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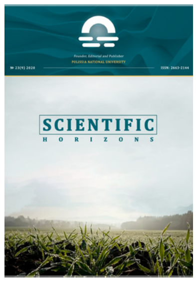

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Reducing Greenhouse Gas Emissions from Chicken Droppings for the Use of Inorganic and Biologically Active Substances

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Abstract. The leading place in the structure of livestock production is occupied by poultry farming. The intensive development of this industry poses a problem in maintaining the cleanliness of the environment since, in addition to the main products, there is a considerable amount of waste. The latter serves as a source of greenhouse gases entering the atmosphere, which are one of the main causes of negative changes in the climatic balance of the planet. Therefore, determining the level of greenhouse gas emissions under the influence of inorganic and biologically active substances was the basis of the planned research. As a result of the conducted studies, the effectiveness of the studied substances – perlite, glauconite, saponite, vermiculite, biopreparations Kapeliukhiv Yarok and Scarabei, magnesium acetate and superphosphate – was established to reduce the level of methane (CH_4), carbon dioxide (CO_2) and nitric oxide (NO) release from poultry litter *(in vitro)*. In particular, it was determined that vermiculite, which most effectively affects greenhouse gas emissions from poultry litter from natural sorbents, reduces the level of CH_4 and CO_2 by 10.5-14.4%, and NO – 9.6-11.2%. The biological product of Kapeliukhiv Yarok more effectively reduces the emission of CH_4 and CO_2 from the test substrate by 12.9-17.3%, and Scarabei – NO by 11.8-13.3%. The introduction of magnesium acetate and superphosphate into fermented poultry litter helps to reduce the level of CH_4 and CO_2 release by 14.8-18.7% and 14.0-17.4%, respectively, and NO – by 15.3-16.1% and 12.4-14.7%. Studied substances that reduce greenhouse gas emissions to the greatest extent *(in vitro)* – magnesium acetate, superphosphate, biopreparations Kapeliukhiv Yarok and Scarabei, vermiculite from the studied substrate, and at the same time provide the lowest pH level – 6.55-7.15 units. Thus, the determination of the effectiveness of the studied inorganic and biologically active substances on reducing greenhouse gas emissions from poultry litter *(in vitro)* indicates the prospects of their use to prevent environmental pollution in the intensive management of the poultry industry

Keywords: poultry farming, waste, methane, carbon dioxide, nitric oxide

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INTRODUCTION

The agricultural sector with its basic component, agriculture, is system-forming in the national economy and provides stability, food independence, and security of the state [1; 2]. The most dynamic branch of agriculture, which began to revive one of the first and has already achieved high technological and economic results is the poultry industry, which provides high-quality food to the population of Ukraine and allows exporting some products abroad [3]. It is known that one kilojoule of energy from eggs and poultry requires twice less energy than milk production and three times less than pork and beef [4]. Intensive development of the poultry industry faces the problem of excessive environmental pollution, as along with the main products (meat, eggs, products of slaughter and processing, down, feathers, etc.) there is an accumulation of considerable by-products of animal origin, including large quantities of poultry litter [5; 6]. Thus, the average anthropogenic load from poultry waste on the territory of Ukraine is 0.22 million tonnes/km^2, that is, 3000 tonnes for every thousand of population [4; 7].

The accumulation of considerable amounts of waste causes various types of atmospheric pollutions, including greenhouse gases such as methane, carbon dioxide, nitrogen oxide, etc., which serve as a source of air, soil, and water pollution and thus lead to air temperature increase on the planet, emergence of acid rain, droughts, floods, declining of drinking water supplies, formation of atmospheric aerosols [8; 9]. Greenhouse gases are the driving factors of climate change that have befallen humanity over the last century [8]. According to the Food and Agriculture Organisation of the United Nations (FAO), greenhouse gas emissions from agriculture, forestry and fisheries have almost doubled over the past 50 years and tend to increase by 30% by 2050 if a number of effective measures will not be implemented to improve environmental situation [10]. In terms of the greenhouse gas emissions scale, agriculture, although inferior to energy and industry, is still a powerful source of pollution both in Ukraine and worldwide [11; 12]. Agriculture, which often suffers from climate change, is simultaneously one of the reasons for this change [13]. Given the above, a necessary condition for the development of the poultry industry is maintaining a balance between increasing production and effective rational disposal of waste, which will minimise the negative effect of agriculture on the environment [14-16]. The research of many scientists has been devoted to the problems of environmental pollution caused by the activities of poultry farms [17-19]. However, the available literature provides information mainly on reducing emissions of certain gases from the waste, in particular, ammonia or hydrogen sulfide [20-22]. The task of developing measures to reduce the emission of greenhouse gases – methane, carbon dioxide, nitrogen oxide from animal by-products remains unsolved.

