SHORT COMMUNICATION
Journal of Fundamentals of Renewable Energy and Applications
2020
Vol.10 No.5

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

Bor-Yann Chen[1*]
[1]Department of Chemical and Materials Engineering, National I-Lan University, China

ABSTRACT
This sequential examination uncovered the ideal technique to enhance concentrates of polyphenolics plentiful restorative spices and Camellia tea as electron transports (ESs) for invigorating bioenergy age in microbial energy units (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. Ideal substance of polyphenolics rich spices and tea removes with maximal electrochemical exercises could be steadily acquired. Force thickness of MFC enhanced with Camellia green tea concentrate could fundamentally build 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. Also, compound structure is emphatically influenced whether cancer prevention agent exercises of polyphenolics bountiful home grown concentrates could be reversibly changed to be electron transporting capacities (e.g., replacement designs). Dihydroxyl substiutuents of ortho or para to one another were likely encouraging for electron-transporting, yet not for meta substituents. In addition, bioelectrochemical treatment upon therapeutic home grown concentrates (e.g., cyclic electron giving and pulling back procedures) may give an electroactive choice to weaken natural biotoxicity to completely communicate bioenergy-carrying exercises in applications (e.g., bioenergy extraction and home grown drug).

Keywords: Microbial fuel cells, Electron shuttle, Camellia tea, Polyphenolic antioxidants

INTRODUCTION

As per UN report, sustainable power source would turn into a significant segment of worldwide vitality sources to overall use. Specifically, biomass-based vitality was the most suitable sustainable power source for reasonable turn of events. Truth be told, microbial power device (MFC) is a bioelectrochemical framework that coordinates an electric flow acquired from organics oxidation by utilizing indigenous electroactive microorganisms or potentially blended consortia. It was likewise uncovered that redox go between (RM)- supported MFC was the most vitality sparing and financially encouraging as supplementation of electron transports (ESs) would improve successful electron move (ET) productivity and altogether diminish interior vehicle opposition for power generation [1-4] . ESs or RMs (e.g., catechol, riboflavins) are natural chemical(s) that can be reversibly oxidized and decreased to intervene ET marvels as electroactive impetuses for vitality extraction. That is, with supplementation of ESs, improvement of ET abilities could consequently heighten the proficiency of contamination corruption and bioelectricity age for electrochemically-guided bioremediation.

Be that as it may, enlargement of icily combined ESs (e.g., methylene blue, unbiased red, decolorized metabolites of material colors) to hoist pace of contamination corruption would be clearly not ecologically fitting because of undesired presentation of optional contaminant(s) for treatment. On the off chance that ES supplementation to improve activity proficiency of MFC is inescapable, enlargement of normally present ESs would be toppriority determination to limit natural effect on lives. As to structures of ESs, when electron-pulling back gatherings (e.g., hydroxyl (−OH) substituent(s)) were available on benzene ring ortho or para to one another, such synthetic species would emphatically display electrochemically stable electron-carrying attributes to animate force age in MFCs [4-6]. That is, within the sight of hydroquinone-like substance structures, such synthetic compounds could possess promising electron-transporting attributes of ESs to invigorate ET productivity in MFCs. In this manner, utilizing polyphenolics (i.e., −OH substituents)- rich therapeutic spices and consumable greenery (e.g., Camellia and non-Camellia tea) as ESs appeared to be all the more electrochemically suitable to remove bioenergy from organics oxidation in MFCs.

Likewise, restorative spices – Lonicera japonica (Jīnyín-huā) and Syzygium aromaticum (Dīng-xiāng) [7, 8] contained noteworthy measures of polyphenolics and flavonoids antioxidants [9, 10]. In this way, cancer prevention agent and ES abilities of polyphenolics-plentiful common bioresources may be considered as inducible electrochemical qualities that could be controlled by exogenous conditions for bioelectricity incitement. That is, if ES exercises could be communicated appropriately, the nearness of polyphenolics species may likewise synergistically cooperate with electrochemical exercises for ET incitement in MFCs. In actuality, significant constituents of Camellia tea-catechins could assume double jobs of either cancer prevention agents or ESs at suitable conditions. In spite of the fact that Chen and Hsueh (2016) recommended conceivable motivations to clarify polyphenols-rich eatable verdure as ESs (e.g., flavonoids cancer prevention agents as conceivable ESs) for bioenergy applications (e.g., MFCs, electrofermentation), correlation upon various common bioresources to propose promising competitors had still remained essentially open for conversation. Obviously, this would prompt unusual practicability of utilizing suitable ES sources to boost bioenergy extraction. Here, relative evaluation upon test tests showed that concentrates of Camellia tea (e.g., green tea, oolong tea, Pu'er tea and dark tea) would be the most proper to animate electron transport marvels in MFCs. Follow-up studies would decode whether just some critical synthetic species as principle effectors or synergistic collaborations of a

few electrochemically dynamic animal varieties legitimately expand power age in MFCs.

