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COMPARISON OF ANTIMICROBIAL ACTIVITY OF TWO POLYMERIC GUANIDINE DERIVATIVES

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The polymeric guanidine derivatives have long proven to be efficient disinfectants and antiseptics. They have clearly expressed bactericidal, virucidal, fungicidal, and algicidal properties [1, 2]. There is much information on the application of polymeric guanidine derivatives in the composition of different disinfectants and antiseptics, for instance, e.g., in the treatment of hospital-acquired infections (biofilms) [2, 3, 4]. In addition, polyhexamethylene guanidine (PHMG), has also been used with some effect in the purification of sewage and underground waters [5].

We conducted comparative studies of the bactericidal properties of two polymeric derivatives of guanidine together with private firm «Termit» (Rivne, Ukraine).

We studied and compared antimicrobial effects of polyhexamethylene guanidine (PHMG) and polyhexamethylene biguanidine (PHMB) both in the hydrochloride form. They differ somewhat in price and disinfectant properties.

We used three test strains of microorganisms. These were gram-negative bacteria *Esherichia coli* ATCC № 25922 and *Pseudomonas aeruginosa* ATCC № 27853 (F 51), and gram-positive bacteria *Staphylococcus aureus* ATCC № 25923 (F 49). Research was conducted using generally accepted methods [6, 7, 8].

Aqueous solutions of drugs were prepared in concentrations of 0.01-1.0%, pH 5.5-6.0.

For *E. coli*, the minimum bactericidal concentration (MBC) of PHMG was 0.05% for a duration of exposure of 30 min., for 15 min. exposure, a weak growth of colonies was still observed. MBC for PHMB was 0.02% in 15 min. Exposure.

The situation was similar for *P. aeruginosa.* MBC of PHMG was 0.05% for a duration of exposure of 5 min., for PHMB it was 0.02%.

For *S. aureus* MBC of PHMG was 0.04% for 15 min. exposure, MBC for PHMB for the same time was also 0.02%. Therefore, PHMB shows greater efficiency than PHMG in vitro.

At the same time, our further studies showed that in the presence of a protein load (cattle serum), the advantages of PHMB almost disappear, no significant differences in the action of both disinfectants are observed.

It is known that organic contamination of surfaces can significantly affect the activity of PGMG, for example, it can be the effect of body [9].

It can be assumed that PHMG when acting on a colony of microorganisms and biofilm will be no less effective due to its ability to influence intercellular interactions, proteins and exchange of information between cells. A similar effect is known for eukaryotes [10].

PGMB also shows sufficiently high activity against biofilms, such as those formed by *Prototheca spp*. [11].

Conclusions. Therefore, despite the higher activity of PHMB compared to PHMG *in vitro*, it can be assumed that when using disinfectants made on the basis of PHMG or PHMB *in vivo*, the effect will be approximately the same when disinfecting livestock facilities. However, this thesis needs further experimental verification. We plan to conduct inspections on livestock farms and dairy equipment.

References:

[1] Mashat, B. H. (2016). Polyhexamethylene biguanide hydrochloride: features and applications. *British Journal of Environmental Sciences,* 4(1), 49–55. http://www.eajournals.org/wp-content/uploads/Polyhexamethylene-Biguanide-Hydrochloride-Features-and-Applications1.pdf

[2] Oule, M. K., Lesage, C., Gauvin, J., Friesen, M., Dickman, M., Bernier, A. M., & Diop, L. (2017). *In vitro* assessment of the toxic effects of an AKWATON based disinfectant on human tissues. *Journal of Antimicrobial Agents,* 3(2), 140–146. https://doi.org/10.4172/2472-1212.1000140

[3] Vitt, A., Sofrata, A., Slizen, V., Sugars, R. V., Gustafsson, A., & Gudkova, E.I. (2015). Antimicrobial activity of polyhexamethylene guanidine phosphate in comparison to chlorhexidine using the quantitative suspension method. *Annals of Clinical Microbiology and Antimicrobials*, 14(36). https://doi.org/10.1186/s12941-015-0097-x

[4] Moshynets, O. V., Baranovskyi, T. P., Iungin, O. S., Kysil, N. P., Metelytsia, L. O., Pokholenko, I., Potochilova. V. V., Potters, G., Rudnieva, K. L., & Rymar, S. Y. (2022). eDNA Inactivation and Biofilm Inhibition by the Polymeric Biocide Polyhexamethylene Guanidine Hydrochloride (PHMG-Cl). *Int. J. Mol. Sci.*, 23(731). https://doi.org/10.3390/ijms23020731

[5] Kvartenko, O., Lysytsya, A., Kovalchuk, N., Prysiazhniuk, I., & Pletuk, O. (2021). Technology of combined treatment of storm runoff and circulating waters from territories of auto transport enterprises. *Journal of Water and Land Development*, 50(VI–IX), 180–186. https://doi.org/10.24425/jwld.2021.138173

[6] Morozova, N. S. (2008). Vyznachennya chutlyvosti/stiykosti mikroorhanizmiv do dezinfikuyuchykh zasobiv: metod. rek. [Determination of sensitivity/resistance of microorganisms to disinfectants: method. rec.]. – Kyiv: Knowledge of Ukraine. [in Ukrainian].

[7] EN 12353:2006. Chemical disinfectants and antiseptics. Preservation of microbial strains used for the determination of bactericidal and fungicidal activity. – Brussels: European Committee for Standardization.

[8] EN 13727:20012+A2:2015. Chemical disinfectants and antiseptics. Quantitative suspension test for the evaluation of bactericidal activity in the medical area. Test method and requirements. – Brussels: European Committee for Standardization.

[9] Dias, F. G. G., Parreira, R. L. T., Pereira, L. F., Veneziani, R. C. S., Ambrósio, M. A. L. V., Almeida, V. T. S., Barros, R. A., Dias, L. G. G., & Ambrósio, S. R. (2022). Topical formulations based on polyhexamethylene hydrochloride guanidine for surgicalfield antisepsis. *Turkish Journal of Veterinary & Animal Sciences,* 3(46), 6. https://doi.org/10.55730/1300-0128.4211

[10] Kim, J. W., Jeong, M. H., Yu, H. T., Park, Y. J., Kim, H. S., & Chung, K. H. (2023). Fibrinogen on extracellular vesicles derived from polyhexamethylene guanidine phosphate-exposed mice induces inflammatory effects via integrin β. *Ecotoxicology and Environmental Safety*, 252, 114600. https://doi.org/10.1016/j.ecoenv.2023.114600

[11] Fidelis, C. E., Leite, R. F., Garcia, B. L. N., Gonçalves, J. L., Good, L., & Santos, M. V. (2022). Antimicrobial activities of polyhexamethylene biguanide against biofilm-producing *Prototheca bovis* causing bovine mastitis. *Journal of Dairy Science*, 2(106), 1383-1393. https://doi.org/10.3168/jds.2022-22468