Thus, minimising greenhouse gas emissions from poultry litter is an extremely important task today due to the active development of the poultry farming and the intensive accumulation of a considerable amount of waste. Therefore, the search for effective means and ways to reduce greenhouse gas emissions from poultry litter without harming the environment is an important scientific and practical issue to solve.

The purpose of the study was to establish the effect of inorganic and biologically active substances on the emission of greenhouse gases from poultry litter – CH_4, CO_2, NO during anaerobic fermentation *(in vitro)* to prevent their entry into the environment.

MATERIALS AND METHODS

Research for establishing the effectiveness of inorganic and biologically active substances on the level of such greenhouse gases emission as methane, carbon dioxide, nitrogen oxide from poultry litter was carried out using experimental-laboratory, statistical-mathematical, and analytical methods. To conduct the experiment, samples of poultry litter without additions were taken at the farm "Zahid-Ptytsia" in Pustomyty district, Lviv region. The study was performed *in vitro* according to the method of O.G. Skliar et al. [23]. Closed tanks were used in the experiment for anaerobic conditions. To stabilise the process of anaerobic fermentation, poultry litter was diluted with water and the substrate humidity was adjusted to 92%. Each option of the experiment was repeated three times. During the experimental studies, the substrate was periodically shaken. Similar conditions of the biofermentation process were in the control option of the study, where anaerobic fermentation of the substrate occurred due to the natural microflora of litter, as well as in experimental analogues using the studied inorganic and biologically active substances. In the experiment, at each stage of biofermentation (hydrolysis, oxidation, acetogenesis, methanogenesis), the temperature regime was maintained. The study was conducted under the mesophilic regime at a temperature within 33°C since the mesophilic regime is characterised by the highest stability of the biofermentation process and small temperature fluctuations are allowed without disrupting fermentation. It is known that biofermentation can be carried out in a wide range of temperatures, but not below 6°C since there is a cessation of the microorganisms' activity at this temperature [24]. One of the important factors is also the time of biomass fermentation. Depending on the temperature, the fermentation exposure is set in the following intervals: at 10-25°C up to 30 days, at 25-40°C – from 10 to 20 days, at 45-55°C – from 4 to 8 days [25]. In this experiment, the exposure to biomass fermentation was 17 days.

To achieve the reduction of greenhouse gas emissions from poultry litter, on the 17th day from the beginning of anaerobic fermentation, inorganic and biologically active substances were added to the fermented substrate in optimal pre-established and economically substantiated doses: Option I – control (without substances); Option II – perlite, 3%; Option III – glauconite, 3%; Option IV – saponite, 3%; Option V – vermiculite, 3%; Option VI – Kapeliukhiv Yarok, 150 g/m^3; Option VII – Scarabei, 40 g/m^3; Option VIII – magnesium acetate, 3%; Option IX – superphosphate, 3%. In addition, the level of greenhouse gases – methane, carbon dioxide, nitrogen oxide in the control and experimental variants was measured. Subsequently, during the experiment, every three days, the measurement of greenhouse gases level was performed using a portable alarm-analyser Dozor C-M-5 (certificate of the device verification type UA.TR.001 212-18 and certificate of conformity UA.TR.002.CB.1234-19). The key factor determining the area of anaerobic fermentation is the hydrogen index (pH). That is why the experiment also determined the acid of the test substrate (at the beginning of the experimental studies and their completion) using a pH-meter Tour N5170. Statistical and mathematical analysis of the obtained research results was performed using the methods of variation statistics and Student's t-test standard package *Microsoft* EXCEL and *AtteStat*. Arithmetic mean values (M) and arithmetic mean errors (m) were calculated. Differences between arithmetic means were considered statistically significant by: *P<0.05; **P<0.01; ***P<0.001.

RESULTS AND DISCUSSION

Based on the studies, it was established that the pH of poultry litter in hydrogen substrates in the control options (without the introduction of substances) before and at the end of the study *(in vitro)* was in the range of 8.35-8.55 units (Fig. 1), that is, had an alkaline reaction. After the introduction of inorganic and biologically active substances into the fermented poultry litter, the processes of anaerobic fermentation decreased and at the end of the study, there was a change in the hydrogen substrates of poultry litter in pH to the acidic side with the use of perlite – up to 7.38 units, glauconite – 7.3, saponite – 7.6, vermiculite – 7.15, biologically active substances – Kapeliukhiv Yarok – 6.55, Scarabei – 6.7, magnesium acetate – 6.65, superphosphate – 6.75 units, compared with the control – 8.55 units, which indicates inhibition of the activity of microorganisms due to increasing concentrations of H^+ ions.

