Effects of Biofilm Transfer and Electron Mediators Transfer on *Klebsiella quasipneumoniae* sp.203 Electricity Generation Performance in MFCs

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Abstract

Background: Extracellular electron transfer (EET) is essential in improving the power generation performance of electrochemically active bacteria (EAB) in MFCs. Klebsiella has been proved to be an EAB capable of EET. Here, we cover the anode of MFC-1 with a layer of microfiltration membrane to block the effect of the biofilm mechanism, and then explore the EET of the electron mediator mechanism of Klebsiella quasipneumoniae sp.203 and electricity production performance of a K.quasipneumoniae sp.203-inoculated MFCs.

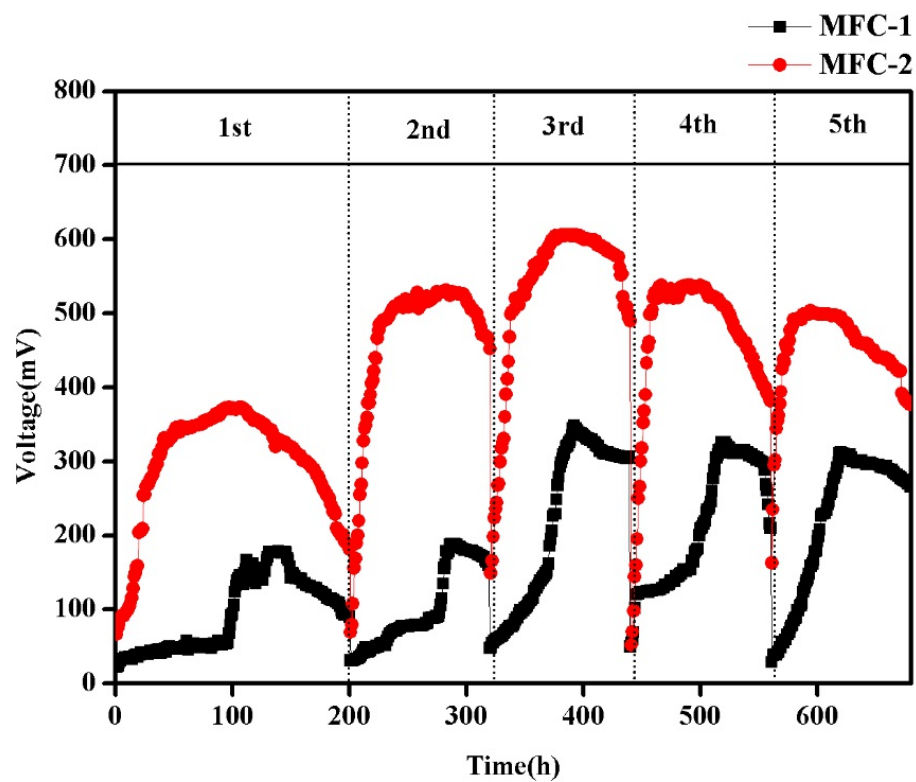
Results: Herein, we covered the anode of microbial fuel cells (MFCs) with a layer of microfiltration membrane to block the effect of the biofilm mechanism, and then explore the EET of the electron mediator mechanism of K.quasipneumoniae sp.203 and electricity production performance. In the absence of short-range electron transfer, we found that K.quasipneumoniae sp.203 can still produce certain power generation efficiency and redox activity. It was proved that in the case that EAB cannot attach to the growth anode, K.quasipneumoniae sp.203 can still perform EET through the electron mediator mechanism. To further verify the effect of electron mediators on electrochemical performance of MFCs, in the first cycle of well-functioning MFCs, the self-produced sterile supernatant was added to the different stages of electricity generation performance. We found that adding electron mediators during the rising phase, the MFCs can reach a maximum output voltage of 442mV in about 24 hours, which is about 70mV higher than MFC-Normal. Therefore, the addition of electron mediators can effectively improve the electrical performance in the stable growth stage of anode EAB in MFCs. Finally, we combined the CV analysis and HPLC-MS to analyze the anode supernatant of MFCs. It was speculated that K.quasipneumoniae sp.203 produced more than one electron mediator, which were 2,6-DTBHQ, 2,6-DTBBQ, ACNQ and DHNA.

