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Catalase enzyme inhibition's effect on plasma medicine

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Biochemical studies of tissue reveal that the endogenous levels of antioxidant enzymes vary greatly across tissue types [1]; this reflects differences in development and metabolism across different organ systems [2]. In most cancer cells, the intrinsic levels of antioxidant enzymes are low compared to healthy cells or non-transformed cells [3]. This suggests that most cancer cells lack the biochemical machinery to metabolize H2O2 effectively.

Plasma medicine is a new field that uses cold atmospheric plasma (CAP) for various medical applications, such as sterilization, wound healing, blood coagulation, and cancer treatment [3]. CAP interacts with the oxygen, nitrogen, water, etc., in air to produce various radical and non-radical species, for example, hydroxyl radicals (•OH), superoxide (O_2•−), singlet oxygen ($^1O_2$), nitrogen dioxide (NO2), hypochlorite (ClO^-), atomic oxygen (O), and nitric oxide (NO). During the plasma–liquid interactions, some relatively long-lifetime reactive species are generated in liquid, such as hydrogen peroxide (H_2O_2), nitrites (NO_2−), and nitrates (NO_3−) [4]. To understand the CAP mechanism in the complex bio-organism it is important to understand CAP action on the proteins.

To understand the plasma treatment effect on the structure and activity of catalase, we treated bovine liver catalase using pulsed DBD and Jet for 5, 10, and 20 min. We investigated the structural and thermodynamic changes in catalase through UV-visible, fluorescence, and circular dichroism spectroscopies after DBD and Jet plasma treatments at various time intervals. We have also performed mass spectrometry analysis to reveal the possible modified amino acids in catalase after both types of plasma treatments (DBD and jet). The jet plasma treatment modifies the catalase structure to a greater extent than the DBD plasma. Additionally, we performed molecular dynamics simulations based on the mass spectrometry analysis to gain insight into the structural deformation of catalase. Finally, we have observed that inhibition of catalase enzyme in A375 cancer cells increases the plasma treatment (DBD and jet) efficiency. Molecular dynamic simulation studies show more change in RMSD for catalase after Jet treatment than DBD treatment, **as shown in Figure 1**. Therefore, we conclude that the enzymatic activity of catalase in cancer cells decreases after plasma treatment. Still, this decrease is not strong enough to completely inhibit the catalase cellular function (to metabolize H_2O_2) in cancer cells.

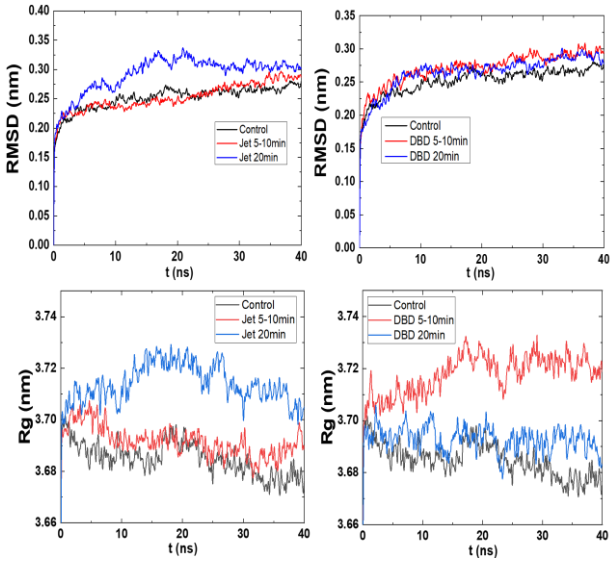

Figure 1: RMSD and Rg values of Catalase before and after plasma modification

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