The obtained experimental data indicate that the studied substances, which caused the greatest decrease in pH, were at the same time the most effective in reducing the emission of studied greenhouse gases – CH_4 (Fig. 2), CO_2, NO from the substrate of poultry litter (*in vitro*).

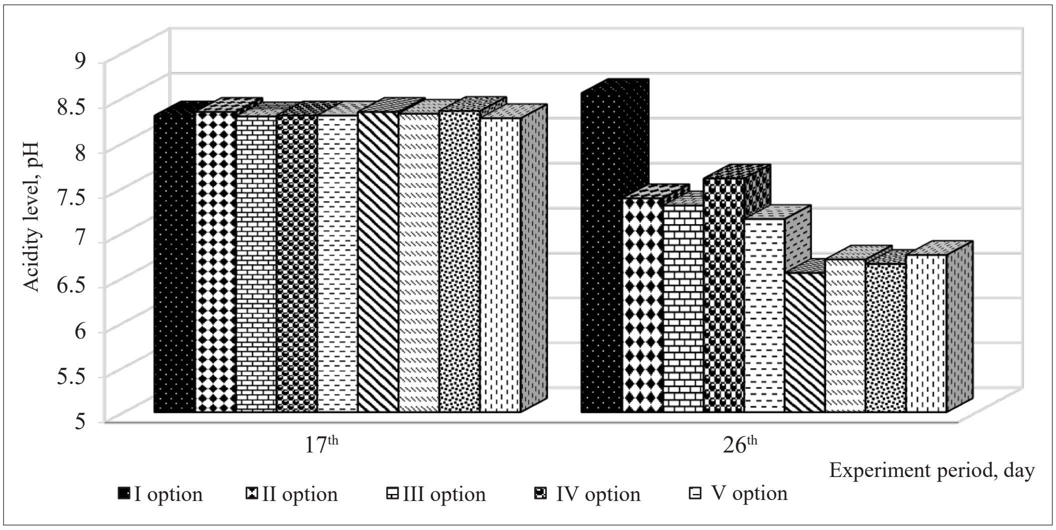

Figure 1. *Acidity level in options using inorganic and biologically active substances*

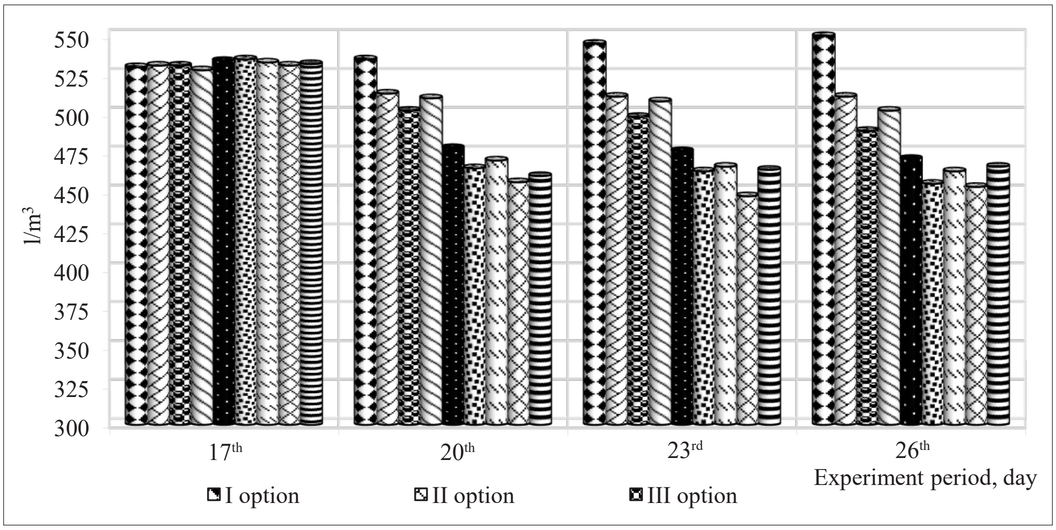

Figure 2*. The level of methane emission in options using inorganic and biologically active substances*