Conclusions: To the best of our knowledge, the three modes of EET did not exist separately. K.quasipneumoniae sp.203 will adopt the corresponding electron transfer mode or multiple ways to realize EET according to the living environment to improve electricity generation performance.

Full Text

However, the manuscript can be downloaded and accessed as a PDF.

Figures

A

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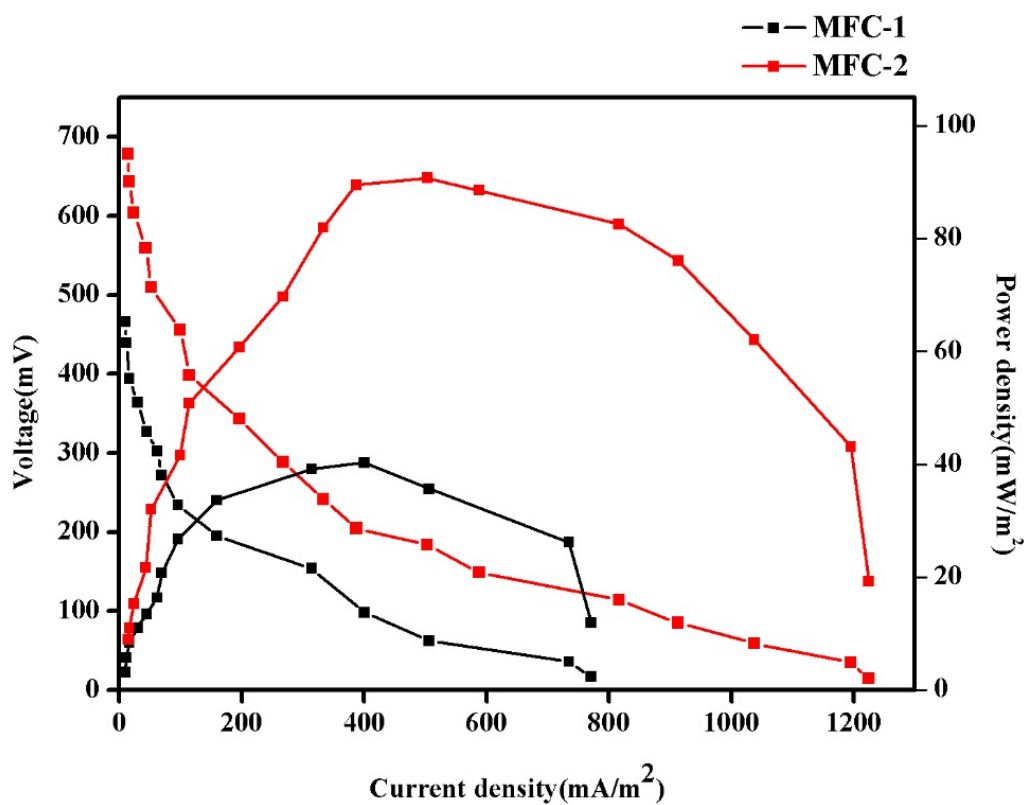
Figure 1

(a) MFC-1 and MFC-2 were incubated for 680 hours of output voltage, and the anode

medium was replaced when the output voltage droped. (b) Polarization curve (hollow

pattern) and power density curve (solid pattern) when the output voltage of the reaches its

