Green Phellodendri Chinensis Cortex-based Carbon Dots for Ameliorating Imiquimod-induced Psoriasis-like Inflammation in Mice

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Research

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Abstract

Background: Carbon dots with multifaceted advantages have been provided hope for development brand-new nanodrug for treating thorny diseases.This study developed a green and simple calcination method to prepare novel cardon dots (CDs) as promising drug for psoriasis treatment. The as-prepared CDs using Phellodendri Chinensis Cortex (PCC) as sole precursor were characterized by a series of methods, mainly including electron microscopy, optical technology and X-ray photoelectron spectroscopy (XPS).

Results: Results displayed that fluorescence (Quantum yield =5.63%) and nontoxic PCC-based CDs (PCC-CDs) with abundant chemical groups exhibited solubility and tiny sizes at average of (1.93 ± 0.53) nm, which may be beneficial for its inherent biological activity. Moreover, by using the typical imiquimod (IMQ) – induced psoriasis-like skin mouse model, we firstly demonstrated the pronounced anti-psoriasis activity of as-prepared PCC-CDs on ameliorating the appearance, psoriasis area and severity index (PASI) scores as well as histopathological morphology of both back tissues and right ears in IMQ-induced mouse. Further potential mechanisms behind the anti-psoriasis activities may be related to the anti-inflammation effects of PCC-CDs by descending the serum levels of proinflammatory cytokines (TNF-α, IL-6 and IL-17A).

Conclusion: These results suggested that PCC-CDs have potential to be an anti-psoriasis candidate for clinical applications to treat psoriasis, which not only provided an evidence for further broadening the biological application of CDs, but also provided a potential hope for application nanodrugs to treat thorny diseases.

Full Text

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Figures

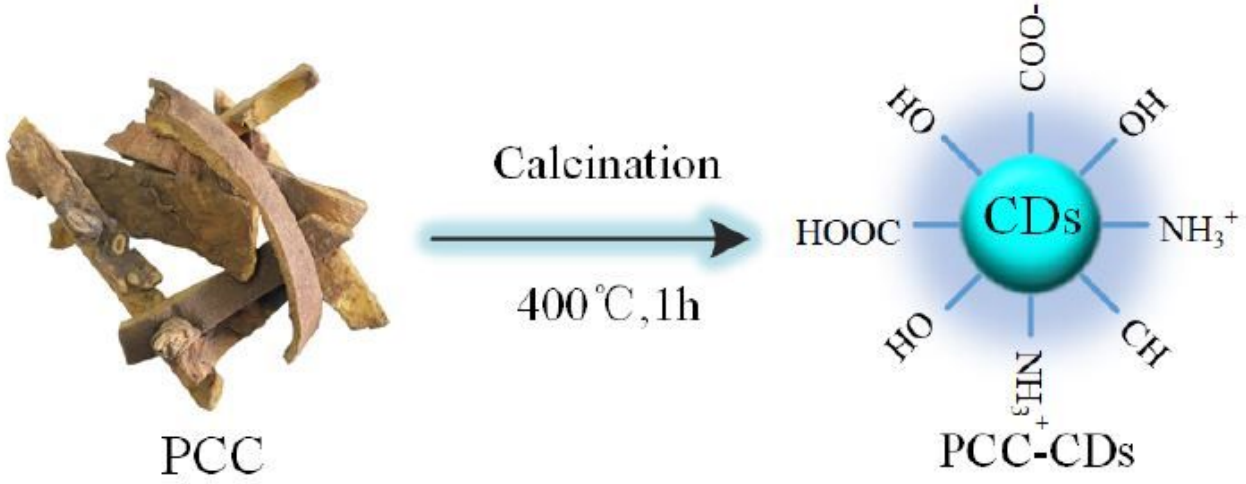

Figure 1

Illustration for as-prepared Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) by one-step calcination method.