Analysis of the results showed that the intensity of anaerobic fermentation and the processes of greenhouse gases emission in the substrate of poultry litter depend on the duration of the experiment. The introduction of natural sorbents into the fermented poultry litter – perlite, glauconite, saponite, and vermiculite helps to reduce the level of methane and carbon dioxide (Fig. 3). In particular, when perlite is added to the studied substrate, methane and carbon dioxide emissions are reduced by 20-26th days, respectively, by 22-39 l/m³ and 15-28 l/m³, that is 3.9-7.1% ($P<0.05$-0.001) regarding control. The use of glauconite causes a decrease in the level of CH_4 and CO_2 from fermented poultry litter, depending on the day of the experiment, respectively, by 33 l/m³ and 24 l/m³ – 6.2% ($P<0.01$-0.001) – 20th day; by 47 l/m³ and 33 l/m³ or 8.5% ($P<0.01$-0.001) – 23rd day; by 61 l/m³ and 44 l/m³, that is 11.1% ($P<0.001$) – 26th day, compared to the control options. It was also established that in the options with the addition of saponite there is a decrease in methane and carbon dioxide emissions from the studied substrate, namely: on the 20th day – 25 l/m³ and 18 l/m³ – 4.6% ($P<0.01$); on the 23rd day – 37 l/m³ and 26 l/m³ or 6.7% ($P<0.05$-0.001); on the 26th day – 48 l/m³ and 34.5 l/m³, that is 8.7% ($P<0.001$), relative to control. During the same study period (20-26 days), the level of CH_4 and CO_2 emissions from fermented poultry litter when using vermiculite was lower than the control, respectively, by 57-79 l/m³ and 41-57 l/m³, which was the percentage – 10.5-14.4% ($P<0.01$-0.001). Thus, the natural sorbent – vermiculite – had the most pronounced effect on reducing the emission of methane and carbon dioxide from the substrate of poultry litter in the above period.

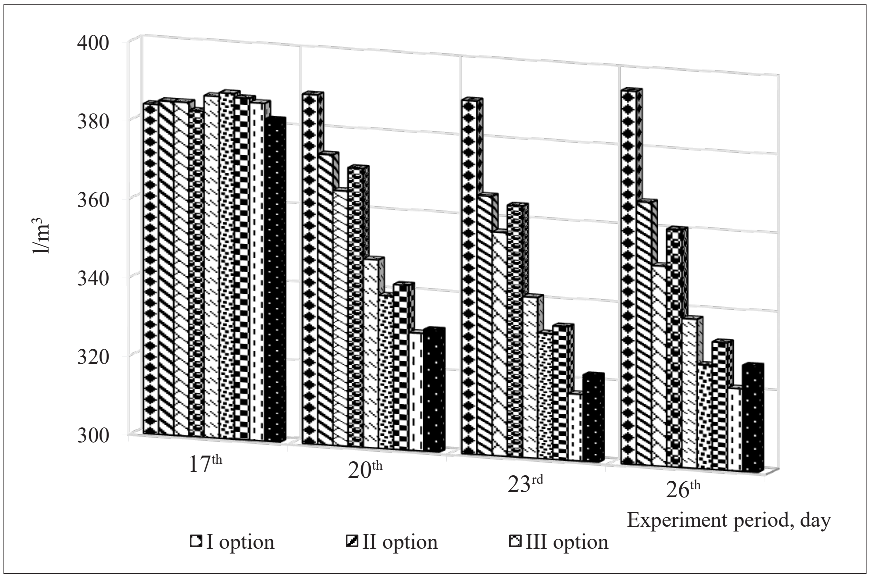

***Figure 3**. The level of carbon dioxide emission in options using inorganic and biologically active substances*

The use of biological products – Kapeliukhiv Yarok and Scarabei – also have a positive effect on the emission of greenhouse gases from the substrate of poultry litter. The application of the biological product Kapeliukhiv Yarok to the substrates helps to reduce the level of methane and carbon dioxide from the studied substrate during anaerobic fermentation, respectively, on the 20th day – 70 l/m³ and 50 l/m³, that is 12.9-13.1% ($P<0.05$-0.001), compared to control; on the 23rd day – 82 l/m³ and 58 l/m³ or 14.9-15.1% ($P<0.001$) and on the 26th day – 95 l/m³ and 68.5 l/m³ – 17.3% ($P<0.001$). The use of the biological product Scarabei reduces the emission of CH_4 and CO_2 from fermented poultry litter by 20-26 days, respectively, by 65-87 l/m³ and 47-62.5 l/m³ relative to the control, which in percentage was 12.1-15.8% ($P<0.001$).

According to the obtained research results, it was established that the introduction of magnesium acetate into the studied substrate helps to reduce the level of methane and carbon dioxide emissions, depending on the day of the study, respectively: on the 20th day – 79 l/m³ and 59 l/m³ or 14.8% and 15.2% ($P<0.001$); on the 23rd day – 98 l/m³ and 73 l/m³ – 18.0% and 18.7% ($P<0.001$), and on the 26th day of the study – 97 l/m³ and 74 l/m³, that is 17.6% and 18.7% ($p<0.001$).