maximum value.
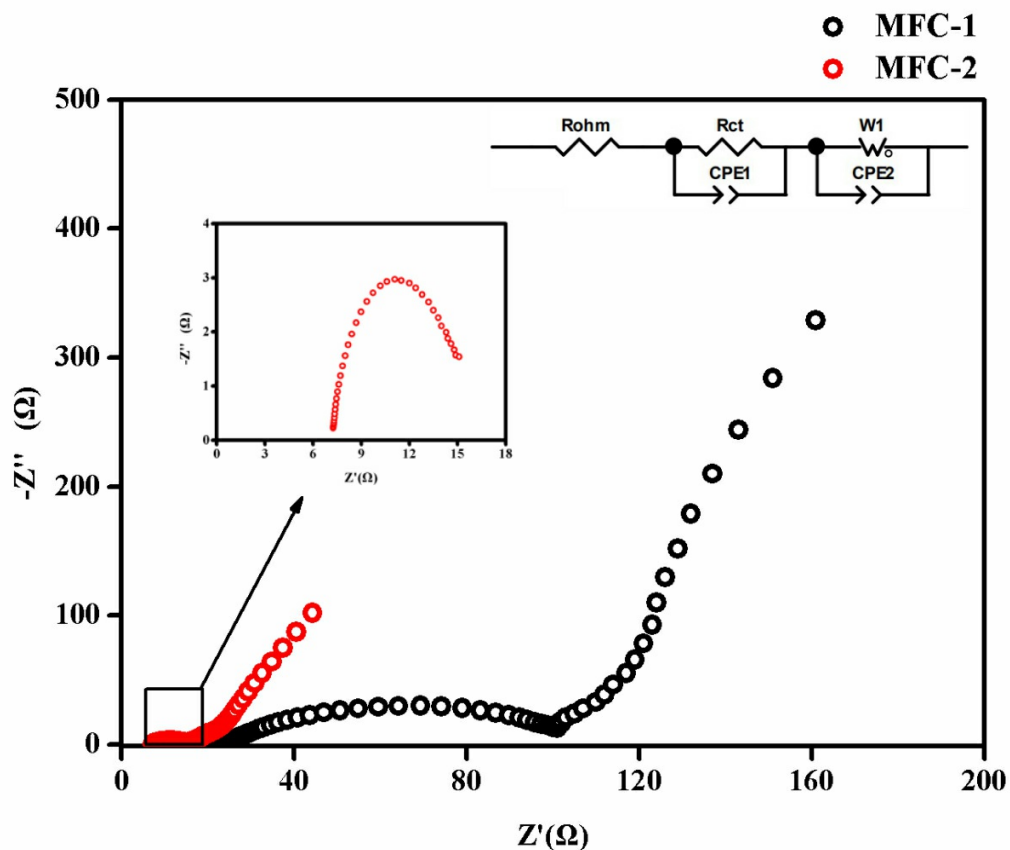
Figure 2

Nyquist plots from electrochemical impedance spectroscopy measurements of MFC-1 （black

empty circle）and MFC-2（red empty circle）scanned at 0.1~100kHz at open-circuit

potential，the inset on the right is the charge transfer resistance in the high frequency

