Enhancing electricity production from wastewater using microbial fuel cells

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Microbial fuel cells represent a promising technology for simultaneous wastewater treatment and renewable electricity production. However, the electricity recovery is still poor, typically <10% of what is theoretically possible and the extracellular electron transfer mechanisms are poorly understood.

The use of co-cultures to improve substrate (glucose) turnover rate and hence electricity recovered was investigated initially. A co-culture of *Shewanella oneidensis* and *Clostridium beijerinckii* gave a maximum power density (P_{max}) of 87 mWm^{-2} (67% COD reduction) compared to 60 mWm^{-2} for *C.beijerinckii* alone and 48 mWm^{-2} for *S.oneidensis* alone. Co-culturing *Geobacter sulphurreducens, C. beijerinckii and Saccharomyces cerevisiae* gave the highest P_{max} value of 80 mWm^{-2} (41% COD reduction) compared to other strain combinations.

Another study investigated the contribution of direct electron transfer mechanism on electricity production by physically retaining *Shewanella oneidensis* cells close to or away from the anode electrode using a dialysis membrane (as well as immobilisation of the cells in alginate). Pyruvate was used as the substrate. The outcome of this study indicated a P_{max} value of 114±6 mWm^{-2} when cells were retained close to the anode, 3.5 times more than when the cells were separated from the anode. Without the membrane P_{max} was 129±6 mWm^{-2} (57% COD reduction).

To understand the role played by c-type cytochromes MtrA, MtrB and MtrC in extracellular electron transfer in *S.oneidensis*, the genes *mtrA, mtrB*, *mtrC* and their combinations were heterologously expressed in non-electrogenic bacteria (*Escherichia coli;* glucose as substrate*)*. The *mtrCAB* transformant gave the highest P_{max} of 24 mWm^{-2} compared to 1 mWm^{-2} for the wild type although cell growth was slower.

The results demonstrate the importance of co-cultures and of the MtrCAB pathway (direct electron transfer mechanism) in improving bacterial electricity production.