In the options using superphosphate, the emission of CH_4 and CO_2 from fermented poultry litter is reduced on 20-26th days of the study, respectively, by 75-84 l/m³ and 58-68 l/m³, which in terms of percentage was 14.0-15.3% and 14.9-17.4% ($P<0.001$). Thus, analysing the obtained results, it should be noted that the lowest level of methane and carbon dioxide emissions from poultry litter substrate in all experimental options using inorganic and biologically active substances was observed on the 26th day of the experiment – 7.1-18.7%.

The obtained results testify that at the introduction of perlite in the investigated substrate there was a decrease in emission of nitrogen oxide (Fig. 4), depending on days of the experiment, accordingly: on the 20th day – 12.5 mg/m³, that is 9.9%; on the 23rd day – 8.7 mg/m³ – 8.3% ($P<0.01$), and on the 26th day – 6.7 mg/m³ or

8.2% ($P<0.05$) relative to control. The use of glauconite helps to reduce the level of NO emission from fermented poultry litter, respectively, by 14.6 mg/m^3 or 11.5% ($P<0.01$) – 20th day; by 10.9 mg/m^3, that is 10.4% ($P<0.01$) – 23rd day; by 8.0 mg/m^3 – 9.7% – 26th day, compared to the control analogue. The introduction of saponite into the studied substrate causes a decrease in nitrogen oxide emission by 20th day – 9.1 mg/m^3 – 7.2%; on the 23rd day – 6.2 mg/m^3 or 5.9% ($P<0.05$), and on the 26th day – 4.3 mg/m^3, that is 5.2%. The level of NO emission from fermented poultry litter was lower in the options with vermiculite, relative to control, respectively, by 14.2 mg/m^3 – 11.2% ($P<0.05$) – 20th day; by 11.1 mg/m^3, that is 10.6% ($P<0.05$) – 23rd day and by 7.9 mg/m^3 or 9.6% ($P<0.05$) – 26th day.

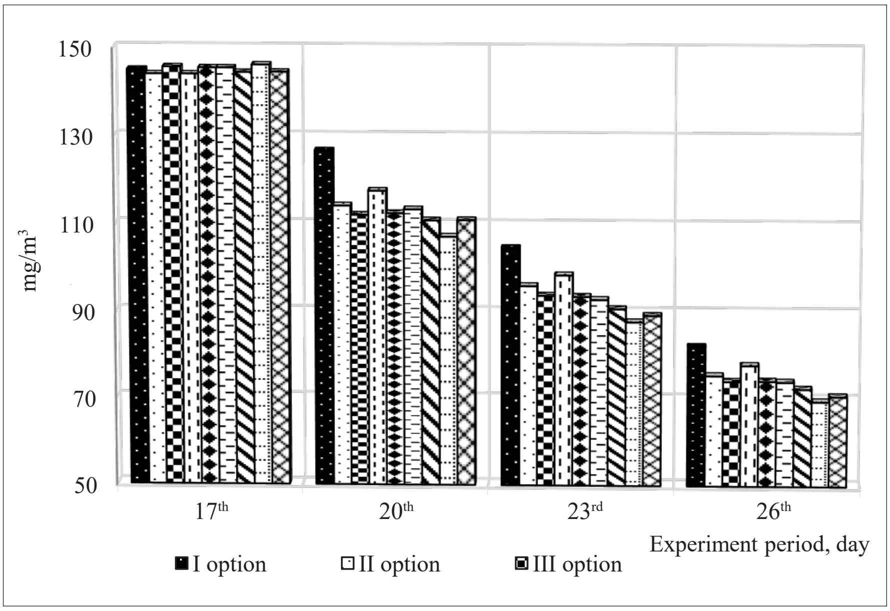

***Figure 4**. The level of nitrogen oxide emission in options using inorganic and biologically active substances*

Reduction of nitrogen oxide emission from the studied substrate is also observed by the use of biological products Kapeliukhiv Yarok and Scarabei, respectively, on the 20th day – 13.3 mg/m^3 and 15.8 mg/m^3, that is 10.5% and 12.5% ($P<0.05$); on the 23rd day – 11.8 mg/m^3 and 13.9 mg/m^3 or 11.3% and 13.3%; on the 26th day – 8.1 mg/m^3 and 9.7 mg/m^3 – 9.9% and 11.8% ($P<0.05$), compared to the control options.

When magnesium acetate and superphosphate were added to the fermented poultry litter, the level of NO emission was lower, respectively, by 19.5 mg/m^3, that is 15.4% ($P<0.05$) and 15.7 mg/m^3 – 12.4% ($P<0.05$) – 20th day; by 16.9 mg/m^3 or 16.1% ($P<0.001$) and 15.4 mg/m^3 – 14.7% ($P<0.01$) – 23rd day; by 12.6 mg/m^3 or 15.3% ($P<0.01$) and 11.4 mg/m^3 that is 13.9% ($P<0.001$) – 26th day.