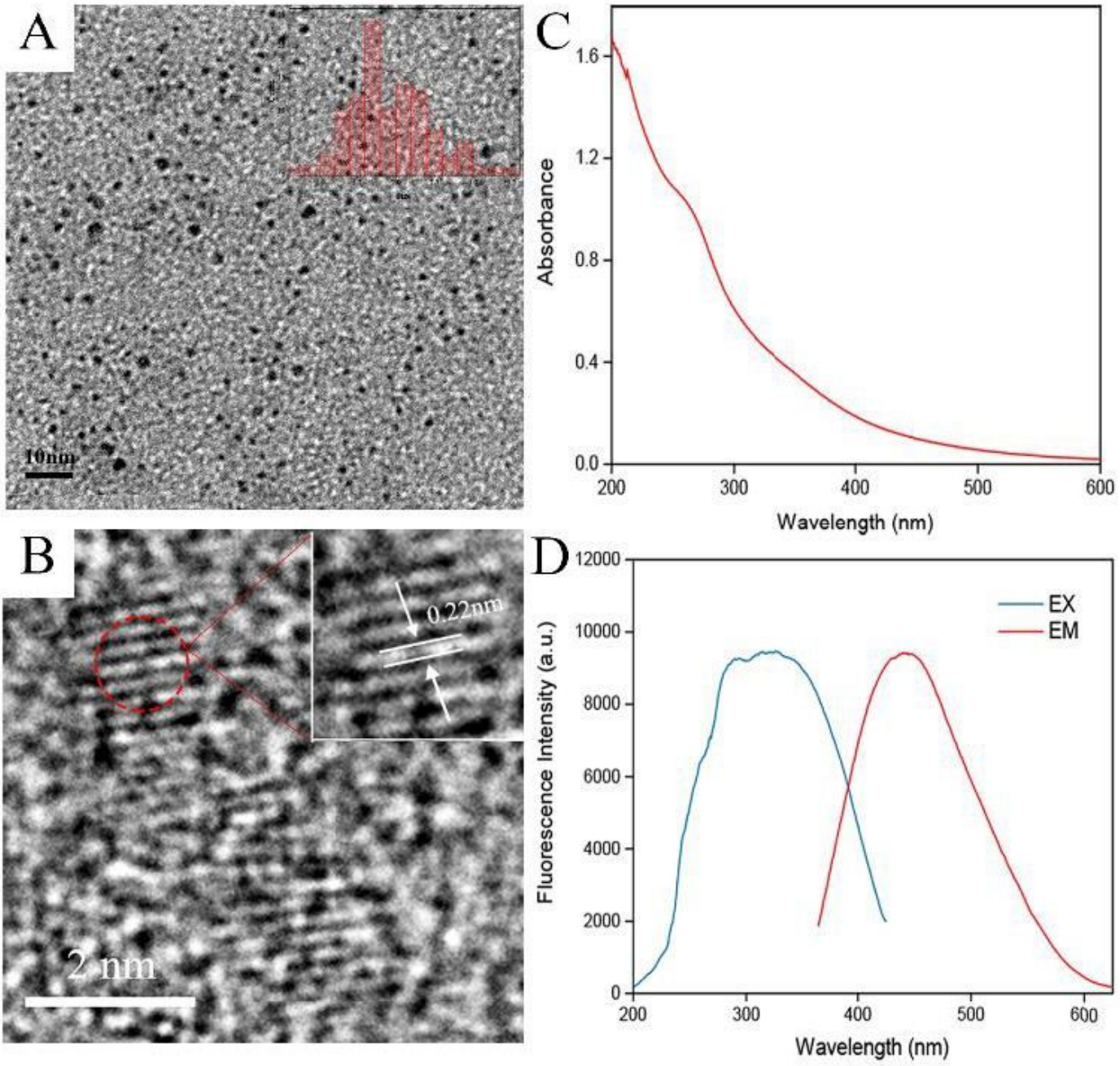

Figure 2

Morphological and optical characterizations of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) prepared at 400 ℃. (A) Transmission electron microscopy (TEM) images. Inset: particle size distribution histogram. (B) High-resolution transmission electron microscopy (HRTEM), Inset: magnification figure. (C) Ultraviolet and visible spectrum and (D) Fluorescence spectra.