MATERIALS AND METHODS

To obtain extract samples, Camellia tea-Camellia sinensis (L.) Kuntze (Green tea), Oolong tea, Camelliaboreali yunnanica, Camellia assamica (Mast.) Chang and non-Camellia tea-Coreopsis tinctoria Nutt. (snow chrysanthemum; 'Kunlun Xunju'), Chrysanthemum (Chrysanthemum morifolium Ramat, "Chuju") and Bellis perennis and therapeutic spices Lonicera japonica (Jīnyín huā or Rěndōng), Syzygium aromaticum (Dīng xiāng), Citrus reticulate (Chénpí) at 2.5 g were ground to be powdered and afterward disintegrated in 50 mL refined water and half ethanol answer for 65 °C all out reflux around 2 h. At that point, such blends of spice or tea separate were concentrated by means of diminished weight of turning evaporator. Subsequent to cooling to surrounding temperature, such concentrates were centrifuged at 13,000 rpm, 25 °C 10 min to get supernatant. Such supernatants were then separated by means of 0.2 µm channels (Nylon Acrodisk 13 MiniSpike, 13 mm Gelman Sci.) to evacuate leftover particles. Deionized and refined water was then added to have resultant arrangements in 50 mL for concentrate a short time later.

RESULTS AND DISCUSSION

Cost-benefit analysis

Considering relationship among TPC, cancer prevention agent and electronshuttling abilities, approx. 10-overlap TPC substance of unfermented Camellia tea (i.e., green tea) separate than the promising therapeutic spice S. aromaticum was uncovered. Nonetheless, just ca. 3-crease increment in power thickness of supplement-bearing MFCs was shown. The enormous contrast of electrochemical articulation was likely because of the accompanying reasons: (a) Biotoxicity: Extracts of Camellia, non-Camellia tea and restorative spices may have biotoxic/inhibitory intensity to microscopic organisms, influencing bioelectricity creating abilities in MFCs. In this manner, increasing execution was not exactly envisioned. (b) Electron move confinement: Although electron transports could fundamentally animate bioelectricity age, immobilized cell focus, carbon fabric terminal attributes and different mass exchange factors despite everything restricted power age in MFCs. (c) Antioxidant/electron transport transformation: Rehashed CV check results showed that electroactive creations of tea remove step by step constricted. That is, tea contained bountiful cell reinforcements, yet sytheses of electron transport like chemical(s) were moderately low. (d) CV versus MFC condition: Cyclic voltammetric process was upheld abiotic electron-giving and tolerating forms for redox responses; nonetheless, bioelectricity-creating attributes were not basic metabolic capacities and in this manner the presentation was definitely not completely communicated in MFCs. (e) Inconsistency of redox capacity: Reductive and oxidative potential pinnacles were not evenly predictable, showing that the presence of unequal electrochemical activity was inevitable. Thus, redox electrochemical activity might not be fully exhibited for reversible electron transfer. (f) Biodegradation: Some compositions in tea extracts could not solely be used as electron shuttles and were utilized by bacteria as energy sources, resulting in lower performance than expected.

As recent studies [11, 12] also mentioned, myriads of teas from non-Camellia plants were found to own remarkable antioxidant activities as they usually do not contain addicted substances (e.g., purine alkaloids caffeine, theophylline). Moreover, some nonCamellia teas contained significant amount of amino acids and polypohenols with antioxidant capabilities, but were basically caffeine-absent to be considered “GRAS” for a variety of applications. This firstattempt study disclosed that extracts of non-Camellia teas (i.e., Chrysanthemum-related C. tinctoria Nutt. as shown herein) were also electrochemically active to stimulate promising power generation in MFCs. In fact, power stimulating capabilities of caffeine-free C. tinctoria Nutt. (max. power density 19.06 mW/m2) were nearly identical to those of Oolong tea or black tea (C. yunnanica, C. assamica (Mast.) Chang) extracts (max. power density 16.28–21.10 mW/m2). This might be due to not only abundant polyphenols, antioxidants, but also specific free amino acids present in some non-Camellia teas as great functional natural products for medicinal uses [12]. In addition, regarding screening toolbox of bioactive substances from natural bio resources [13], MFC test modules also provided alternatives to find successful “drug” or medicinal candidates with electrochemical potentials for practical uses.

