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Anti-virus Efficacy of Plasma-Activated Solution and its mechanism

M. G. KONG, Frank Reidy Center for Bioelectrics, Old Dominion University, Norfolk, USA

Reactive oxygen species inactivate viruses in a dose-dependent fashion. For example, hydrogen peroxide (H2O2) can reduce SARS-CoV-2 on abiotic surfaces by 4-6 logs of plague-forming unit (PFU) per mil in 1 min. There are also evidences that viruses are vulnerable to ROS-generating agents such as cold atmospheric plasma (CAP). To gain specific insight, we studied whether a surface cold atmospheric plasma (CAP) and its activated water may inactivate bacteriophages, viruses that infect bacteria, as surrogates of human viruses. We considered three types of bacteriophages, namely T4, F174 and MS2 that have different nuclear acids, namely double-stranded DNA (T4), single-stranded DNA (F174), and RNS (MS2). Incubation with CAP for 60 s or with PAS for 80 s led to 10 log PFU/ml) reduction of F174 and MS2 were reduced by 10 logs of PFU/ml by 60 s-CAP or 80 s-PAS treatment, both with 1-h incubation post treatment, whereas 10-log reduction of T4 required a longer treatment of CAP or PAS. Experiments using ROS reconstitution and scavenging identified singlet oxygen as a major player. Further, DNA and protein analysis of T4 bacteriophages found (1) DNA and protein damage of virus that limit their replication; and (2) aggregation of bacteriophages that compromise their propagation (Fig. 1). Together, these data suggest that CAP and PAS are active in coronaviruses and may be further improved with its antiviral mechanism.

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In collaboration with: l. Guo, State Key Lab Electrical Insulation and Power Equipment, Center for Plasma Biomedicine, Xi'an Jiaotong University Xi'an, People's Republic of China; H. L. Chen, Frank Reidy Center for Bioelectrics, Old Dominion University, Norfolk, USA