MODELLING MICROBIAL COMPETITION IN PLANT MICROBIAL FUEL CELLS

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Aims and Background

The plant microbial fuel cell (Plant-MFC) can generate electricity in a clean, renewable, sustainable and efficient manner (Strik, 2008). The plant provides electron donors as rhizodeposits to a microbial community including electrochemically active bacteria (EAB) which use the anode electrode as final electron acceptor (Rothballer, 2011). The anode electrode functions as an alternative electron acceptor in the rhizosphere. EAB compete with the microbial community that use naturally available electron acceptors in the rhizosphere (e.g. oxygen, nitrate, sulfate, carbon dioxide) for electron donors (rhizodeposits and electrode). Objective was to model microbial competition in Plant-MFCs and show at which conditions EAB outcompete other microorganisms and show what the impact is on the carbon cycle including methane mitigation.

Methods

The Plant-MFC model (Hamelers, 2011) was extended and combined with the estimated yield of various competing microorganisms using the Gibbs energy dissipation method (Kleerebezem, 2010).

Results

At realistic anode overpotentials of up to 0.4 V, EAB are outcompeted by aerobic bacteria and denitrifying bacteria. Methanogenic micro-organisms and sulfate reducing bacteria, however, can be outcompeted by EAB at anode overpotentials of 0.02 V and 0.03 V, respectively. The model shows the effect on the C-cycle.

Conclusion

The EAB can dominate in the Plant-MFC in case oxygen and nitrate availability is reduced and an overpotential of at least 0.03 V is maintained.

References

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