**Microbial cathodes formed from salt marsh sediment may boost the development of microbial fuel cells**

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**Highlights**

* Halotolerant O2-reducing biocathodes were designed using salt marsh sediments
* Maximal current density reached 2.9 A m-2 under air saturation at 0.22 V/SCE
* An unusual Gammaproteobacteria was among the dominant bacteria of the biocathodes
* In MFCs the biocathodes led to the highest power density obtained using biotic cathodes

**1. Introduction**

Microbial fuel cells (MFCs) associate a bioanode, where the catalyst is a microbial biofilm, with a biotic or abiotic cathode. As MFCs consume organic matter as the fuel at the anode, they can produce electrical current by simultaneously abating the organic matter contained in an effluent. MFCs may consequently be promising systems for effluent treatment [1]. Unfortunately, the ionic conductivity of common effluents is far too low to hope an electrochemical process fairly performs. MFC development must therefore be considered in the context of highly saline and hypersaline effluents [2].

Salt marsh sediments have previously demonstrated to be efficient inocula for the design of halotolerant bioanodes working under polarization at +0.1 V/SCE, and saline conditions up to 60 g.L-1 NaCl [3,4]. Nevertheless, no efficient cathode exists yet for ensuring O2 reduction at the neutral pH values, which are required by the bioanodes. No metallic catalyst is known to be efficient for O2 reduction around neutral pH.

Here, a solution to this issue is proposed by designing O2-reducing biocathodes from salt marsh sediments. The biocathodes were firstly designed and characterized independently, in electroanalytical conditions. Then, coupled with a bioanode, they led to the highest power density produced so far in highly saline media, using microbial catalysts on both electrodes.

**2. Methods**

All O2-reducing biocathodes were designed under polarization at +0.1 V/SCE (chronoamperometry) on graphite felt electrodes. Their electrochemical behaviour was characterized by mean of chronoamperometry and cyclic voltammetry (1 mV s-1). The current produced during operation of MFCs was recorded flowing through a 1200 Ohm resistance. Polarization curves were recorded every 72 hours. Biofilms on electrodes were imaged using epifluorescence microscopy. After extraction, bacterial DNA was sent for 16S-pyrosequencing to RT-Lab Genomics, Lubbock, Texas.

**3. Results and discussion**

The 8 biocathodes displayed similar electrochemical behaviour. O2 reduction current started after 3 days of polarization and maximal current density reached 2.0 A m-2, with peaks up 2.9 A m-2 during voltammetry recording (1 mV.s-1). Current density fluctuated during the 30 days of polarization but was never lower than 0.4 A m-2. Voltammetric recordings evidenced oxygen reduction starting around +0.4 V/SCE. These values are of the same order than the best recorded in the literature for O2-reducing biocathodes in usual media [5,6].

**Figure 1.** Representative current production recorded with a O2-reducing biocathode. A: polarization at +0.1 V/SCE; B: Cyclic voltammetry recorded on day 17.5.

Biofilm imaging showed fair colonisation of the felt electrodes. Population analyses of the 8 biocathodes revealed similar microbial populations; their profile were significantly different from previous anodes, notably lacking Deltaproteobacteria. Orders counting potentially autotrophic genera (Rhizobiales and Rhodobacterales) were highly represented, together with an unusual Gammaproteobacteria, phylogenetically closed to *Thioalobacter thiocyanaticus,* a known chemoautotrophic strain. They may play a key role in inorganic carbon fixation and so the sustenance of the whole biofilm [7].

The biocathodes coupled to bioanodes prepared as previously described led to microbial fuel cells that operated for more than 13 days and produced up to 272 mW m-2.

**4. Conclusions**

The efficient halotolerant O2-reducing biocathodes designed here, in a reproducible way, should be a key element boosting the actual development of MFCs for the treatment of highly saline and hypersaline effluents.

**References**

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