PALLADIUM NANOPARTICLES PRODUCTION BY *Geobacter sulfurreducens* AND THEIR POTENTIAL APPLICATION FOR WATER TREATMENT

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Introduction. Palladium importance is known as it is widely applied as catalyst; however their availability has become more and more limited (1). There is a trend to switch from the use of bulk materials towards nanoparticles (NPs) of palladium, since NPs are more active and thus less catalyst is needed. A promising alternative for chemical synthesis is to exploit the bioreductive deposition of metals by bacteria (2). This biotechnological approach can serve both as a sustainable production method of nanomaterials as well as an efficient recovery technique from industrial wastes. In addition, Pd-based catalysts can be applied for the transformation of a number of priority drinking water contaminants (3).
This works explores the mechanism of palladium NPs formation by *Geobacter sulfurreducens*. The aim of the study was to demonstrate that this strain is capable of biologically reducing Pd(II) to Pd(0) using acetate as electron donor. The impact of anthraquinone-2,6-disulfonate (AQDS) in the process was also studied.

Methods. *Geobacter sulfurreducens* strain PCA (DSM 12127; ATCC51573) was routinely cultured as previously described (4). Microbial reduction of Pd(II) was carried out for a concentration of 25 mg Pd(II)/L and a cell concentration of 800 mg/L DCW (dry cell weight) as previously described (5). To document microbial reduction of Pd(II) and NPs formation, samples were prepared and analyzed by inductively coupled plasma-optic emission spectroscopy (ICP-OES Varian 730-ES), transmission electron microscopy (TEM), high resolution Transmission Electron Microscopy (HRTEM) and X-ray diffraction analysis (XRD).

Results. The results obtained demonstrated that *Geobacter sulfurreducens* can reduce Pd(II) to Pd(0) using acetate as electron donor with concomitant formation of Pd NPs ranging from 5 to15 nm (Fig.1). It was also demonstrated that AQDS promoted a faster reduction process (Table 1).

Table 1. Reduction of Pd(II) by *G. sulfurreducens* after 24 h of incubation with acetate as electron donor (5 mM) and 25 mg Pd(II)/L . Treatments including AQDS were supplied with 100 µM AQDS

Experiment	%Pd associated with biomass	Pd remaining in solution	Specific reduction rate
Acetate	83.01±2.34	3.52±0.77	17.06
Acetate+AQDS	97.62±0.95	0.39±0.23	23.05

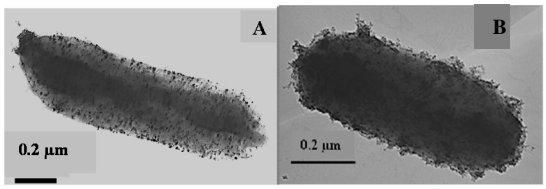

Fig. 1. Pd(0) NPs deposited on *G. sulfurreducens* cells after incubations provided with acetate as electron donor viewed by TEM in the absence (A) and in the presence of AQDS (B).

Conclusions. *Geobacter sulfurreducens* can couple the oxidation of acetate to the reduction of Pd(II) resulting in the formation of Pd NPs. Addition of AQDS increased the microbial production of Pd(0) NPs and promoted the extracellular deposition. The nano-catalyst obtained could be potentially applied for the removal of priority contaminants susceptible of be transformed by palladium catalyzed reactions.

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