region of MFC-2）.
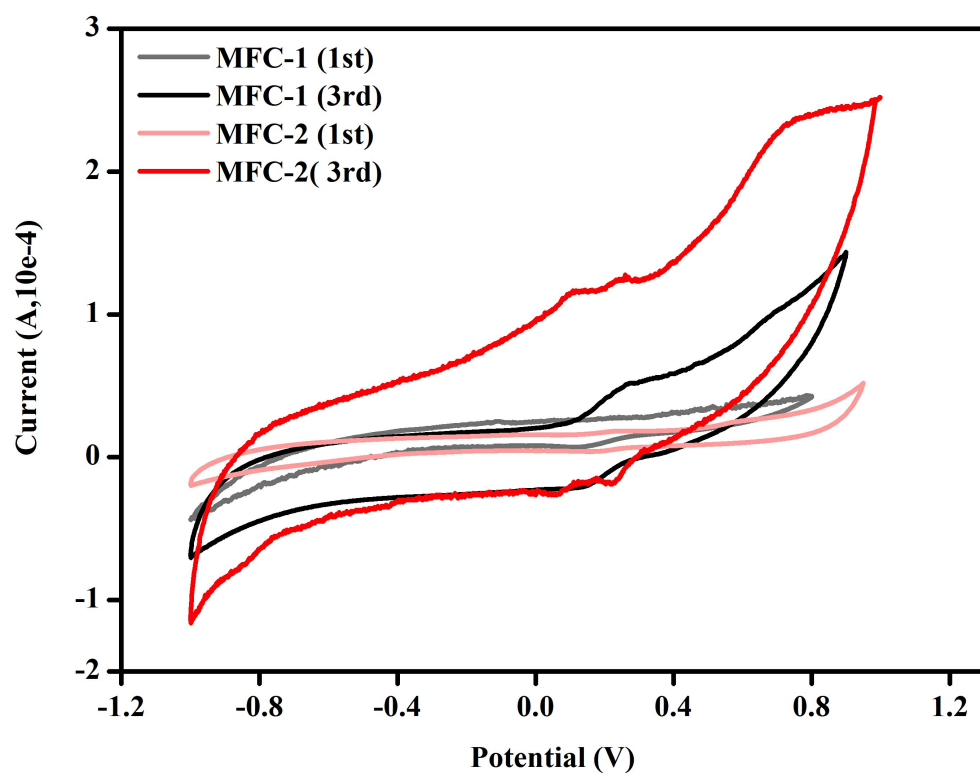
Figure 3

Cyclic voltammograms for MFC-1 and MFC-2
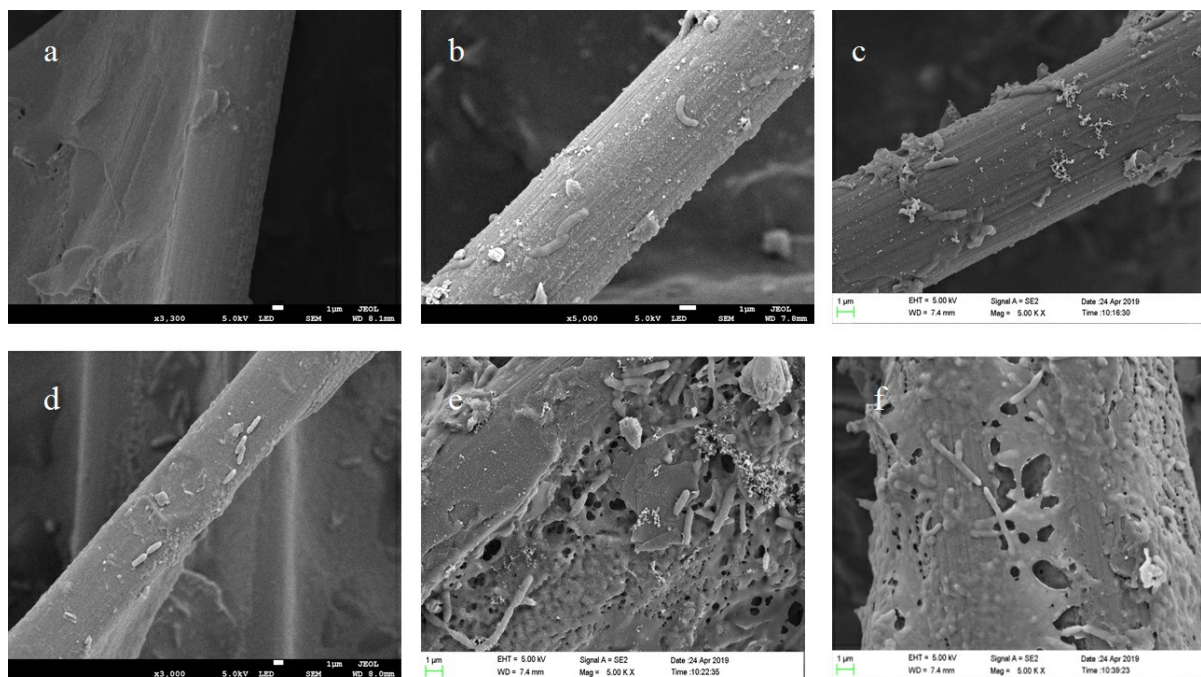
Figure 4

