

Plasma Activated Media for Prostate Cancer Treatment

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Abstract:

Cold Atmospheric Plasma (CAP) is an ionized gas generated at atmospheric pressure with the temperature of particles (molecules, ions, atoms) close to the room temperature. Recent studies have shown that both *in vitro* and *in vivo* plasma exposure to many cancer cell lines is efficient to induce cell deaths through apoptosis pathways [1]. Moreover, non-tumoral cell lines seem to be less impacted by CAP than cancer cell lines: this is called selectivity of plasma [2]. It is highly likely that complex chemical kinetics inside cold plasma coupled with interactions on biological targets lead to formation of Reactive Oxygen and Nitrogen Species (RONS) that cause an important oxidative stress and result in cell deaths through uncleared molecular mechanisms [3]. Direct plasma treatment represents most investigations, but some papers claim that the indirect treatment called Plasma-Activated Medium (PAM) also triggers tumor cell deaths [4]. Therefore, RONS excluding shortest lifetime species remain the only actors for PAM treatment.

In this study, a plasma jet device will be used in controlled conditions to quantify RONS production in the gas phase and into water and/or culture medium (supplemented RPMI-1640).

The experiments will be made for some species in liquid phases irradiated by plasma and in the surrounding gas phase. In liquid phases, a look will be taken for hydroxyl radical ($\cdot\text{OH}$), singlet oxygen ($^1\text{O}_2$), hydrogen peroxide (H_2O_2), nitrites (NO_2^-) and nitrates (NO_3^-). Two liquids will be used as targets: ultra-pure water to have an absolute quantification of species production and culture medium to have a relevant quantification close to *in vitro* experiment conditions. In parallel, ozone (O_3) and nitric oxides (NO_x) production will be measured in gas phase. The importance of some plasma physical parameters on this production will be established. Finally, a link between this chemical study of cold atmospheric plasma and the impact on our future biological assays orientation will be exposed.

Keywords: Cold atmospheric plasma, reactive oxygen and nitrogen species, chemical quantification, liquid phase, gaseous phase.

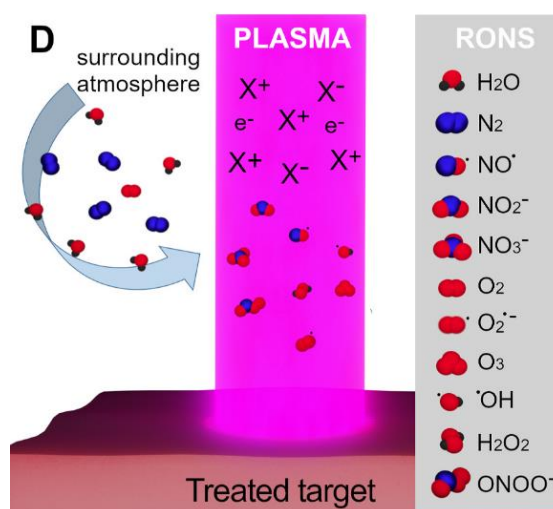


Figure 1: Scheme of reactive oxygen and nitrogen species at plasma-biological target interface. All of them may have a key role on cell deaths through oxidative stress by mechanisms that are still uncleared. Figure from Busco *et al.* [3].

References:

1. Min, T., Xie, X., Ren, K., Sun, T. Wang, H., Dang, C., Zhang, H. (2022) Therapeutic Effects of Cold Atmospheric Plasma on Solid Tumor, *Frontiers in Medicine*, 9.
2. Fofana, M., Buñay, J., Baron, S., Menecier, S., Nivoix, M., Perisse, F., Vacavant, A., Balandraud, X. (2019) Selective treatments of prostate tumor cells with a cold atmospheric plasma jet, *Clinical Plasma Medicine*, 17-18, 100098.
3. Busco, G., Robert, E., Chettouh-Hammas, N., Pouvesle, J.-M., Grillon, C. (2020) The emerging potential of cold atmospheric plasma in skin biology, *Free Radical Biology and Medicine*, 161, 290-304.
4. Saadati, F., Mahdikia, H., Abbaszadeh, H.-A., Abdollahifar, M.-A., Khoramgah, M. S., Shokri, B. (2018) Comparison of Direct and Indirect cold atmospheric-pressure plasma methods in the B16F10 melanoma cancer cells treatment, *Scientific Reports*, 8, 7689.

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