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Investigation of the chemical stability of plasma-activated solutions

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Abstract content

Plasma pharmacy concerns the production, optimization, and stabilization of plasma-activated solutions. To be considered as efficient anti-cancer drugs, plasma-activated solutions should be easily produced and stored, and it is essential that they maintain their anti-cancer properties over time. Given that among the variety of plasma-generated RONS, H_2O_2 and NO_2^- have been established as the main anti-cancer drivers of plasma-activated solutions [1,2], the cytotoxic activity of these liquids is highly dependent on the stability over time of these two reactive species. The purpose of this work was to assess the chemical stability of plasma-treated PBS(Ca_2^+/Mg_2^+), in terms of H_2O_2, NO_2^- and NO_3^- degradation, as a function of storage time and temperature. An atmospheric-pressure plasma jet of coaxial electrode configuration driven by high-voltage pulses in the kHz range was used to produce the plasma [3]. PBS(Ca_2^+/Mg_2^+) solutions were treated by the plasma, and then stored at 4 different temperatures: ~+20°C (room temperature), +4°C, –20°C and –80°C. Alongside, untreated PBS(Ca_2^+/Mg_2^+) containing ad-hoc concentrations of H_2O_2, NO_2^- and NO_3^- (i.e. mimicking solutions) were stored at the same temperatures. The absolute concentrations of H_2O_2, NO_2^- and NO_3^- were measured in these stored solutions after 1, 7, 14, 21 and 75 days of storage. Thus, the degradation of those reactive species, in respect to their initial concentration measured just after the plasma treatment, was determined. The influence of the freezing rate (for solutions stored at –20°C and –80°C) was also studied by comparing fast and slow freezing. Finally, the actual effect of storage time and temperature on the viability and permeability of cancer cells treated *in vitro* by the solutions was also assessed. Our results show that, for both plasma-treated and mimicking solutions, the reactive species considered remain stable for 21 days at room temperature or at +4°C. On the contrary, significant degradation is observed at –20°C and –80°C, even for the first days of storage. We conclude that both plasma-treated and mimicking solutions can preserve their cytotoxic activity, at least for 21 days, if stored at +20°C or +4°C, providing a basis for their practical application in cancer therapy.

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References

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