SEM images on anode carbon paper at different cycles of MFC-1 and MFC-2, （a）MFC-1: 1st cycle, （b） MFC-1: 3rd cycle, （c）MFC-1: 5th cycle （d）MFC-2: 1st cycle, （e） MFC-2: 3rd cycle, （f）MFC-2: 5th cycle.
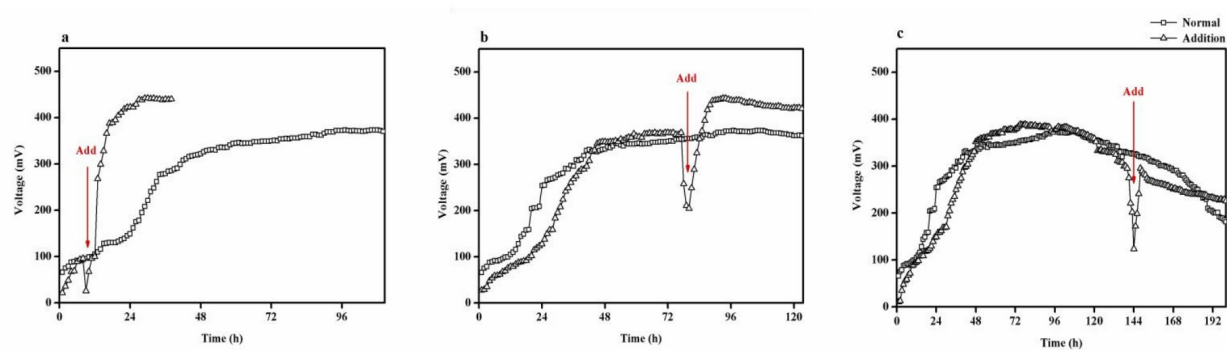
Figure 5

