Preface

Organic waste generation, particularly food waste, is a significant global issue with substantial environmental consequences. According to the Food and Agriculture Organization (FAO) of the United Nations, approximately one-third of the food produced for human consumption worldwide is lost or wasted each year, amounting to about 1.3 billion metric tons of food waste annually. The improper management of organic waste leads to greenhouse gas emissions, water and soil pollution, and air pollution. Leachate, a liquid byproduct of organic waste decomposition, can contain pollutants that seep into the soil and contaminate water sources, leading to water pollution. Moreover, the decomposition of organic waste can generate odorous gases, contributing to air pollution and creating unpleasant living conditions for nearby communities. Microbial Fuel Cells (MFCs) have shown promise as a technology for organic wastewater treatment. One of the primary advantages of MFC is the production of electricity during the wastewater treatment process. As microorganisms break down organic substrate, and release electrons as part of their metabolic processes. The first objective explores the potential of pretreated sweet lime peel slurry as an anolyte with yeast and bacteria anode biocatalyst for bioenergy generation in MFCs. Sterilised cow urine was used as catholyte and Chlorella pyrenoidosa strain as cathode biocatalyst. Three H-shaped dual-chamber MFCs were fabricated using two plastic containers operating with no inoculum, Saccharomyces cerevisiae as only inoculum and co-culture of Saccharomyces cerevisiae with isolated cellulolytic bacteria, respectively, in the anode chamber. The anode was prepared using a rectangular stainless-steel mesh; the cathode was a cylindrical graphite rod. The maximum open-circuit voltages achieved by co-culture of bacteria and S. cerevisiae were 792.33 ± 1.53 mV and 481.33 ± 3.51 mV, respectively. The maximum power densities in these two MFCs were found to be 22.20 ± 1.28 mW/m2 (210.66 ± 6.11 mA/m2) and 204.80 ± 1.28 mW/m2 (640.0±2.0 mA/m2) correspondingly. Results noticeably disclosed that microorganisms consumed the

carbon source available in sweet lime peel. Thus, the sweet lime peel can be an inexpensive alternative for operating MFCs. In the second objective, newspaper powder, dried dead microalgae biomass and mixed fruit peel powder were separately targeted as substrate for the growth of an isolated cellulolytic bacteria inside the anode chamber of three different MFCs. At cathode, bold basal medium with spent engine oil was used as catholyte. An isolated and acclimatized microalgae was used as cathode biocatalyst in order to perform bioremediation of spent engine oil wastewater at cathode chamber. The MFC with newspaper powder showed highest maximum power density of 34.88 ± 1.00 mW/m^2. Both fruit peel powder and dried microalgae powder-based MFCs achieved almost parallel maximum power densities of 15.57 ± 0.49 mW/m^2 (at 161.1 ± 2.54 mA/m^2) and 16.00 ± 0.32 (at 163.3±1.66 mA/m^2), respectively. The anode chambers of all MFCs reflected chemical oxygen demand (COD) removal efficiencies in range of 65 - 86 %. At anode chamber, maximum COD removal of 86.25% was achieved by microalgae powder based MFC. The removal percentage of oil and grease were 37.7%, 42.3% and 29.1% for fruit peel, newspaper powder and microalgae powder based MFCs respectively. Up to 76-80% nitrate-nitrogen, 96-97% ammonium-nitrogen, 90-94% phosphate-phosphorous removal was observed in all the MFCs. Microbial community analysis revealed that Proteobacteria, Firmicutes and Bacteroidetes were the dominant phyla present in all the three anodic biofilms. The third objective evaluates the performance of *S. cerevisiae*-based H-shaped microbial fuel cell with banana peel waste as substrate, operated for 30 days in three cycles. Dried banana peel and banana slurry substrates were prepared with initial COD of 1126±41 mg. L^{-1} and 1366± 64 mg. L^{-1} respectively. Dried banana peel powder was fed into two MFCs, one with no inoculant and the other with *S. cerevisiae*. Dried banana peel powder without inoculant yielded negligible power output, whereas dried banana peel powder with *S. cerevisiae* generated a maximum power density of 2.2±0.1 mW.m^{-2}. The banana peel slurry was fed into two different MFCs one was with *S. cerevisiae* and another was without *S.*

cerevisiae. Banana slurry with *S. cerevisiae* generated a maximum power output of 86.9±0.4 mW. m^{-2}. Banana peel slurry without inoculation, generated a maximum power output of 44.6±0.8 mW. m^{-2}. Microbial community analysis indicated that the high-power output obtained from banana slurry-based MFCs was due to the presence of indigenous microbial consortia. Up to 70-88% COD removal was recorded in MFCs with banana slurry, however, 18-44% of COD removal was observed in MFCs with dried banana peel powder. It was also observed that the simple saccharides available in banana peel waste were consumed by *S. cerevisiae* and other indigenous microbes in the anode chamber. The microbial community released electrons in the anode chamber, which were responsible for voltage generation in MFC. In the fourth objective, MFC was operated using banana peel slurry as substrate with baker's yeast as external inoculum. Decision tree algorithms were applied for optimizing the input parameters of MFC. Input variables including temperature, pH, resistance, pretreatment of slurry and slurry concentration were optimized for achieving the maximum power density in MFC. Total five combination were obtained by the decision tree model that led to high power density. All five combinations were also tested for validation. Experimental validation of decision tree models showed accuracy in range of 77 to 99%. In order to obtain high power density, the best combination was determined by accuracy level and experimental validation. The best set of rules for high power density was 41.47 mL/L < slurry concentration < 87.5 mL/L, 22.44 °C ≤ temperature < 36.25 °C, 5.23 ≤ pH < 7.25, slurry was pretreated and resistance < 285 Ω. It was also observed that temperature, resistance and pretreatment were the most influential input parameters to achieve high power density. Results obtained in this work can be directly implemented at pilot and industrial scale without further experimental trails.