CONCLUSION

Polyphenolics-plentiful palatable verdure and restorative spices displayed promising electrochemical exercises to invigorate power age in MFCs. Specifically, Camellia tea separates (e.g., green tea) demonstrated the most noteworthy abilities of bioelectricity incitement contrasted with nonCamellia tea and reviving restorative spices. Obviously, electrochemical qualities (e.g., cell reinforcements and ESs) and all out phenolics substance are firmly related to one another. Camellia tea concentrate would be more encouraging than non-Camellia tea separate because of higher substance of TPC. As tea extricates appeared to be more proper than therapeutic spices as ESs, biotoxicity strength evaluation upon plant spice concentrates ought to be first thought to be before bioenergy and biorefinery applications.

REFERENCES

1. Chen, B.Y., Ma, C.M., Han, K., Yueh, P.L., Qin, L.J., Hsueh, C.C., 2016a. Influence of textile dye and decolorized metabolites on microbial fuel cell-assisted bioremediation. Bioresour. Technol. 200, 1033–1038.

2. Chen, B.Y., Zhang, M.M., Chang, C.T., Ding, Y., Lin, K.L., Chiou, C.S., Hsueh, C.C., Xu, H., 2010. Assessment upon azo dye decolorization and bioelectricity generation by Proteus hauseri. Bioresour. Technol. 101 (12), 4737–4741.

3. Han, K., Yueh, P.L., Qin, L.J., Hsueh, C.C., Chen, B.Y., 2015. Deciphering synergistic characteristics of microbial fuel cell-assisted dye decolorization. Bioresour. Technol. 196, 746–751.

4. Xu, B., Chen, B.Y., Hsueh, C.C., Qin, L.J., Chang, C.T., 2014. Deciphering characteristics of bicyclic aromatics–mediators for reductive decolorization and bioelectricity generation. Bioresour. Technol. 163, 280–286.

5. Chen, B.-Y., Hong, J., Ng, I.S., Wang, Y.-M., Liu, S.-Q., Lin, B., Ni, C., 2013a. Deciphering simultaneous bioelectricity generation and reductive decolorization using mixedculture microbial fuel cells in salty media. J. Taiwan Inst. Chem. Eng. 44 (3), 446–453.

6. Qin, L.-J., Han, K., Yueh, P.-L., Hsueh, C.-C., Chen, B.-Y., 2016. Interactive influences of decolorized metabolites on electron-transfer characteristics of microbial fuel cells. Biochem. Eng. J. 109, 297–304.

7. Chen, B.-Y., Hsu, A.-W., Wu, C.-C., Hsueh, C.-C., 2017a. Feasibility study on biostimulation of dye decolorization and bioelectricity generation by using decolorized metabolites of edible flora-extracts. J. Taiwan Inst. Chem. Eng. 79, 141–150.

8. Chen, B.-Y., Ma, C.-M., Liao, J.-H., Hsu, A.-W., Tsai, P.-W., Wu, C.-C., Hsueh, C.-C., 2017b. Feasibility study on biostimulation of electron transfer characteristics by edible herbs-extracts. J. Taiwan Inst. Chem. Eng. 79, 125–133.

9. Przygodzka, M., Zielińska, D., Ciesarová, Z., Kukurová, K., Zieliński, H., 2014. Comparison of methods for evaluation of the antioxidant capacity and phenolic compounds in common spices. LWT Food Sci. Technol. 58 (2), 321–326.

10. Shang, X., Pan, H., Li, M., Miao, X., Ding, H., 2011. Lonicera japonica Thunb.: ethnopharmacology, phytochemistry and pharmacology of an important traditional Chinese medicine. J. Ethnopharmacol. 138 (1), 1–21.

11. Bi, W., He, C., Ma, Y., Shen, J., Zhang, L.H., Peng, Y., Xiao, P., 2016a. Investigation of free amino acid, total phenolics, antioxidant activity and purine alkaloids to assess the health properties of non-Camellia tea. Acta Pharmacol. Sin. B 6 (2), 170–181.

12. Bi, W., Shen, J., Gao, Y., He, C., Peng, Y., Xiao, P., 2016b. Ku-jin tea (Acer tataricum subsp. ginnala or A. tataricum subsp. theiferum), an underestimated functional beverage rich in antioxidant phenolics. J. Funct. Foods 24, 75–84.

13. Wang, B., Deng, J., Gao, Y., Zhu, L., He, R., Xu, Y., 2011. The screening toolbox of bioactive substances from natural products: a review. Fitoterapia 82 (8), 1141–1151.