The most effective in reducing nitrogen oxide emissions in the process of biofermentation of the studied substrate using natural sorbents – perlite, glauconite, saponite and vermiculite were set on the 20th day, and biological products – Kapeliukhiv Yarok and Scarabei; magnesium acetate and superphosphate – on the 23rd day of research. The obtained research of results in reducing the level of greenhouse gases emission from chicken manure is consistent with studies of W. Qasim et al. who used aluminum sulfate and ferric chloride blend in different ratios in vitro, which caused a pH decrease of the tested substrate and hence a decrease in gas emissions [26]. Researchers K. Anderson et al. [27], B. Eugene et al. [28], J. Sims et al. [29], M. Spiehs et al. [30] also obtained similar results in reducing the level of greenhouse gases emission from litter of the poultry industry using various substances of organic and inorganic origin. Thus, it is experimentally proved that the studied substances – perlite, glauconite, saponite, vermiculite, biological products – Kapeliukhiv Yarok and Scarabei, magnesium acetate and superphosphate have an effect on reducing the level of greenhouse gases – CH_4, CO_2 and NO from the substrate of poultry litter during mesophilic fermentation.

The most effective of natural sorbents (perlite, glauconite, saponite, vermiculite) in reducing the level of greenhouse gases – methane, carbon dioxide and nitrogen oxide from the studied substrate in anaerobic fermentation is vermiculite (9.6-14.4%), and from biological products (Kapeliukhiv Yarok, Scarabei) – Kapeliukhiv Yarok – on CH_4, CO_2, and Scarabei – on NO, respectively, by 12.9-17.3% and 11.8-13.3%. The introduction of magnesium acetate and superphosphate in the fermented poultry litter helps to reduce the emissions of the studied gases – CH_4, CO_2 and NO, respectively, by 14.8-18.7% and 12.4-17.4%.

Therefore, out of the studied inorganic and biologically active substances, the most effective in reducing the emission level of greenhouse gases – CH_4, CO_2 and NO from the substrate of poultry litter was found in the options using magnesium acetate. The effectiveness of others decreases in the following sequence: magnesium acetate – superphosphate – biological product Kapeliukhiv Yarok – biological product Scarabei – vermiculite – glauconite – saponite – perlite.

CONCLUSIONS

The study theoretically substantiated the effectiveness of the use of inorganic and biologically active substances, in particular natural sorbents (perlite, glauconite, saponite, vermiculite), biopreparations (Kapeliukhiv Yarok, Scarabei), as well as magnesium acetate and superphosphate in reducing the emission of the studied greenhouse gases – CH_4, CO_2, and NO from poultry litter *(in vitro)* due to changes in substrate pH. It was experimentally proved that the most effective substances in reducing the level of methane, carbon dioxide and nitrogen oxide from poultry litter (9.6-18.7%) are magnesium acetate, superphosphate, biopreparation Kapeliukhiv Yarok, and vermiculite, which indicates the feasibility of their use to prevent environmental pollution in the intensive management of the poultry farming. A promising area of further research is establishing the influence of studied substances on reducing greenhouse gases emission directly in the premises where poultry are kept and in manure storages (lagoons) during keeping animal by-products, which is important for solving environmental problems of the agro-industrial complex.