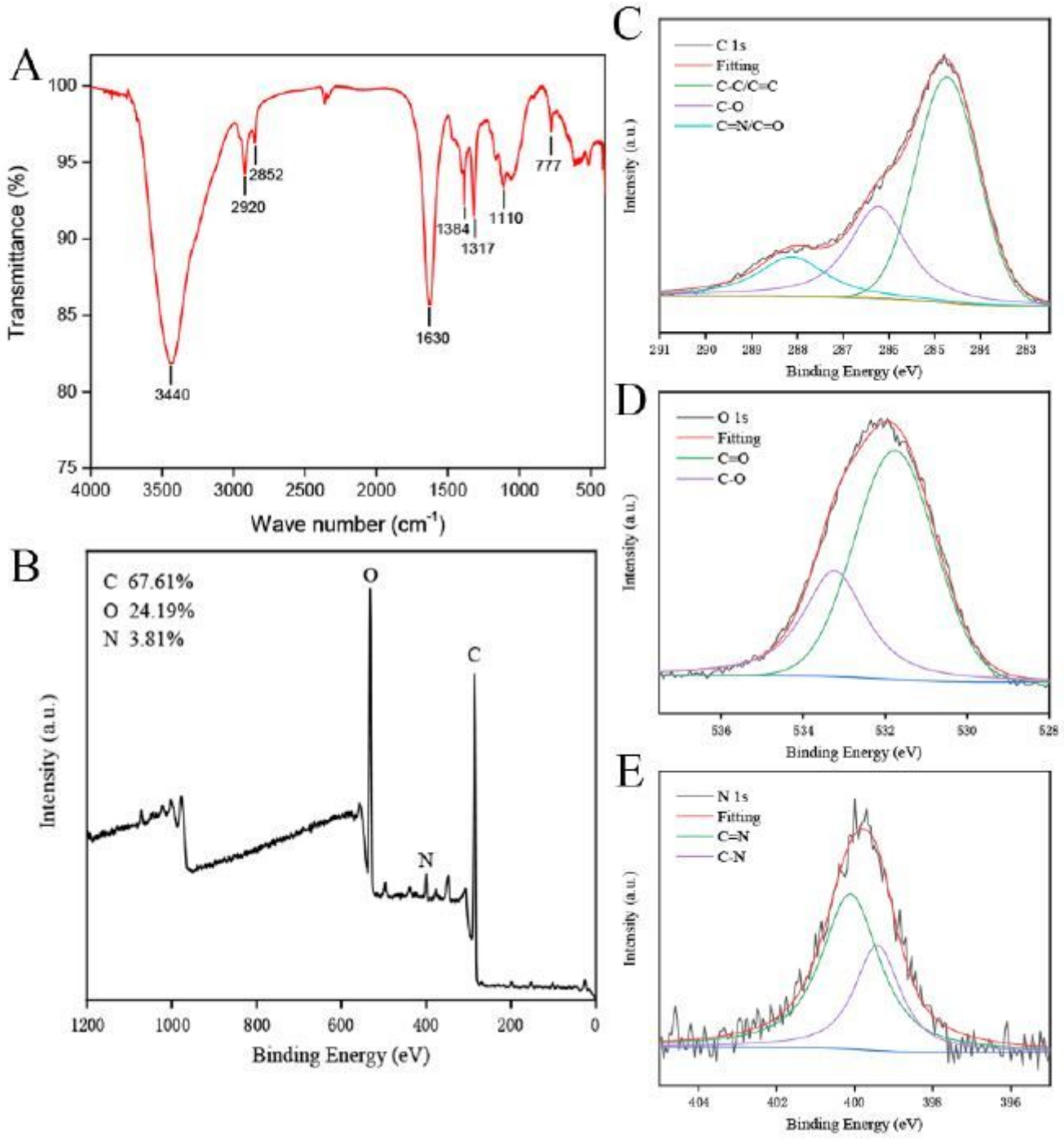

Figure 3

Functional groups and element analysis of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs). (A) Fourier transform infrared spectroscopy spectrum (FT-IR). X-ray photoelectron spectroscopy (XPS) spectrum including (B) full survey spectrum and (C) C 1s, (D) O 1s and (E) N 1s high-resolution survey spectrum.

