Antimicrobial photosensitizers and their formulations: A potential solution to current world scenario

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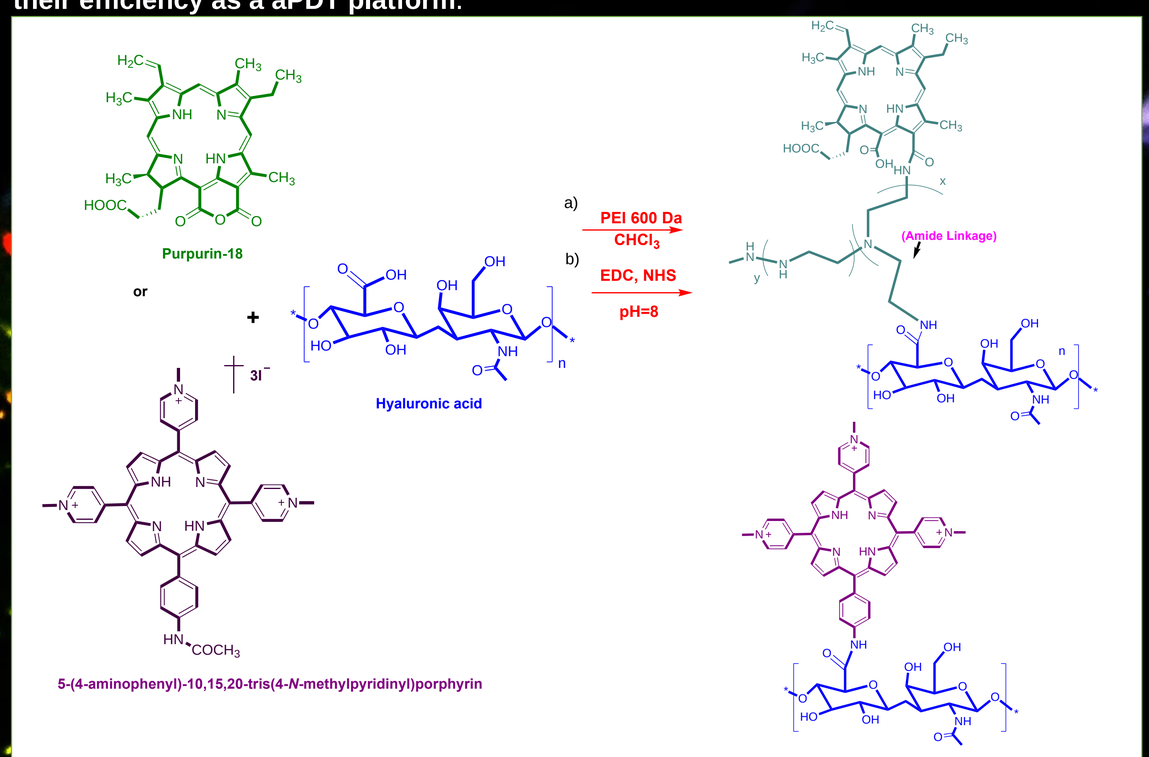
In order to provide a long-lasting solution to infections affecting the current world scenario, photodynamic therapy (PDT) offers a means to destroy pathogenic microbes via formation of reactive oxygen species, promoting the damage of microbial targets such as nucleic acids (DNA or RNA), proteins, lipids, protein complexes, or by impeding the biofilm matrix[1]. The main aim of the study is to design and synthesize photoactive moieties based on porphyrin and chlorin macrocycles and BODIPY dyes for antimicrobial photodynamic therapy (aPDT). Furthermore, incorporating these photo-moieties into biopolymeric hydrogels as shown in Figure 1 for a variety of biomedical applications are targeted [2].

Current work

Cationic 5-(4-aminophenyl)-10,15,20-tris(4-*N*-methylpyridinyl)porphyrin and a naturally occurring chlorin purpurin-18, extracted and chemically modified from *Spirulina maxima*[3] (a blue-green alga) were used as potential photosensitizers and further formulated with a naturally occurring biopolymer of hyaluronic acid to check their efficiency as a aPDT platform.



