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The Role of Liquid Conductivity in Tunning the Physicochemical and Antibacterial Properties of Plasma-Treated Liquids

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Plasma-treated liquid (PTL), as a derivative of cold atmospheric pressure plasma, can inactivate bacteria and greatly expand the application of plasma technology due to the presence of a cocktail of reactive oxygen and nitrogen species (RONS), such as hydroxyl radicals, hydrogen peroxide, nitrites, and nitrates [1]. Varying the nature of liquids, directly or indirectly affects plasma and bulk liquid chemistry, making it crucial to determine the impact of different liquids on plasma discharge and the resulting physicochemical properties, as this alters RONS concentrations through distinct chemical reaction pathways [2]. This study investigated the different biochemical properties of PTLs such as deionized water (DIW~1 μScm^{-1}), tap water (TW~300 μScm^{-1}), and seawater (SW~600 μScm^{-1}), activated using a pin-to-plate dielectric barrier discharge (DBD) plasma source. Key properties such as pH, total dissolved solids (TDS), conductivity, temperature, and nitrate and hydrogen peroxide concentrations were measured as functions of discharge power, treatment time, and distance. Experimental results indicate that plasma treatment increases temperature, TDS, conductivity, hydrogen peroxide, and nitrate concentrations across all water types but more in SW. This was attributed to higher plasma discharge current in SW with a Maxwellian relaxation time (MRT) value of 0.118 ns than TW and DIW. Notably, pH remained constant in TW but decreased significantly in DIW (from 6.95 to 2.89) and SW (from 7.35 to 3.08) under fixed treatment voltage of 5 kV, time of 6 min, distance of 0.5 cm, and frequency of 20 kHz. This pH change is attributed to the lower carbonate concentration in diluted SW compared to TW [3]. The comparison between the antibacterial effect of different PTLs on the E. coli bacteria is also reported in this study.

References

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