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Plasma-activated water: The Impact of Physicochemical Properties on its Antimicrobial Efficacy

Ana Gotvajn[1], Helena Prosen[2], Štefan Pintarič[1], Breda Jakovac Strajn[1]

[1] *Veterinary Faculty, University of Ljubljana, Gerbičeva ulica 60, SI-1000 Ljubljana, Slovenija, Europe*
[2] *Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenija, Europe*

e-mail: ana.gotvajn@vf.uni-lj.si

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Plasma-activated water (PAW) is a novel and sustainable technology that has attracted considerable attention in various fields of application, including disinfection, due to its strong antimicrobial efficacy. PAW has already been proven effective against a wide range of microorganisms, including bacteria, biofilms, spores, yeasts, and even certain viruses. In contrast to most used disinfectants in veterinary medicine, which are based on chemical compounds, PAW does not contain any added chemical substances that could pose a risk to human or animal health and harm the environment.

PAW is produced when water is treated with plasma, an ionized gas. The chemical reactions that take place lead to the formation of reactive oxygen and nitrogen species (RONS), such as hydroxyl radicals (•OH), nitric oxide (NO) and peroxynitrite ($ONOO^-$), which typically have a half-life ranging from nanoseconds to a few seconds, as well as long-lived species such as hydrogen peroxide (H_2O_2), ozone (O_3), nitrite (NO_2^-) and nitrate (NO_3^-). Therefore, PAW is a dynamic system rather than a stable entity, in which short-lived reactive species continuously decay and transform into more stable compounds. Along with the resulting low pH and high oxidoreduction potential (ORP), these factors are considered the key contributors to PAW's antimicrobial activity. However, the efficacy of disinfectants depends on various factors. One of them is the presence of impurities in the environment, particularly those of organic origin. Therefore, in our future research we aim to address the antimicrobial efficacy of PAW against relevant microorganisms encountered in veterinary medicine in the presence of organic matter, while simultaneously evaluating its selected physicochemical parameters. Our study follows the standardized protocols used for testing the efficacy of commercial chemical disinfectants, which include assessing disinfectant efficacy in the presence of organic matter. This enables comparison with established chemical disinfectants and, at the same time, the standardization of the antimicrobial efficacy of this novel disinfectant. We will also attempt to identify the products formed in the process, as it is known that PAW induces the degradation of organic matter, which will also contribute to understanding of the environmental acceptability of this potential disinfectant.