Antibacterial activity of selenium nanoparticles studied by calorimetry, flow cytometry and electron microscopy

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Nanoparticles (NPs) are of growing interest for various applications due to their unique properties, such as elevated surface-to-volume-ratio and variability of composition surface features and charge. Moreover, certain metal NPs possess antimicrobial activity and are therefore considered as alternative to common antibiotics to overcome the recently emerging issue of bacterial resistance against common antibiotics [1].

Silver (Ag) NPs are well-studied concerning their antimicrobial activity and already applied in medicine and household products. However, cellular interaction mechanisms and consequent toxicity are not entirely elucidated. It is proposed, that NPs either interact with the cell membrane via intermolecular interactions, such as charge-charge interactions or intracellular accumulation. Once interacting with the cell extra- or intracellularly, NPs release reactive oxygen species and metal ions, which subsequently damage the cell membrane and affect enzymatic activity, ultimately leading to cell death. [1]

Besides Ag NPs, selenium (Se) NPs exhibit prominent antimicrobial activity, without being studied into more detail [2,3]. In our approach, gram-positive and gram-negative bacterial strains are chosen their putatively differing response to the metal NPs based on differing cell wall compositions. Calorimetric studies of differentially-coated Se NPs exhibited a decrease in growth rate of the bacterial model strains, indicating their antimicrobial activity. To further investigate the cytotoxicity, influence of reactive oxygen species and enzymatic activity, fluorescence-based flow cytometry is being performed. Furthermore, electron microscopy is exploited to localize the NPs and to elucidate putative metal ion release.

[1] Brandelli *et al.* (2017) *Springer Int Publ* **337-363**.
[2] Piacenza *et al.* (2017) *Microb Biotechnol* **10**, 804-818.
[3] Srivastava & Mukhopadhyay (2015) *Bioprocess Biosyst Eng* **38**, 1723-1730.