Scheme 1. Functionalizing purpurin-18 and 5-(4-aminophenyl)-10,15,20-tris(4-*N*-methylpyridinyl)porphyrin with polyethylene imine(PEI) and further formulation with hyaluronic acid to form a hydrogel

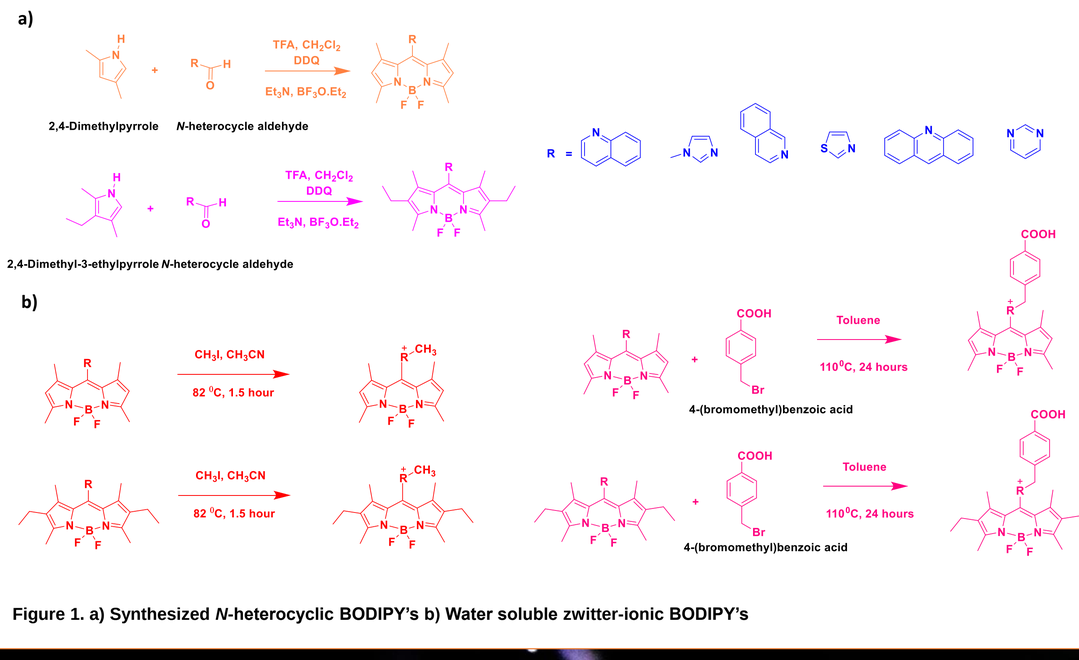
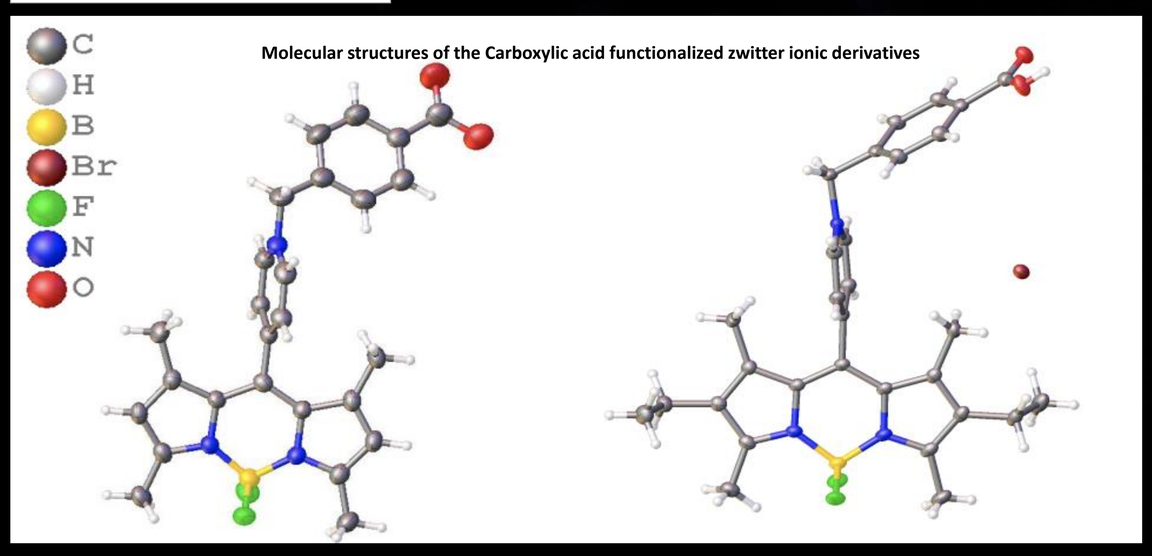


