Perfect Combination for *Escherichia coli* Death: Silica Nanoparticles, Photosensitizer and Light

Larissa, S.Amaral[1,*,#], Elias, P.P.Neto[2], Ubirajara, P. Rodrigues Filho [2], Janice, R.Perussi[1,2]

[1]Universidade de São Paulo, Programa de Pós-Graduação Interunidades em Bioengenharia EESC/FMRP/IQSC, Av. Trabalhador São Carlense, 400 - Parque Arnold Schmidt, São Carlos - SP, 13566-590, Brazil.
[2]Universidade de São Paulo, Instituto de Química de São Carlos, Av. Trabalhador São Carlense, 400 - Parque Arnold Schmidt, São Carlos - SP, 13566-590, Brazil.

[#]Corresponding author: larissa.bioegenharia@usp.br

The nanoparticles have specific high surface areas that result in greater interactions between materials, increasing the strength and/or chemical/thermal resistance [1]. The silica nanoparticles (SiNp) are distinguished by high surface area, ease changing on the surface in order to increase the adsorption efficiency [2], penetrability of hydrophobic molecules in gram negative bacteria being nontoxic to mammalian cells and more photo-stable than most organic compounds [3]. This study aimed to analyse the influence of SiNp in the effectivity of the photoinactivation of *E.coli* by Photodynamic Therapy using Methylene Blue (MB) as photosensitizer excited by white light with the aid of factorial design. Initially it was performed a 2^3 factorial design in which Incubation Time (IT); Light Dose (LD) and Concentration of photosensitizer (C) were 8 and 16 min; 15 and 30 J cm^{-2}, and 20 and 45 µmol L^{-1} of MB. With the obtained results in the model, calculations and new experiments were performed in order to optimize the photoinactivation. Then a quadratic model with axial points was used followed by statistic treatment leading to the optimum point of 100% inactivation with the use of SiNp: 26 µmol L^{-1} of SiNp-MB incubated with *E. coli* by 22 min and irradiation with 40 J cm^{-2}. On the other hand using only MB without SiNp, the concentration was 32 µmol L^{-1}; IT of 28 min and LD of 31 J cm^{-2}. We can conclude that the use of SiNp allows the use of a smaller concentration of photosensitizer and a lower incubation time corresponding to a decrease in this parameters of 19 and 21.4% respectively, to reach a complete photoinactivation which can be explained by the high affinity of this SiNp for gram negative bacteria such as *E.coli*. Besides, the use of factorial design allowed total photoinactivation with fewer experiments and lower costs.

[1] Chatterjee, D. K; Fong, L.S et al, Nanoparticles in photodynamic therapy: An emerging paradigm**.** Advanced Drug Delivery reviews. **60**, (2008) 1627-1637.

[2] Niu, Y.; Rongjun, Q.; Lei, M. et al. Synthesis of Silica Supported Salicylaldehyde Modified PAMAM Dendrimers for the Effective Removal of Hg (II) from Aqueous Solution. Journal of Hazardous Materials. **278**, (2014) 267–278.

[3] Capeletti, L.D; Oliveira, L.F; Gonçalvez, K.A et al. Tailored silica-antibiotic nanoparticles: overcoming bacterial resistance with low cytotoxicity. Langmuir, American chemical society. **30**, (2014) 7456-7464.