metabolic processes capable of modulating protein metabolism efficiency depending on the organism's nutritional status. Further research should aim to explore the underlying mechanisms of this influence and to optimize the parameters for applying ELF-PEMF in poultry farming to achieve maximum productivity.*
Keywords: non-ionizing radiation, ELF-PEMF, Dominant D959 chickens, productivity, carcass weight, internal organs, breast muscles, crude protein

In the current context of poultry farming development, increasing the productivity of agricultural poultry and improving meat quality have become particularly important (Balamatsia, 2006; Asmarani, 2024). The growing demand for environmentally safe and high-quality meat encourages the search for new technologies that achieve high performance without the use of chemical growth stimulants (Alugwu, 2022). One promising direction is the use of physical factors, particularly non-ionizing radiation, which includes electromagnetic radiation of various ranges (ultraviolet, infrared, microwave, etc.) (Lin, 2011; Prosyanyi, 2020; You, 2024).

Among environmental factors that cause significant changes in the functional state of biological organisms, electromagnetic fields (EMFs) play a special role (Zymantienė, 2020; Tong, 2024).

Studies on the biological effects of the hypogeomagnetic field indicate that this factor induces a wide range of physiological, biochemical, and morphological changes in the organism (Balamatsia, 2006). This is directly related to the issues of «industrial extreme conditions», «magnetic deprivation», or «situational industrial chronic stress» (Wang, 2021).

Unlike ionizing radiation, non-ionizing radiation does not have the ability to break molecular bonds but can influence physiological and biochemical processes in animals (Gunes, 2020). Recent studies suggest a potential positive effect of such radiation on metabolism, immune response, and morphofunctional characteristics of tissues (Hashim, 2024). However, data on the effect of non-ionizing radiation on the meat productivity of chickens remain limited and contradictory, highlighting the need for further research in this area (Wang, 2021).

A key feature of the effect of electromagnetic radiation (EMR) on biological objects is its pronounced resonance (frequency-dependent) nature, which is considered one of the principal differences between informational and energetic influences, the latter being less sensitive to frequency (Chun, 2010; Lindberg, 2024).

Based on a review of the literature, it can be concluded that EMFs, especially with prolonged exposure, can cause physiological and morphological changes in animals (Indiarto, 2023). Changes in body weight and the condition of internal organs depend on the characteristics of the radiation (frequency, intensity, duration) and the sensitivity of the specific animal species. Given the inconsistency of the results, the topic requires further in-depth experimental research (Chun, 2010).

Electromagnetic radiation, as a non-specific stimulus that can trigger a range of adaptive responses and increase the overall adaptive resistance of the organism, allows the relevance of this research and the mechanisms of EMR action to extend from fundamental biological to applied agricultural aspects.

The aim of this study is to investigate the effect of extremely low-frequency pulsed electromagnetic fields (ELF-PEMF) on the quantitative (weight of the eviscerated carcass and internal organs) and qualitative (crude protein content in breast muscles) indicators of meat products in Dominant D959 crossbreed chickens. The results of this study may serve as a basis for the development of new biotechnological approaches in poultry farming aimed at improving product quality while maintaining safety and environmental sustainability.

Materials and methods. The study was conducted on Dominant crossbreed chickens, D959, raised under standard poultry farm conditions. One hundred clinically healthy 6-month-old chickens were selected for the experiment. They were divided into four experimental groups and one control group, each consisting of 20 chickens.

Irradiation and feeding of the chickens were carried out according to the experimental scheme (Table 1). In the magnetobiology laboratory, the room where the experiment was conducted was completely de-energized, and all external surfaces were covered with foil to isolate it from external magnetic radiation.

Variable pulse electromagnetic fields (VPEMFs) were generated using a signal generator capable of producing magnetic fields with individually set frequencies ranging from 0.01 to 20 kHz and oscillation amplitudes from 0 to 100 V, which is equivalent to a power of 150 W. Voltage and signal modulation control from the generator to the solenoid was performed using an S1-49 oscilloscope. The induction produced by the VPEMF was monitored with a G-49 microteslameter. Experimental studies involving low-frequency VPEMF were conducted at a frequency of 8 Hz, which is considered the fundamental frequency of the ionospheric waveguide and is close to the frequency of certain biorhythms.