Effect of electron mediator secreted by Klebsiella quasipneumoniae sp.203 on electricity generation performance of MFCs.（a）the rising phase）, b）the gradual phase,（c）the falling phase
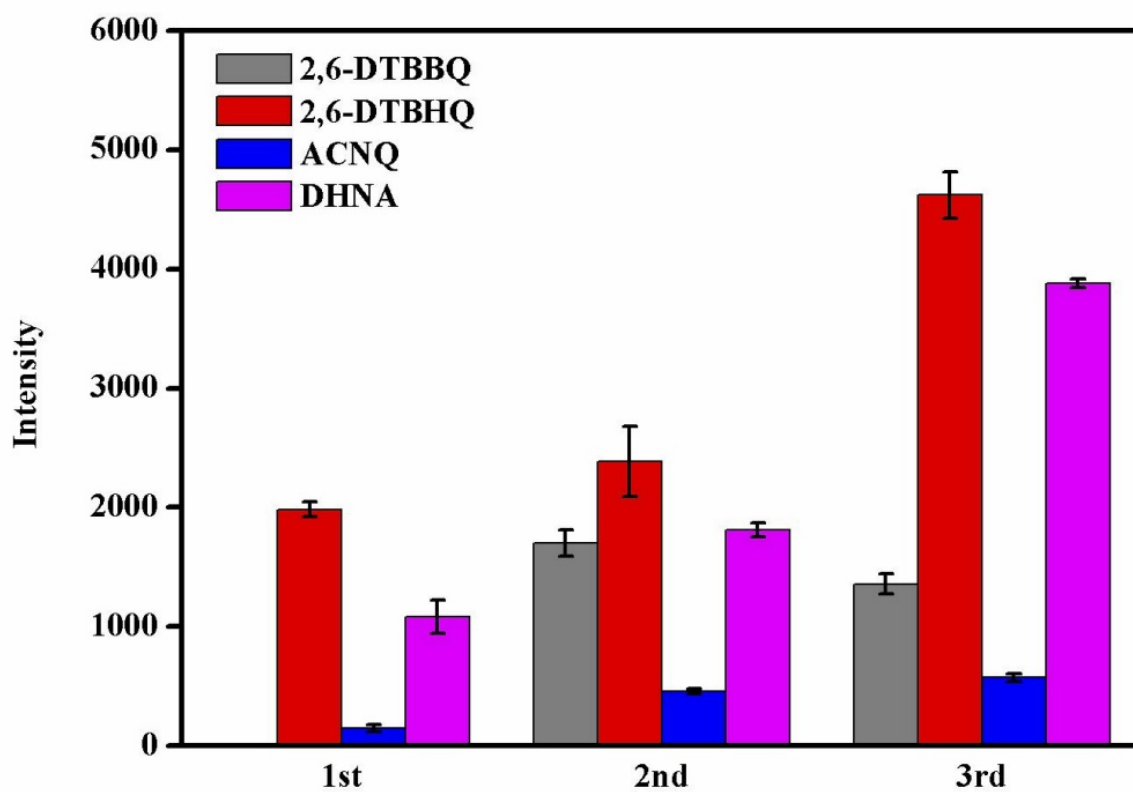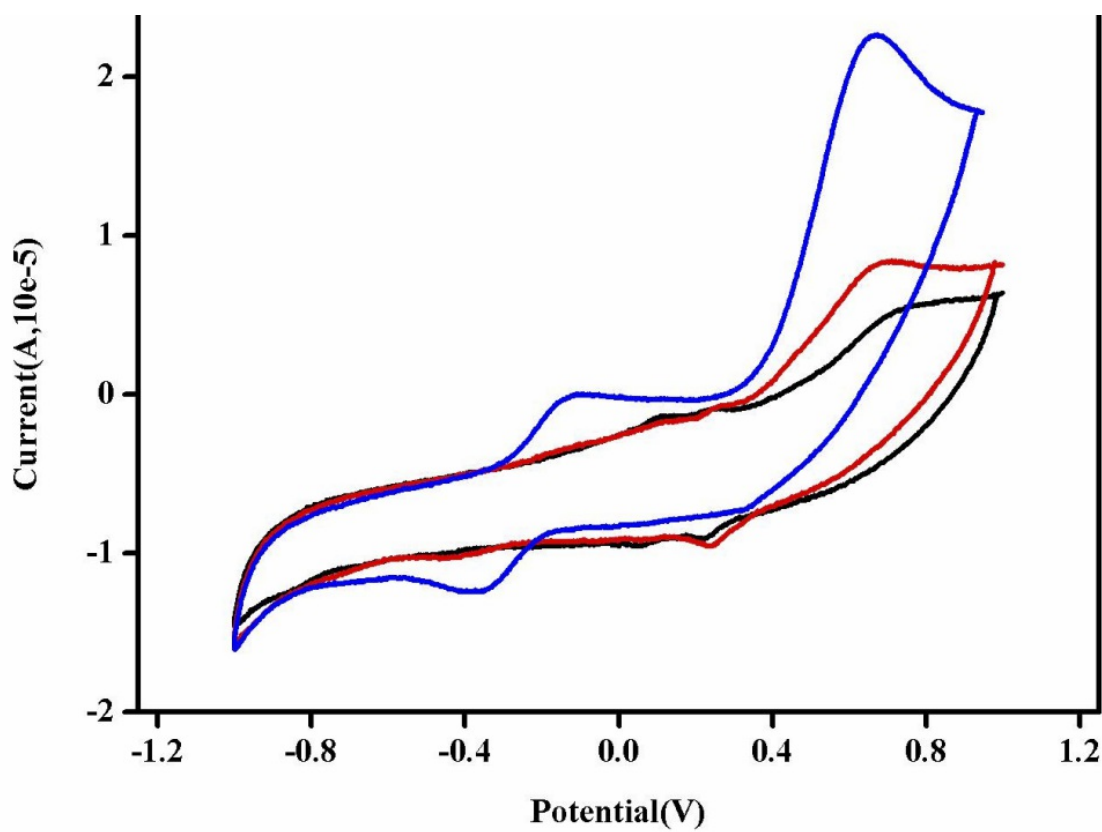
Figure 6

