ABSTRACT

Microbial fuel cell (MFC) is a device that uses bacteria as a catalyst to oxidize organic matter present in wastewater to generate electricity and offer treatment to the wastewater. In the present research various strategies to improve the coulombic efficiency (CE) and power generation of MFC was studied by proper inoculum pre-treatment, anode modification and employing cathode catalyst. Inoculum pre-treatment was done to reduce the substrate loss to methanogens by using lauric acid, *Chaetoceros* sp. dry biomass and nitroethane. In the presence of lauric acid pretreated inoculum, MFC produced maximum volumetric power density of 4.8 W/m^3 and the CE increased from 3.6% (for untreated inoculum) to 11.6%. MFC inoculated with *Chaetoceros* sp. pre-treated mixed anaerobic sludge demonstrated maximum CE of 45.18%, with volumetric power density of 21.43 W/m^3 and current density of 93 A/m^3. A sustainable enhancement in CE was achieved with intermittent dosing of the marine algae in anodic chamber. The optimum concentration of marine algae to be added in an anaerobic sludge for suppressing methanogens to improve power production of MFC was evaluated. The performance of MFC increased with increasing concentration of *Chaetoceros* sp. upto 10 mg/ml concentration and noted a gradual decreasing trend with further increase in concentration. *Chaetoceros* sp. can be effectively used both as an electron donor and methanogen inhibitor in MFCs due to its high organic matter content and methanogen inhibition properties. A maximum power density of 15.13 W/m^3 and CE of 47.25% could be obtained in MFC fed with 2000 mg/l *Chaetoceros* sp. as substrate. MFC inoculated with nitroethane pre-treated anodic inoculum demonstrated a maximum operating voltage of 541 mV, with coulombic efficiency and sustainable volumetric power density of 39.85% and 14.63 W/m^3, respectively.

Electricity generation from microbial fuel cell (MFC) can be enhanced by proper manifestation of electrogenic bacterial growth on the anode surface. Effect of graphene oxide (GO)/Polytetrafluoroethylene (PTFE) composite bio-anode and polyaniline modified anode on electricity generation in MFC was investigated. MFC using GO/PTFE composite bio-anode demonstrated a maximum power density of 20.52 W/m^3; whereas, the MFC using carbon felt anode without GO/PTFE modification produced a maximum power density of 10.25 W/m^3. The polyaniline (PANI) modified MFC could generate a maximum power density of 228 mW/m^2 (21.35 W/m^3), which was 1.37 times higher than MFC having bare carbon felt anode. Palladium (Pd-C) nanoparticle was used as a cathode catalyst in air-cathode microbial fuel cell (MFC) and its performance was compared with MFC using MnO_2nano particle as cathode catalyst and MFC without any cathode catalyst. A maximum volumetric power density of 6.07 W/m^3 was obtained in MFC using Pd-C as cathode catalyst. Hence, while treating wastewater and using mixed anaerobic sludge as inoculum pre-treatment with *Chaetoceros* sp. is recommended. GO/PTFE or PANI can be used for anode modification and Pd nanoparticles shall be used on cathode for improving power produced by MFC while offering simultaneous treatment to wastewater.

Keywords: *Chaetoceros* sp., Coulombic efficiency, Graphene oxide, Lauric acid, Microbial fuel cell, Nitroethane, Palladium, Polyaniline.