After the experiment, 150 days later, the chickens were slaughtered and the carcasses eviscerated. The eviscerated carcass weight was determined by weighing after removing the head, legs up to the hock joint, digestive tract, and thoracic and abdominal organs. The mass of the internal organs was determined separately by weighing the liver, heart, lungs, kidneys, spleen, and muscular stomach. Before weighing, the organs were rinsed to remove feed residues and blood. All weighing procedures were carried out using electronic laboratory scales with an accuracy of 0.01 g.

Table 1

Experimental design

Group	Number of chickens	VLF-EMF irradiation regimen	Feeding regimen
Experimental I	20	Irradiation with VLF-EMF for 30 minutes daily for 150 days	Basic diet (BD) + 15% increased protein level
Experimental II	20	Irradiation with VLF-EMF for 30 minutes daily for 150 days	BD + 15% reduced protein level
Experimental III	20	Irradiation with VLF-EMF for 30 minutes daily every other week for 150 days	BD + 15% increased protein level
Experimental IV	20	Irradiation with VLF-EMF for 30 minutes daily every other week for 150 days	BD + 15% reduced protein level
Control	20	No irradiation	BD with protein content according to standard norms

Note: VLF-EMF – Very Low Frequency Electromagnetic Field; BD – Basic Diet

Crude protein in the breast muscles of chickens was determined in accordance with DSTU EN ISO 5983-2:2022 Animal feedstuffs — Determination of nitrogen content and calculation of crude protein content — Part 2: Block digestion and steam distillation method (EN ISO 5983-2:2009, IDT; ISO 5983-2:2009, IDT).

All obtained experimental data were processed using methods of descriptive and inferential statistics with the help of Microsoft Excel and Statistica 10.0 software. Results are presented as mean values (M) and standard deviations (SD). To determine the significance of differences between group means, the Student's t-test was used for normally distributed data, while the Mann–Whitney U test was applied when the data distribution deviated from normality. Differences between groups were considered statistically significant at $p < 0.05$. In cases where $p < 0.01$, the differences were considered highly significant.

Results. During slaughter, we performed a veterinary and sanitary assessment of the carcasses and internal organs of the experimental chickens, which revealed no deviations from the norm.

A comparative analysis of the eviscerated carcass weight of chickens from different experimental and control groups (Table 2) demonstrated significant changes under the influence of low-frequency variable pulse electromagnetic fields (VPEMF-LF). Specifically, the eviscerated carcass weight in birds from the first and second experimental groups exceeded that of the control group by 1.29 and 1.24 times, respectively ($p < 0.05$). This indicates a pronounced positive effect of VPEMF-LF on body weight gain in these groups.

At the same time, the carcass weight in chickens from the third and fourth experimental groups was lower than that of the control group, although these differences were not statistically significant.

As for the internal organ weights, although certain fluctuations were observed between the experimental groups and the control group, none of the differences were statistically significant. This indicates a stable physiological condition of the internal organs in all groups, which, on the one hand, confirms the safety of the applied VPEMF-LF exposure regimens, regardless of the protein content in the diet, and on the other hand, demonstrates the lack of substantial influence on the development of internal organs.

Table 2

Eviscerated carcass weight and internal organ weights in chickens (M ± m, n = 100)

Indicator		Control Group	Group I	Group II	Group III	Group IV
Eviscerated body weight, kg		1.55 ±0.09	2.00 ±0.11*	1.92 ±0.09*	1.50 ±0.12	1.51 ±0.08
Internal organ weights, g	Liver	38.72 ±0.93	38.23 ±1.16	37.91 ±1.02	38.47 ±0.81	37.98 ±1.40
	Heart	10.28 ±0.89	9.64 ±0.70	10.71 ±0.65	9.69 ±0.83	10.13 ±0.92
	Lungs	9.23 ±0.48	9.78 ±0.68	8.96 ±0.70	8.84 ±0.48	8.63 ±0.51
	Kidneys	8.03 ±0.39	8.25 ±0.35	7.99 ±0.30	7.88 ±0.29	7.80 ±0.44
	Spleen	2.99 ±0.19	3.25 ±0.31	2.73 ±0.22	3.04 ±0.43	3.10 ±0.20
	Muscular stomach	38.48 ±1.27	38.90 ±2.47	38.74 ±2.16	38.54 ±0.92	37.95 ±0.86

Note: *$p < 0.05$ – statistically significant difference compared to the control group.