(a) The CV of the supernatant of the anode on the 1-3 cycle (b) Quinones electron mediators

secreted by Klebsiella quasipneumoniae sp.203
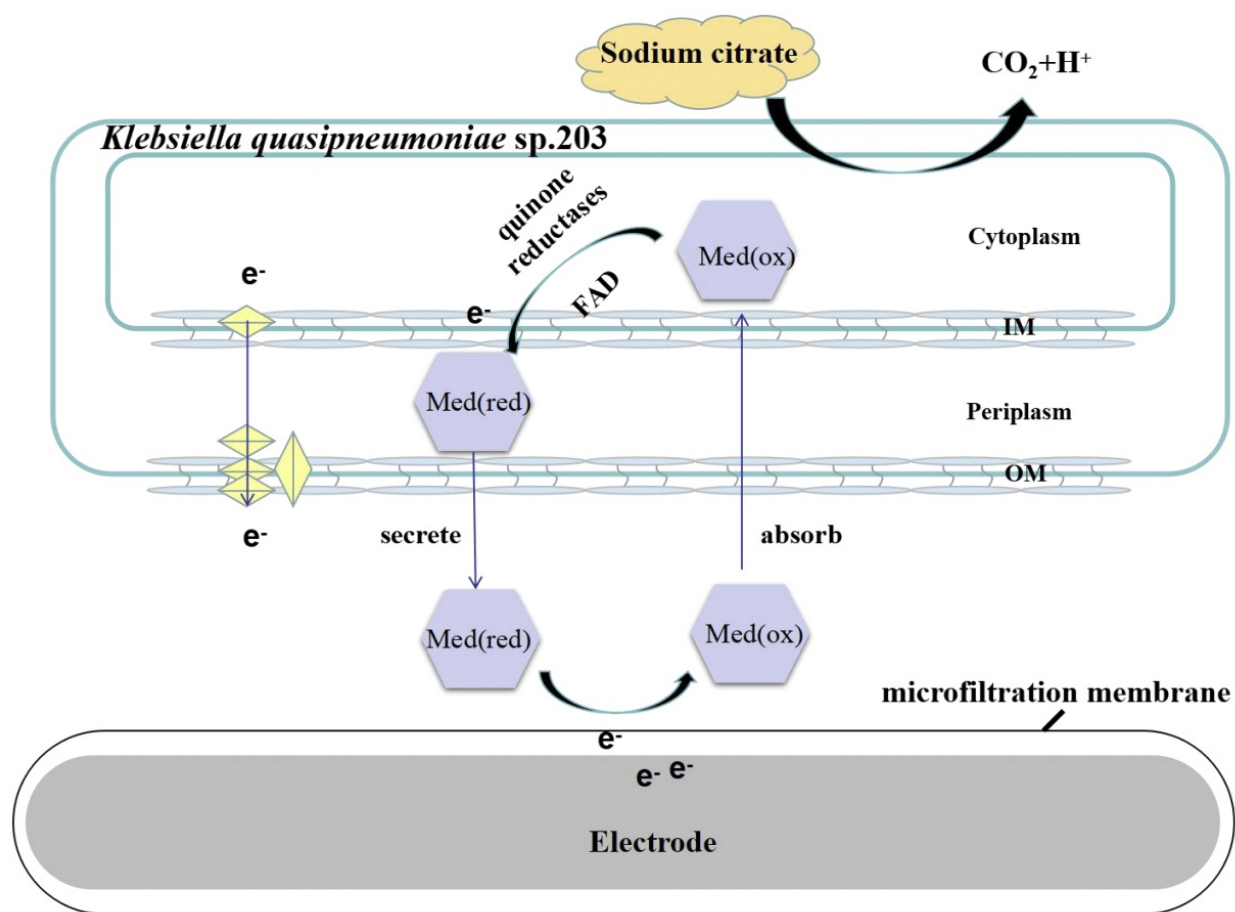
Figure 7

The transfer mechanism of the electron mediators in a K.quasipneumoniae sp.203-

inoculated MFCs.