

Electrochemical and Neuroprotective Evaluation of Anthocyanin-Rich Extracts: Toward Functional Dietary Agents for Parkinson's Disease

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Abstract:

This feasibility study used anthocyanin-rich herbal extracts from black goji berry, black roselle, butterfly pea, and blueberry to explore their potential for neuroprotective drug development. Anthocyanins as one of natural polyphenolic compounds could exhibit electron shuttle (ES) characteristics and simultaneously express antioxidant, anti-inflammatory, and antiviral activities. Prior study has highlighted the significance of ES-based molecules (e.g., L-Dopa and dopamine) in Parkinson's disease (PD) treatment. Thus, anthocyanins were considered as model dietary electron mediators relevant to neurodegenerative disease prevention. First, electrochemical properties of the extracts were assessed via microbial fuel cells (MFCs), total phenolic content (TPC), total anthocyanin content (TAC), DPPH radical scavenging assays, and cyclic voltammetry (CV) to compare time courses of keystone compositions after abiotic or biological treatment. The most promising extracts with maximal bioenergy potentials were further adopted to identify through HPLC/MS analysis. Next, network pharmacology, molecular docking, molecular dynamics simulations, and PC12 cell-based assays were applied to evaluate their PD-related therapeutic potential. As the finding indicated, anthocyanins from black goji berry exhibited strong binding affinity toward α -synuclein and MAO-B, with favorable gastrointestinal absorption, P-glycoprotein activity, and blood-brain barrier permeability. These findings clearly suggested promising characteristics of black goji berry for both bioenergetic

enhancement and efficacious neuroprotection to PD treatment. Thus, optimal electrochemical treatment could be obtained to maximize bioenergy-rich compound yields and suggest maximum efficacy to PD treatment.

Keywords:

Anthocyanins, Electrochemical Processing, Drug development, Neuroprotective, Molecular docking, Electron shuttle.