Based on the conducted research, it was found that the crude protein content in the breast muscles of chickens from the fourth experimental group, where VPEMF-LF exposure alternated with weekly breaks and the protein level in the diet was 15% below the norm, reached its maximum level, exceeding that of the control group by 1.06 times, which is statistically significant at $p < 0.01$ (Fig. 1).

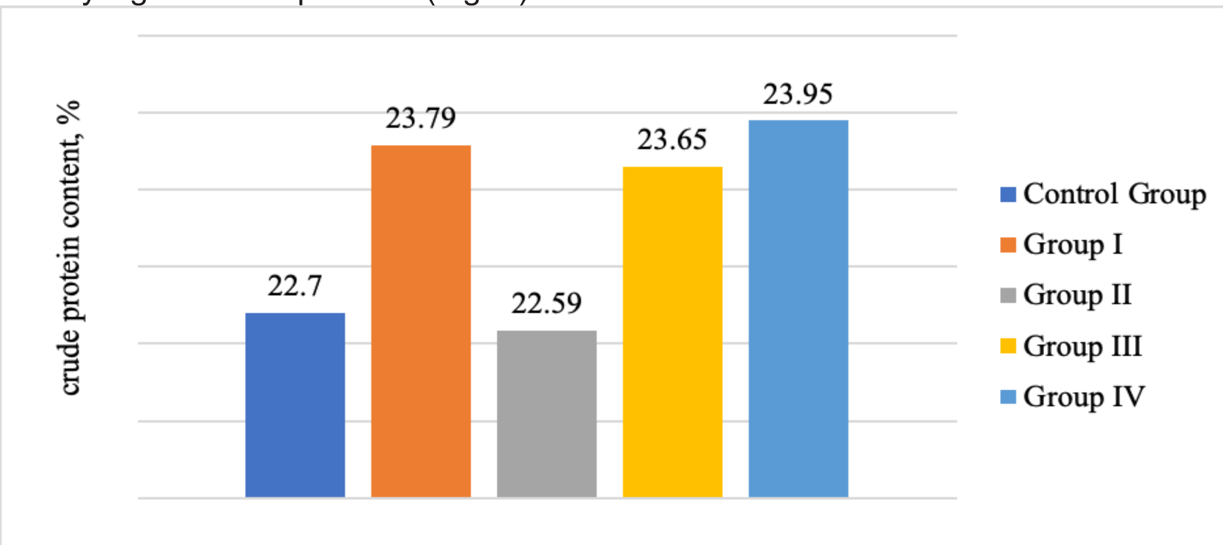

Fig. 1. Crude protein content in the hydrolysates of breast muscle proteins in experimental chickens

Under a similar VPEMF-LF exposure regimen but with a 15% increase in dietary protein, the crude protein content in the breast muscles of chickens from the third experimental group was slightly lower than in group IV, yet 1.04 times higher than the control group ($p < 0.05$).

Data analysis shows that in the first experimental group, where birds were exposed to VPEMF-LF continuously without interruption and received a protein-enriched diet, the crude protein content in breast muscles was 1.05 times higher ($p < 0.01$) compared to the control group.

Conversely, under the same exposure regimen but with a protein-deficient diet (second experimental group), the crude protein level in breast muscle hydrolysates was slightly lower than the control value, although the difference was not statistically significant.

Discussion. In today's context, with the active implementation of technologies that generate electromagnetic fields (EMF), it is important to study their effects on biological systems. Particular interest lies in changes in the morphofunctional state of the organism, including body weight and the condition of the internal organs of animals under the influence of EMF, specifically low-frequency alternating pulse electromagnetic radiation (Prosyanyi, 2021; Chun, 2010; Lindberg, 2024).

