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Plasma jet activation of acetyl donors for decontamination of pathogens

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Antibiotics are commonly used as the first line of defense in the treatment of infectious diseases. They have revolutionised medicine, farming and agriculture, and veterinary care, and are used in many other industries including commercial paint formulations. However, their overuse, particularly in the case of antibiotics, has rendered them less effective through the rise of antimicrobial resistance [1]. Consequently, new non-antibiotic strategies are urgently needed to combat AMR.

Here we present a novel strategy utilizing cold plasma for the "on-demand" activation of acetyl donor molecules [2]. The process generates an aqueous-based antimicrobial formulation comprising a rich mixture of highly oxidizing molecules: peracetic acid, hydrogen peroxide and reactive oxygen and nitrogen species. We investigated the use of two antimicrobial precursor acetyl donors, tetraacetylethlynediamine (TAED) and pentaacetate glucose (PAG), to amplify the antimicrobial effects of cold plasma. TAED and PAG and their by-products are readily biodegradable and are non-toxic if used at low concentrations and can be manufactured using green chemistry [3-5]. Plasma generated H_2O_2 reacts with the acetyl donors of TAED and PAG to produce peracetic acid (PAA) which acts in synergy with H_2O_2 and other plasma generated RONS, providing a potent broad-spectrum antimicrobial solution (**Figure 1**). The synergistic potent oxidative action between these molecules is shown to be highly effective at eradicating common wound pathogenic bacteria (Pseudomonas aeruginosa and Staphylococcus aureus) and at inactivating a virus (SARS-CoV-2).

Overall, this study demonstrates how the antimicrobial effects of cold plasma can be amplified with acetyl donor molecules. The acetyl donor formulation can be configured for on-demand use either in a liquid formulation as demonstrated in this study, or potentially in a cream or gel formulation, or even within a hydrogel wound dressing activated by a small hand-held cold plasma device. Major advantages of on-demand plasma activation of acetyl donors for these applications include the ability to produce stable formulations with a long shelf-life and without the requirement of refrigeration, and its multipronged action coupled with on-demand activation prevents prolonged exposure of microorganisms to sub-optimal concentrations of the antibacterial agents; all of which are likely to help resist the development of AMR in healthcare and in our environment.

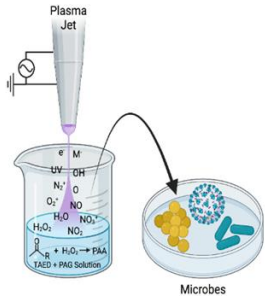

Figure 1. Pictorial overview of the cold plasma activation of an acetyl donor from TAED and PAG generating PAA, H2O2 and other RONS for the eradication of pathogenic microbes.

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