From bio-based cryopreservation strategies to structural modelling: the case study of FucoPol and its scalability to greater structure-function understanding

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The cryopreservation of biological material has been consolidating its importance in biomedical research for decades now. Its biggest end goal has been to achieve timeless whole-body preservation but current methodologies still struggle with something as simple as cryoprotectant cytotoxicity. A bio-based approach then shows the most promise in tackling a cytotoxicity problem. Thus, we studied the adequacy of FucoPol, a fucose-rich bacterial biopolysaccharide, as a supplement in cryoprotective formulations.

After several years of studying FucoPol, we have unveiled its biocompatible, cryoprotective, antioxidant and photoprotective properties. FucoPol has demonstrated to be non-cytotoxic to animal and human cell lines, its inherent viscosity does not hinder nutrient diffusion, and is able to preserve the integrity of cells by extracellularly protecting them against cryoinjury. Its strong antifreeze activity is due to a non-colligative increase of the freezing point of water with concomitant reduction of mean ice crystal size. In vitro, this property appears to be independent of ionic composition or cell line studied, demonstrating its high versatility. Ionic multivariate cluster analysis shows that FucoPol can compete with textbook hypothermic formulations and CryoStorTM, showing similar cell viability post-storage whilst reducing formula complexity and production cost. Recently, we have discovered the photoprotective effect of FucoPol against UV radiation. Arctic frost flowers host psychrophilic bacteria that produce cryoprotective polysaccharides, but due to a thinner ozone layer, they are more prone to damaging irradiation. By adaptation, these molecules show good defenses against damaging UV radiation. Turns out FucoPol does not photodegrade under intense UV exposure and can protect human cells against all UV types.

This continuous multifunctional research focusing on FucoPol has raised questions regarding the truthfulness behind the affirmation that structure-function relationships are solely a cause of environmental adaptation when FucoPol derives from a mesophilic bacteria but shows traits of halophilic buffer capacity and psychrophilic antifreeze properties.

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