The results of studies on the effect of EMF on the body weight of animals are contradictory. It has been established that radiofrequency radiation causes a decrease in the mass of chicken embryos (Siddiqi, 2019). At the same time, research (Dyche, 2012) showed no significant changes in body weight under the influence of low-frequency EMF, suggesting that the effect depends on the intensity and duration of exposure.

Studies on laboratory animals indicate that chronic exposure to EMF can lead to structural and functional changes in internal organs. Specifically, researchers (Zymantienė, 2020) confirm structural and functional changes in the internal organs of laboratory animals after chronic exposure to electromagnetic fields.

Data on the effects of EMF on the cardiovascular system, kidney, and liver function show that prolonged exposure to low-intensity EMF can cause both adaptive and pathological changes in the body (Yakymenko, 2011). Studies also recorded structural changes in the heart muscle of chicken embryos after incubation under EMF conditions (Pawlak, 2018). Other studies point to the possible influence of EMF on the hormonal balance, which, in turn, may affect body weight growth. In animal experiments, slight fluctuations in weight were observed depending on the exposure parameters (Nisbet, 2016).

However, information on the specific effects of low-frequency extremely low-frequency EMF (ELF-EMF) on birds is rather limited.

Our comparative analysis of the slaughter weights of chickens from the experimental groups indicates significant changes under the influence of experimental ELF-EMF exposure regimes. Specifically, chickens from the first and second experimental groups showed a significant statistically reliable increase in this parameter compared to the control group, indicating a real biological effect of the conditions used in these groups.

The results suggest that continuous, uninterrupted, prolonged exposure to ELF-EMF for 30 minutes daily, as applied in the first and second experimental groups, positively affects muscle mass formation and overall growth intensity. Regardless of the protein content in the diet, ELF-EMF acts as a stimulating factor influencing the overall meat productivity of the poultry. Meanwhile, in the third and fourth experimental groups, the increase in slaughter weight was negligible, and statistical analysis revealed no significant difference compared to the control group. This may suggest that intermittent exposure, with weekly intervals of 30 minutes daily, did not significantly affect the growth intensity of the chickens in these groups.

These results allow us to hypothesize that continuous exposure to ELF-EMF without breaks contributed to more efficient nutrient absorption, intensified metabolic processes, and, as a result, more active muscle mass growth. On the other hand, the absence of significant changes in the third and fourth experimental groups compared to the control suggests that periodic but prolonged exposure to ELF-EMF had no substantial effect on the muscle mass increase in chickens.

Regarding the mass of internal organs, the analysis demonstrated certain fluctuations between the experimental and control groups. However, statistical processing of the data did not reveal significant differences, which may suggest no substantial impact of the experimental factors we used on the morphofunctional state of the internal organs. On the one hand, this indicates the biological safety of the applied approaches since no developmental disorders or hypertrophy of specific organs were detected, while on the other hand, it indicates a selective effect of ELF-EMF mainly on muscle tissue.

Thus, the results of the study point to the potential of the methods used in the first and second experimental groups for improving poultry productivity. Further research could focus on determining the mechanisms of these effects, optimizing their dosage or conditions of application.

The analysis of the conducted scientific studies allows us to conclude that the effect of EMF may have both positive and negative effects on protein metabolism in animal muscles, depending on the exposure parameters (frequency, intensity, duration) and the physiological state of the organism.

In particular, in the study (Morabito, 2024), the effect of extremely low-frequency electromagnetic fields on the skeletal muscles of adult mice was found to cause oxidative stress with short-term exposure, which is subsequently compensated by adaptive mechanisms in muscle tissue. Specifically, an increase in protein carbonyl content in muscles was observed after the first and fifth weeks of exposure, indicating oxidative protein damage.

Meanwhile, the effect of pulsed electromagnetic fields can stimulate muscle cell proliferation and accelerate muscle tissue regeneration processes without inducing apoptosis or significantly disrupting metabolic activity (Zhang, 2016).