Figure 1. a) Synthesized *N*-heterocyclic BODIPY's b) Water soluble zwitter-ionic BODIPY's

Several known/new *N*-heterocyclic BODIPY-dyes have been synthesised via introduction of cationic charge (figure 1a) or via functionalization in such a way to introduce the water solubility via formation of zwitter-ion onto the BODIPYs (figure 1b) has been done, thus enhancing the efficacy of the fluorescent dye as a potential photosensitizer.

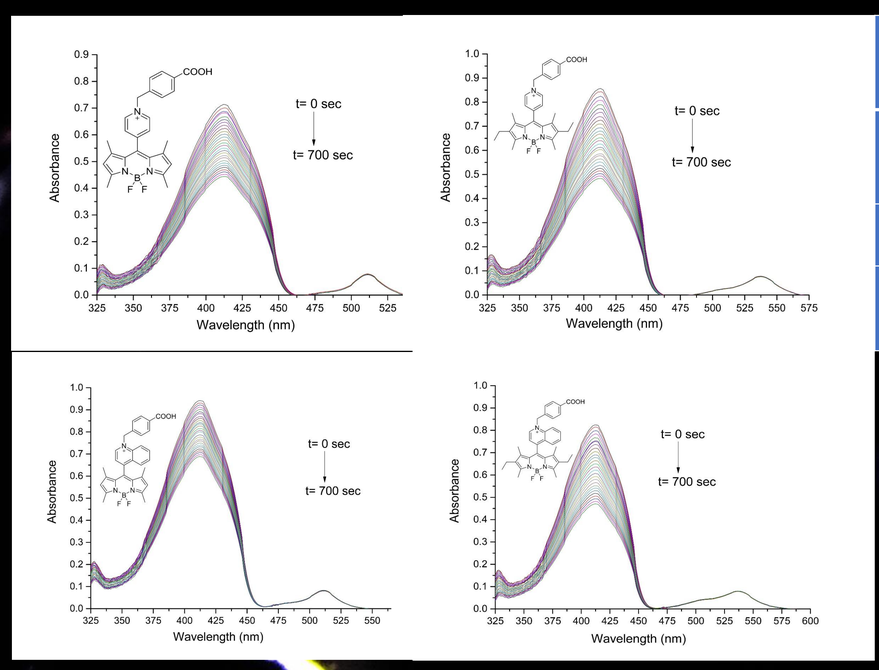
These derivatives of BODIPY dyes will be incorporated onto the polymeric hydrogel platforms to further enhance their efficacy as an aPDT formulation.

Results and discussions



Results and advances

Analytical details of the hydrogel platforms



Pyridine DM CA	0.0324
Pyridine EDM CA	0.0490
4-Quinoline DM CA	0.0303
4-Quinoline EDM CA	0.0462

Table1. $^1O_2$ generation quantum yield measured in methanol using methylene blue (MB, ΦΔ = 0.50) as a reference.