REFERENCES

[1] Liashenko, M.V. (2018). Ecological paradigm of localization of livestock production. *Investments: Practice and Experience*, 1, 70-75.
[2] Stasiv, O.F., & Kotкo, N.M. (2020). Agricultural risks and opportunities of global climate change for the development of the agricultural sector of Ukraine. *Scientific Collection "InterConf"*, 3(39), 162-164.
[3] Boiko, L.O., Boiko, V.O., & Avercheva, N.O. (2016). Development of the forecast and the prospect of development of the branch of poultry farming by 2020. *Technology Audit and Production Reserves*, 4/6(30), 34-40.
[4] Vorobel, M., Kaplinskyi, V., Pinchuk, V., & Dmytrotsa, A. (2021). Effect of different doses of biological preparation Meganit Nirbator on greenhouse gas emissions from chicken manure. *Bulletin of Agricultural Science*, 2(815), 52-59. doi: 10.31073/agrovisnyk202102-07.
[5] Herrero, M., Havlik, P., Valin, H., Notenbaert, A., Rufino, M. C., Thornton, P.K., Blümmel, M., Weiss, F., Grace, D., & Obersteiner, M. (2013). Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. *PNAS*, 110(52), 20888-20893. doi: 10.1073/pnas.1308149110.
[6] Bolan, N.S., Szogi, A.A., Chuasavathi, T., Seshadri, B., Rothrock Jr., M.J., & Panneerselvam, P. (2010). Uses and management of poultry litter. *World's Poultry Science Journal*, 66(4), 673-698. doi: 10.1017/S0043933910000656.
[7] Iashchenko, S.V. (2010). Ecological assessment of sewage treatment and disinfection of poultry complex. *NTB IBT and DNDKI of Veterinary Preparations and Feed Additives*, 11(2/3), 328-331.
[8] Binkovska, H.V., & Shanina, T.P. (2016). Estimation of greenhouse gas emissions in agricultural waste management systems of Odesa region. *Bulletin of KhNU named after V.N. Karazin. Series: Ecology*, 14, 91-97.
[9] Caro, D. (2019). Greenhouse gas and livestock emissions and climate change. In *Encyclopedia of food security and sustainability* (pp. 228-232). Amsterdam: Elsevier. doi: 10.1016/B978-0-08-100596-5.22012-X.
[10] Tubiello, F.N., Salvatore, M., Cóndor Golec, R.D., Ferrara, A., Rossi, S., Biancalani, R., Federici, S., Jacobs, H., & Flammini, A. (2014). *Agriculture, forestry and other land use emissions by sources and removals by sinks*. Retrieved from https://www.fao.org/publications/card/en/c/cf02ec83-b364-57ae-bcff-cc285d1d4b1a/.
[11] Zakharchenko, O.V. (2017). Utilization of natural origin waste of agrarian formations: Problematic aspect. *Bulletin of KhNAU named after V.V. Dokuchaev. Series: Economic Sciences*, 1, 58-67.
[12] Koneswaran, G., & Nierenberg, D. (2008). Global farm animal production and global warming: Impacting and mitigating climate change. *Environmental Health Perspectives*, 116, 5, 578-582. doi: 10.1289/ehp.11034.
[13] Johnson, J.M.-F., Franzluebbers, A.J., Weyers, S.L., & Reicosky, D.C. (2007). Agricultural opportunities to mitigate greenhouse gas emissions: Review. *Environmental Pollution,* 150, 107-124.
[14] Kebreab, E., Liedke, A., Caro, D., Deimling, S., Binder, M., & Finkbeiner, M. (2016). Environmental impact of using specialty feed ingredients in swine and poultry production: A life cycle assessment. *The Journal of Animal Science*, 94, 2664-2681. doi: 10.2527/jas.2015-9036.
[15] Smith, D.W. (2014). Mitigation of greenhouse gas emissions in animal agriculture. *Animal Agriculture in a Changing Climate*, 1, 1-7.
[16] Petersen, S.O., Blanchard, M., Chadwick, D., Del Prado, A., Edouard, N., Mosquera, J., & Sommer, S.G. (2013). Manure management for greenhouse gas mitigation. *Animal*, 7(S2), 266-282. doi: 10.1017/S1751731113000736.
[17] Chen, H., Awasthi, M.K., Liu, T., Zhao, J., Ren, X, Wang, M., Duan, Y., Awasthi, S.K., & Zhang, Z. (2018). Influence of clay as additive on greenhouse gases emission and maturity evaluation during chicken manure composting. *Bioresource Technology*, 266, 82-88.
[18] Kalus, K., Opaliński, S., Maurer, D., Rice, S., A. Koziel, J., Korczyński, M., Dobrzański, Z., Kołacz, R., & Gutarowska, B. (2017). Odour reducing microbial-mineral additive for poultry manure treatment. *Frontiers of Environmental Science and Engineering*, 11(3), article number 7. doi: 10.1007/s11783-017-0928-4.
[19] Ryapolova, I.O., & Konnova, D. (2019). Resolving environmental problems with wastes of hunting by equipment. *The Art of Scientific Mind*, 3, 90-92. doi: 10.11232/2617-7064.3.1.