Our research showed that the impact of ELF-EMF combined with different protein levels in the diet had a significant effect on the raw protein content in the breast muscles of chickens. The highest protein content was observed in the fourth experimental group, where exposure alternated with weekly breaks under conditions of protein deficiency (15% less than normal). In this case, protein content exceeded the control level by 1.06 times ($p<0.01$), which may indicate adaptive protein metabolism processes in response to intermittent stress caused by the electromagnetic field.

Similar results align with other researchers' data (Takegaki, 2017; Reed, 2023), which suggest that intermittent stress factor exposure can activate protein metabolism and stimulate protein synthesis in tissues. Likely, alternating periods of exposure with recovery phases contribute to the activation of compensatory metabolic rearrangement mechanisms, allowing the body to use available protein resources more efficiently, even with dietary protein deficiency. Thus, intermittent exposure creates a favorable environment for activating compensatory protein metabolism mechanisms, even in conditions of limited protein intake.

In the third experimental group, where the ELF-EMF exposure regime with breaks was also applied but the protein content in the diet was higher, a slight decrease in protein content was observed compared to the fourth group, yet the level still exceeded the control by 4% ($p<0.05$). This phenomenon can be explained by studies from other authors (Morabito, 2017; Morabito, 2024), who established that low-frequency electromagnetic fields can affect protein metabolism in muscle tissues. Specifically, the study (Gerardi, 2008) showed that low-frequency EMF exposure leads to an increase in protein content in rat muscles, likely due to the activation of protein synthesis processes through stress-induced adaptation. Similar data on other tissues is provided by Lin (2011), where osteoblasts (7F2) were exposed to low-frequency pulsed electromagnetic fields (75 Hz, 1.5 mT) for 9 hours under inflammatory conditions. The results showed a significant increase in cell proliferation (by 23%) and expression of type I collagen mRNA (by 3.4 times) compared to the control, indicating activation of protein synthesis processes in cells. This study demonstrates that low-frequency electromagnetic fields can affect protein metabolism in cells, not limited to muscle tissue.

Interestingly, in the first group (continuous exposure + increased protein content in the diet), protein levels were also high (1.05 times higher than the control, $p<0.01$). This aligns with data indicating that a high-protein diet promotes increased muscle protein synthesis (Fouad, 2014), and continuous exposure, although exerting some stress, when combined with optimal feeding, may stimulate anabolic processes.

On the other hand, in the second group (continuous uninterrupted exposure + protein deficiency), a decrease in raw protein content was observed to a level lower than the control, though the difference was not statistically significant. This indicates the destructive effect of continuous ELF-EMF exposure combined with protein deficiency, suppressing anabolism and promoting catabolic processes, as also indicated by some researchers (Gunes, 2020; Morabito, 2024).

Thus, the results suggest that alternating exposure periods with recovery phases (absence of ELF-EMF exposure) under even moderate protein deficiency may have a more pronounced positive effect on muscle protein synthesis than continuous exposure with adequate or excessive protein supply. This highlights the importance of the exposure regime as a factor modulating the metabolic response of the organism.

Conclusion. Continuous daily exposure of chickens to ELF-EMF for 30 minutes per day leads to a significant increase in the weight of the slaughtered carcass compared to the control, indicating a stimulating effect of such regimes on the meat productivity of the birds. In chickens subjected to intermittent exposure (30 minutes daily with weekly intervals), the increase in carcass weight was insignificant and did not reach statistical significance, indicating the insufficient effectiveness of this mode of ELF-EMF exposure. The absence of significant changes in the mass of internal organs in all groups suggests a selective action of ELF-EMF, with a predominant effect on muscle tissue without disrupting the morphological and functional state of internal organs.

The effect of ELF-EMF, combined with different protein levels in the diet, significantly influences the crude protein content in the breast muscles of chickens. The highest level of crude protein in muscle tissue (6% higher than the control, $p < 0.01$) was observed in the experimental chickens, where ELF-EMF exposure alternated with weekly breaks under conditions of protein deficiency (15% below the norm), indicating the activation of compensatory adaptive mechanisms in protein metabolism in response to intermittent stress.