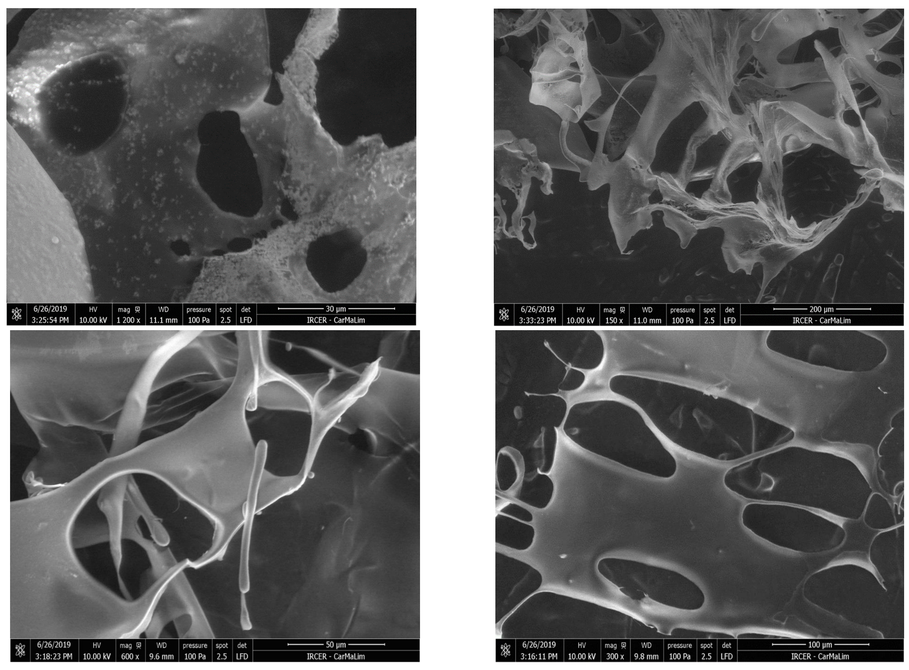


Figure1.(a,b)FE-SEM images of Pp18-PEI-HA hydrogels at different magnifications (c,d)FE-SEM images of cationic porphyrin-HA hydrogels at different magnifications

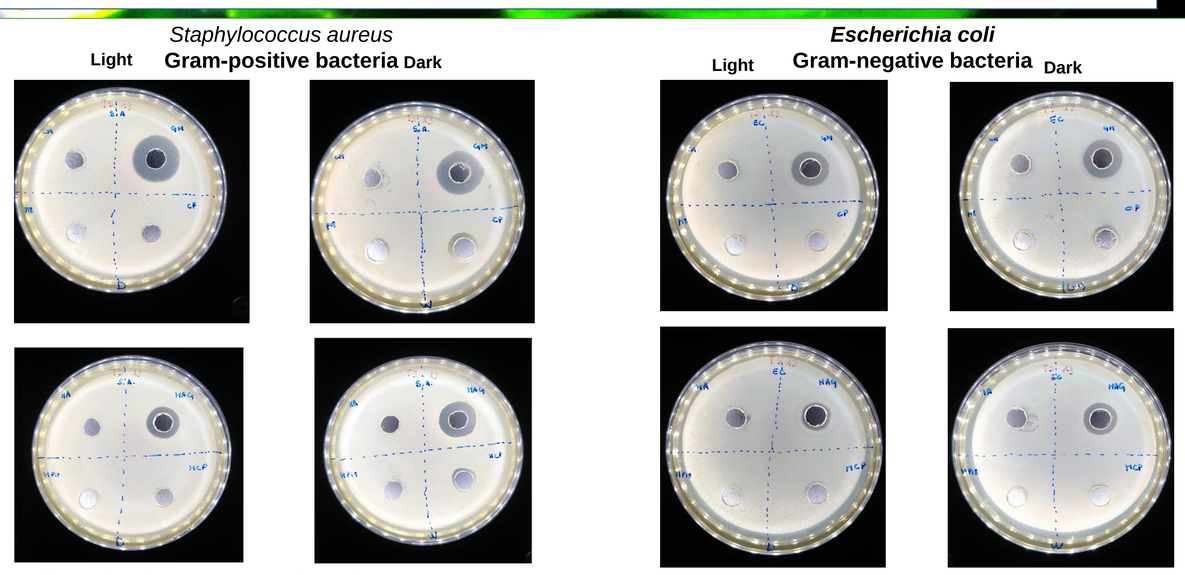


Figure 2. Anti-microbial evaluation of the porphyrin and chlorin with *Staphylococcus aureus* in dark and in light
a) porphyrin/chlorin alone in dark and light
b) porphyrin/chlorin hyaluronic acid in dark and light

Figure 3. Anti-microbial evaluation of the porphyrin and chlorin with *Escherichia coli* in dark and in light
a) porphyrin/chlorin alone in dark and light
b) porphyrin/chlorin hyaluronic acid in dark and light

Future work and outlook;

1. **Expanding library of cationic and zwitter-ionic BODIPY's.**
2. **Formulating the polymeric hydrogels with the BODIPYs and other photosensitizers.**
3. **Checking the aPDT potency of molecules and hydrogel formulations as synthesized.**

References;

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Acknowledgements;

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement n°764837