[20] Choi, I.H., Choi, J.H., Ko, S.H., & Moore, P.A. (2011). Reducing ammonia emissions and volatile fatty acids in poultry litter with liquid aluminum chloride. *Journal of Environmental Science and Health. Part B,* 46(5), 432-435. doi: 10.1080/03601234.2011.572525.
[21] Chung, Y.H., & Choi, I.H. (2019). Comparison of bentonite and illite on the growth performance and litter quality of duck. *Advances in Animal and Veterinary Sciences*, 7(6), 522-525. doi: 10.17582/journal.aavs/2019/7.6.522.525.
[22] Riabinina, E.V., Melnik, V.A., & Rudaia, V.S. (2021). Influence of different methods of litter treatment on the content of harmful gases in the air of the poultry house. *Actual Problems of Intensive Development of Animal Husbandry*, 22(2), 292-297.
[23] Skliar, O.G., Skliar, R.V., & Hryhorenko, S.M. (2019). Program and methods of experimental research on a laboratory biogas plant. *Bulletin of Kharkiv National Technical University of Agriculture named after P. Vasylenko*, 199, 267-275.
[24] Vorobel, M., Moroz, V., & Kaplinskyi, V. (2018). Efficiency of action of natural minerals at emission of greenhouse gases in substratum of dung. *Bulletin of Agricultural Science*, 10(787), 35-40. doi: 10.31073/agrovisnyk201810-05.
[25] Soluk, G.S., Butsiak, V.I., & Butsiak, A.A. (2015). Biotechnology of biogas production from agricultural waste. *Scientific Bulletin of LNUVM and BT named after S.Z. Gzhytsky,* 3(63), 312-319.
[26] Qasim, W., Moon, B.E., Phonsuwan, M., Jo, J.S., Lee, M.H., Nafees, M., & Kim, H.T. (2017). Effects of an aluminum sulfate and ferric chloride blend on poultry litter characteristics in vitro. *Journal of Applied Poultry Research*, 27(1), 92-102. doi: 10.3382/japr/pfx046.
[27] Anderson, K., Moore, P.A., Jr., Martin, J., & Ashworth, A.J. (2021). Evaluation of a novel poultry litter amendment on greenhouse gas emissions. *Atmosphere*, 12(5), article number 563. doi: 10.3390/atmos12050563.
[28] Eugene, B., Moore, P.A., Jr., Li, H., Miles, D., Trabue, S., Burns, R., & Buser, M. (2015). Effects of alum additions to poultry litter on in-house ammonia and greenhouse gas concentrations and emissions. *Journal of Environmental Quality,* 44(5), 1530-1540. doi: 10.2134/jeq2014.09.0404.
[29] Sims, J.T., & Luka-Mccafferty, N.J. (2002). On farm evaluation of aluminum sulfate (alum) as a poultry litter amendment. *Journal of Environmental Quality,* 31(6), 2066-2073. doi: 10.2134/jeq2002.2066.
[30] Spiehs, M.J., Woodbury, B.L., & Parker, D.B. (2019). Ammonia, hydrogen sulfide, and greenhouse gas emissions from lab-scaled manure bedpacks with and without aluminum sulfate additions. *Environments – MDPI*, 6(10), article number 108. doi: 10.3390/environments6100108.

Зменшення емісії парникових газів з курячого посліду за використання неорганічних та біологічно активних речовин

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Анотація. Провідне місце у структурі виробництва продукції тваринництва займає птахівництво. Інтенсивний розвиток цієї галузі становить проблему щодо збереження чистоти довкілля, оскільки крім основної продукції накопичується значний обсяг відходів. Останні слугують джерелом надходження в атмосферу парникових газів, які є однією із основних причин негативних змін у кліматичному балансі планети. Тому, встановлення рівня емісії парникових газів за впливу неорганічних і біологічно активних речовин були основою запланованих досліджень. У результаті проведених досліджень встановлено ефективність дії досліджуваних речовин – перліту, глауконіту, сапоніту, вермикуліту, біопрепаратів Капелюхів Ярок й Скарабей, ацетату магнію та суперфосфату на зменшення рівня виділення метану (CH_4), вуглекислого газу (CO_2) і оксиду азоту (NO) із курячого посліду *(in vitro)*. Зокрема, визначено, що найефективніше на зниження емісії парникових газів із курячого посліду з природних сорбентів впливає вермикуліт, який зменшує рівень виділення CH_4 і CO_2 на 10,5–14,4 %, а NO – 9,6–11,2 %. Біопрепарат Капелюхів Ярок більш ефективно обумовлює зниження емісії з досліджуваного субстрату CH_4 та CO_2 на 12,9–17,3 %, а Скарабей – NO на 11,8–13,3 %. Внесення ацетату магнію та суперфосфату в зброджений курячий послід сприяє зменшенню рівня виділення CH_4 та CO_2, відповідно на 14,8–18,7 % та 14,0–17,4 %, а NO – на 15,3–16,1 % й 12,4–14,7 %. Досліджувані речовини, які в найбільшій мірі зменшують емісію парникових газів *(in vitro)* – ацетат магнію, суперфосфат, біопрепарат Капелюхів Ярок та Скарабей, вермикуліт із досліджуваного субстрату, забезпечують водночас і найменший рівень pH – 6,55–7,15 од. Отже, встановлення ефективності впливу досліджених неорганічних та біологічно активних речовин на зниження емісії парникових газів з курячого посліду *(in vitro)* вказують на перспективність їх застосування для запобігання забруднення довкілля при інтенсивному веденні галузі птахівництва

Ключові слова: птахівництво, відходи, метан, вуглекислий газ, оксид азоту