Conditions of continuous ELF-EMF exposure combined with an increased protein level (+15%) also contributed to the increase in crude protein content in the muscles (5% higher than the control, $p < 0.01$). However, in the presence of protein deficiency, the protein level in such conditions decreased to values lower than the control, indicating the catabolic effect of prolonged ELF-EMF exposure in conditions of protein insufficiency. The obtained results suggest that intermittent exposure to ELF-EMF has a more pronounced positive effect on muscle protein synthesis, even under conditions of limited protein intake, compared to continuous exposure under optimal or excessive protein provision.

REFERENCES

1. Al-Akhras M.A. (2008) Influence of 50 Hz magnetic field on sex hormones and body, uterine, and ovarian weights of adult female rats. Electromagnetic Biology and Medicine. 27(2):155–163. https://doi.org/10.1080/15368370802072125.
2. Alugwu S.U., Okonkwo T.M., Ngadi M.O. (2022) Effect of cooking on physicochemical and microstructural properties of chicken breast meat. European Journal of Nutrition & Food Safety; 14:43–62. https://doi.org/10.9734/ejnfs/2022/v14i111264.
3. Asmarani R.R., Ujilestari T., Sholikin M.M., Wulandari W., Damayanti E., Anwar M., Aditya S., Karimy M.F., Wahono S.K., Triyannanto E., Adli D.N., Sujarwanta R.O., Wahyono T. (2024) Meta-analysis of the effects of gamma irradiation on chicken meat and meat product quality. Veterinary World.; 17(5): 1084–1097. https://doi.org/10.14202/vetworld.2024.1084-1097.
4. Balamatsia C.C., Rogga K., Badeka A., Kontominas M.G., Savvaidis I.N. (2006) Effect of low-dose radiation on microbiological, chemical, and sensory characteristics of chicken meat stored aerobically at 4°C. Journal of Food Protection; 69(5): 1126–1133. https://doi.org/10.4315/0362-028x-69.5.1126.
5. Chun H.H., Kim J.Y., Lee B.D., Yu D.J., Song K.B. (2010) Effect of UV-C irradiation on the inactivation of inoculated pathogens and quality of chicken breasts during storage. Food Control; 21(3):276–280. https://doi.org/10.1016/j.foodcont.2009.06.006.
6. Dyche J., Anch A.M., Fogler K.A.J., Barnett D.W., Thomas C. (2012) Effects of power frequency electromagnetic fields on melatonin and sleep in the rat. Emerging Health Threats Journal; 5(1):10904. https://doi.org/10.3402/ehtj.v5i0.10904.
7. Fouad A.M., El-Senousey H.K. (2014) Nutritional factors affecting abdominal fat deposition in poultry: a review. Asian-Australasian Journal of Animal Sciences; 27(7):1057–1068. https://doi.org/10.5713/ajas.2013.13702.
8. Gerardi G., De Ninno A., Prosdocimi M., Ferrari V., Barbaro F., Mazzariol S., Bernardini D., Talpo G. (2008) Effects of electromagnetic fields of low frequency and low intensity on rat metabolism. BioMagnetic Research and Technology; 6(1):3. https://doi.org/10.1186/1477-044x-6-3.
9. Gunes S., Buyukakilli B., Yaman S., Turkseven C.H., Ballı E., Cimen B., Bayrak G., Celikcan H.D. (2020) Effects of extremely low-frequency electromagnetic field exposure on the skeletal muscle functions in rats. Toxicology and Industrial Health; 36(2):119–131. https://doi.org/10.1177/0748233720912061.

