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Exploring optimal supplement strategy of polyphenolics-abundant herbal extracts for bioenergy stimulation in microbial fuel cells

This serial study revealed the optimal strategy to supplement extracts of polyphenolics abundant medicinal herbs and *Camellia* tea as electron shuttles (ESs) for stimulating bioenergy generation in microbial fuel cells (MFCs). Apparently, *Camellia sinensis* (L.) Kuntze and *Syzygium aromaticum* were promising electroactive ESs. Moderate temperature (ca. 65°C) and slightly alkaline pHs (~10) were electrochemically feasible conditions for herbal extraction. Optimal contents of polyphenolics rich herbs and tea extracts with maximal electrochemical activities could be stably obtained. Power density of MFC supplemented with *Camellia* green tea extract could significantly increase ca. 176%, suggesting that unfermented green tea extract would be the most appropriate ESs. As correlation analysis indicated that total phenolic contents and electron shuttling capabilities were all electrochemically associated. In addition, chemical structure is strongly affected whether antioxidant activities of polyphenolics abundant herbal extracts could be reversibly switched to be electron shuttling capabilities (e.g., substitution patterns). Dihydroxyl substiutuents of ortho or para to each other were very likely promising for electron-shuttling, but not for meta substituents. Moreover, bioelectrochemical treatment upon medicinal herbal extracts (e.g., cyclic electron donating and withdrawing processes) might provide an electroactive alternative to attenuate herbal biotoxicity to fully express bioenergy-shuttling activities in applications (e.g., bioenergy extraction and herbal medication).

Recent Publications

1. Chen B, Ma C, Han K, Yueh P and Hsueh C (2016) Influence of textile dye and decolorized metabolites on microbial fuel cell-assisted bioremediation. Bioresource Technology 200:1033-1038.
2. Chen B, Hsu A, Liao C, Wu C and Hsueh C (2017) Feasibility study on biostimulation of dye decolorization and bioelectricity generation by using decolorized metabolites of edible flora-extracts. Journal Taiwan Institute of Chemical Engineers 79:141-150.
3. Chen B, Ma C, Liao J, Hsu A, Tsai P, Wu C and Hsueh C (2017) Feasibility study on biostimulation of electron transfer characteristics by edible herbs-extracts. Journal of the Taiwan Institute of Chemical Engineers 79:125-133.
4. Chen B, Liao J, Hsu A, Tsai P and Hsueh C (2018) Exploring optimal supplement strategy of medicinal herbs and tea extracts for bioelectricity generation in microbial fuel cells. Bioresource Technology 256:95-101.
5. Chen B, Liao J, Hsueh C, Qu Z and Zhang S (2018) Deciphering biostimulation strategy of using medicinal herbs and tea extracts for bioelectricity generation in microbial fuel cells. Energy 161:1042-1054.

Biography

Bor-Yann Chen has expertise in biomass energy and bioremediation for biotechnology. His serial studies focused on applications in wastewater decolorization, bioremediation engineering, environmental toxicology and biofuel cells. He has completed PhD from University of California, Irvine in 1995 and used to be NRC awarded Research Associate to work in NRMRL/US EPA, Cincinnati Ohio. He is a distinguished Professor in Department of Chemical and Materials Engineering, National I-Lan University, Taiwan. He has published 150+ SCI-peer reviewed articles in reputed journals and has many national awards (e.g., Professor Yen-Ping Shih Best Paper Awards of 2007, 2011, 2013 and 2016 from Taiwan Institute of Chemical Engineers). Recently his findings also deciphered chemical structures of electron shuttles and recalcitrant dyes which are crucial to simultaneous pollutant biodegradation and biomaterial/bioenergy recycling for sustainable green technology. Considering environmental friendliness, this study explored natural bioresources (e.g., medicinal herbs and edible flora) for bioenergy and high-value production generation. He provided different alternatives to re-evaluate indigenous biomaterials with electrochemical potentials for bioenergy extraction, biorefinery development and derived applications.

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