Hyperthermia produced by magnetic nanoparticles as an alternative method to control a major foodborne pathogen

Diana Rodrigues[1], Manuel Bañobre[2], Marta Ferreira, and Joana Azeredo[1]

[1]Centre of Biological Engineering, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal
[2]International Nanotechnology Laboratory (INL), Av. Mestre José Veiga s/n, 4715-310 Braga, Portugal
dianaalexandra@deb.uminho.pt

Salmonella enterica is responsible for the majority of the reported foodborne outbreaks, and that is why it is considered one of the most important foodborne pathogens nowadays [1]. Like many others bacteria, *S. enterica* can survive disinfection and resist a wide variety of biocidal agents [2]. Nowadays, the synthesis of superparamagnetic nanoparticles (MNPs) and its application in magnetic hyperthermia (MH) is of great interest, with MH being recently reported as a viable alternative to traditional disinfection methods against bacteria [3]. However, fundamental studies comprising the MH effect on different populations of planktonic cells and biofilm cells are scarce. Therefore, this work aimed at evaluating the effect of MH on different populations of planktonic cells and biofilms of *S. enterica*.

The work was performed using a *S. enterica* collection strain (NCTC 13349), which different planktonic cell populations (lag, exponential, and stacionary phase) were adjusted to a final concentration of $\approx 1 \times 10^8$ cells/ml, while biofilms were formed in silicone coupons. Samples containing both magnetite nanoparticles and *S. enterica* cells or biofilms have been subjected to an alternating magnetic field of chosen amplitude 100 Oe with frequency of 873 kHz until different temperatures were reached. In order to evaluate the bactericidal effect of MH, survival of planktonic and biofilm cells was determined by colony forming unit (CFU) enumeration. Based on the most relevant results, cell membrane integrity and the effects of MH on cells surface and biofilm structure were analysed through microscopy techniques.

Results showed that the high structural-magnetic quality magnetite nanoparticles used were effective against all planktonic cell populations and biofilms under an oscillating magnetic field. In fact, MNPs-based hyperthermia was able to promote a significant cell viability reduction on all planktonic cell populations both bacterial lyfe styles. Nonetheless, planktonic cells were more tolerant to MH than biofilms, possibly due to diffusion limitations along these bacterial communities. Microscopy images of planktonic cells and biofilms showed that MH can affect cell membrane integrity as well as the biofilms' structure.

In conclusion, this work presents evidences of the bactericidal effect of MH produced by MNPs against *S. enterica*, both regarding planktonic populations and biofilms. This ability of MH to control a major foodborne pathogen constitutes a novel contribution to the finding of new useful applications of hyperthermia.

References

[1] EFSA. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-Borne Outbreaks in 2013 (2015). Authors, Journal, Issue (Year) page
[2] Joseph B, Otta SK, Karunasagar I et al., International Journal of Food Microbiology, 64 (2001) 367–372.
[3] Bañobre-López M, Rodrigues D, Espiña B, Azeredo J, Rivas J., IEEE Transactions of Magnetics, 49 (2013) 3508–3511.