10. Hashim M.S., Yusop S.M., Rahman I.A. (2024) The impact of gamma irradiation on the quality of meat and poultry: a review on its immediate and storage effects. Applied Food Research; 4(2):100444. https://doi.org/10.1016/j.afres.2024.100444.
11. Indiarto R., Irawan A.N., Subroto E. (2023) Meat irradiation: a comprehensive review of its impact on food quality and safety. Foods; 12(9):1845. https://doi.org/10.3390/foods12091845.
12. Lin H.Y., Lin Y.J. (2011) In vitro effects of low frequency electromagnetic fields on osteoblast proliferation and maturation in an inflammatory environment. Bioelectromagnetics; 32(7):552–560. https://doi.org/10.1002/bem.20668.
13. Lindberg L., McCann R.R., Smyth B., Woodside J.V., Nugent A.P. (2024) The environmental impact, ingredient composition, nutritional and health impact of meat alternatives: a systematic review. Trends in Food Science & Technology; 104483. https://doi.org/10.1016/j.tifs.2024.104483.
14. Morabito C., Steimberg N., Rovetta F., Boniotti J., Guarnieri S., Mazzoleni G., Mariggiò M.A. (2017) Extremely low-frequency electromagnetic fields affect myogenic processes in C2C12 myoblasts: role of gap-junction-mediated intercellular communication. BioMed Research International; 2017: 1–10. https://doi.org/10.3390/ijms25189857.
15. Nisbet H.O., Akar A., Nisbet C., Gulbahar M.Y., Ozak A., Yardimci C., Comlekci S. (2016) Effects of electromagnetic field (1.8/0.9GHz) exposure on growth plate in growing rats. Research in Veterinary Science; 104:24–29. https://doi.org/10.1016/j.rvsc.2015.11.002.
16. Pawlak K., Nieckarz Z., Sechman A., Wojtysiak D., Bojarski B., Tombarkiewicz B. (2018) Effect of a 1800 MHz electromagnetic field emitted during embryogenesis on chick development and hatchability. Anatomia, Histologia, Embryologia; 47(3):222–230. https://doi.org/10.1111/ahe.12346.
17. Prosyanyi S., Horiuk V. (2021) Influence of non-ionizing radiation on protein metabolism in chickens. Naukovij vìsnik veterinarnoï medicini; (2(168)):136–146. https://doi.org/10.33245/2310-4902-2021-168-2-136-146.
18. Prosyanyi S.B., Horiuk V.V. (2020) The influence of low-frequency electromagnetic radiation on the level of thyroid hormones in chickens. Veterinary Science, Technologies of Animal Husbandry and Nature Management; (5):132–137. https://doi.org/10.31890/vttp.2020.05.24.
19. Reed C., Tystahl A., Bauer E., Eo H., Lee J.H., Buhr T., Clark P., Valentine R. (2023) The effects of acute stress and repeated bouts of ethanol consumption on rates of muscle protein synthesis and related signaling in male mice. Physiology; 38(S1). https://doi.org/10.1152/physiol.2023.38.s1.5733717.
20. Siddiqi N., Al Nazwani N. (2019) Effects of electromagnetic field on the development of chick embryo: an in vivo study. In: Electromagnetic Fields and Waves (Chapter 3). IntechOpen. https://doi.org/10.5772/intechopen.84704.
21. Takegaki J., Ogasawara R., Tamura Y., Takagi R., Arihara Y., Tsutaki A., Nakazato K., Ishii N. (2017) Repeated bouts of resistance exercise with short recovery periods activates mTOR signaling, but not protein synthesis, in mouse skeletal muscle. Physiological Reports; 5(22):e13515. https://doi.org/10.14814/phy2.13515.
22. Tong X., Li Y., Zhang H., Wang L. (2024) Application of the effect of nonthermal technologies on the oxidation of proteins and lipids in pigeon meat during chilled storage. Journal of Food Biochemistry; 48(1):e6696954. https://doi.org/10.1155/2024/6696954.
23. Wang W., Zhao D., Li K., Xiang Q., Bai Y. (2021) Effect of UVC light-emitting diodes on pathogenic bacteria and quality attributes of chicken breast. Journal of Food Protection; 84(10):1765–1771. https://doi.org/10.4315/jfp-21-066.
24. Wang Z., Tu J., Zhou H., Lu A., Xu B. (2021) A comprehensive insight into the effects of microbial spoilage, myoglobin autoxidation, lipid oxidation, and protein oxidation on the discoloration of rabbit meat during retail display. Meat Science; 172:108359. https://doi.org/10.1016/j.meatsci.2020.108359.
25. Yakymenko I., Sidorik E., Kyrylenko S., Chekhun V. (2011) Long-term exposure to microwave radiation provokes cancer growth: evidence from radars and mobile communication systems. Experimental Oncology; 33(2):62–70. https://dspace.nuft.edu.ua/handle/123456789/15577.
26. You Y., Zhang Y., Li X., Wang J. (2024) Effect of gamma irradiation on microbial growth, physicochemical properties, and non-volatile flavour of chicken sausages during storage. International Journal of Food Science & Technology; 59(4):1234–1245. https://doi.org/10.1111/ijfs.16932.
27. Zhang Y., Ding J,. Duan W., Fan H., Zhang J. (2016) Low frequency pulsed electromagnetic field promotes C2C12 myoblasts proliferation via activation of MAPK/ERK pathway. Biochemical and

Biophysical Research Communications; 478(3):1050–1056. https://doi.org/10.1016/j.bbrc.2016.09.044.
28. Zymantienė J., Kairytė A., Šimaitė J. (2020) Effect of electromagnetic field exposure on mouse brain morphological and histopathological profiling. Journal of Veterinary Research; 64(2):319–324. https://doi.org/10.2478/jvetres-2020-0030.

ВПЛИВ НЕІОНІЗУЮЧОЇ РАДІАЦІЇ НА КІЛЬКІСНІ ТА ЯКІСНІ ПОКАЗНИКИ М’ЯСНОЇ ПРОДУКЦІЇ КУРЕЙ

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Резюме. *Зростаючий інтерес до неіонізуючої радіації та її можливого біологічного впливу сприяв активізації досліджень щодо її застосування у тваринництві. У статті розглянуто вплив неіонізуючої радіації (змінного імпульсного електромагнітного поля наднизької частоти (ЗІЕМП ННЧ) на продуктивні показники курей комбінованого напряму продуктивності кросу Домінант, $Д_{959}$. проаналізовано зміни в масі патраної тушки та окремих внутрішніх органів за умов впливу різних рівнів неіонізуючого випромінювання наднизької частоти. Окрему увагу приділено якісним характеристикам м’яса – вмісту сирого протеїну в гідролізатах білків грудних м’язів дослідних курей. Проведене дослідження засвідчило відсутність патологічних змін у внутрішніх органах курей після впливу ЗІЕМП ННЧ, що підтверджує біологічну безпечність застосованих режимів опромінення незалежно від вмісту протеїну в раціоні. Результати дослідження свідчать, що за певних використаних нами режимів опромінення, виникають статистично вірогідні зміни у досліджуваних показниках. Зокрема, виявлено, достовірне зростання маси патраної тушки курей під впливом неіонізуючої радіації за схемою опромінення по 30 хвилин щодоби впродовж 150 діб, годівля яких проводилась з підвищеним або пониженим на 15 % вмістом протеїну в раціоні. Проведені дослідження свідчать про потенційно позитивну роль періодичного впливу ЗІЕМП ННЧ як адаптогенного чинника, що сприяє збереженню або навіть підвищенню вмісту протеїну в м’язовій тканині, особливо за умов помірного стресу і адаптаційного білкового дефіциту. У той же час, постійна дія ЕМП при дефіциті поживних речовин має пригнічуваний ефект на білковий обмін. Отримані дані дають підстави вважати ЗІЕМП ННЧ перспективним фактором для стимуляції росту м’язової маси курей, а постійний режим опромінення – більш ефективним у порівнянні з періодичним. Режим впливу електромагнітного поля слід розглядати як важливий регулятор метаболічних процесів, здатний модулювати ефективність білкового обміну залежно від харчового статусу організму. Подальші дослідження доцільно спрямувати на вивчення механізмів впливу, а також оптимізацію параметрів застосування ЗІЕМП ННЧ у птахівництві для досягнення максимальної продуктивності.*

Ключові слова: неіонізуюча радіація, ЗІЕМП ННЧ, кури кросу Домінант Д959, продуктивність, маса тушки, внутрішні органи, м’язова тканина, сирий протеїн

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