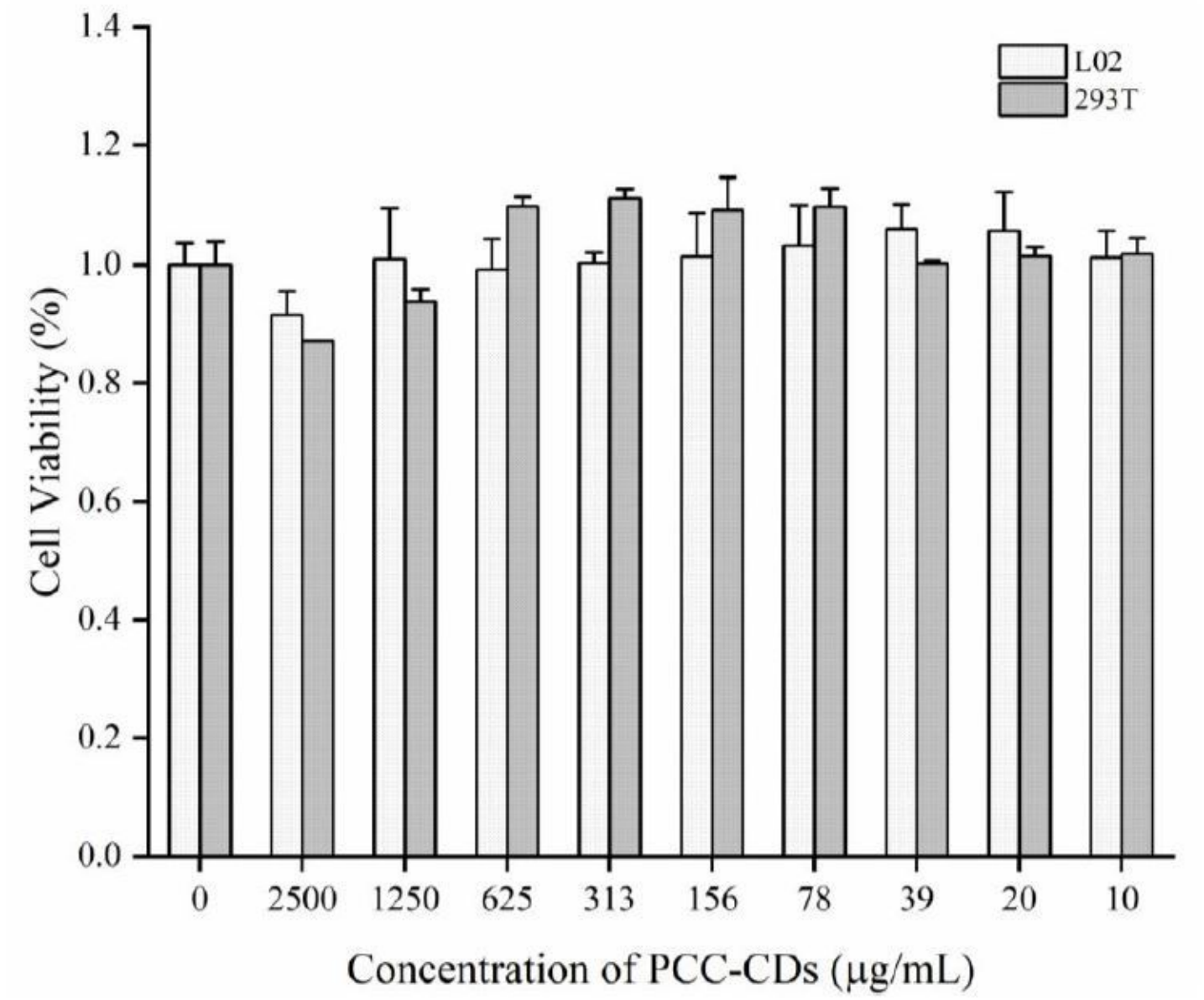

Figure 4

Cytotoxic effects of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) at increasing concentrations on L02 and 293T cells via CCK-8 assay for 24h.

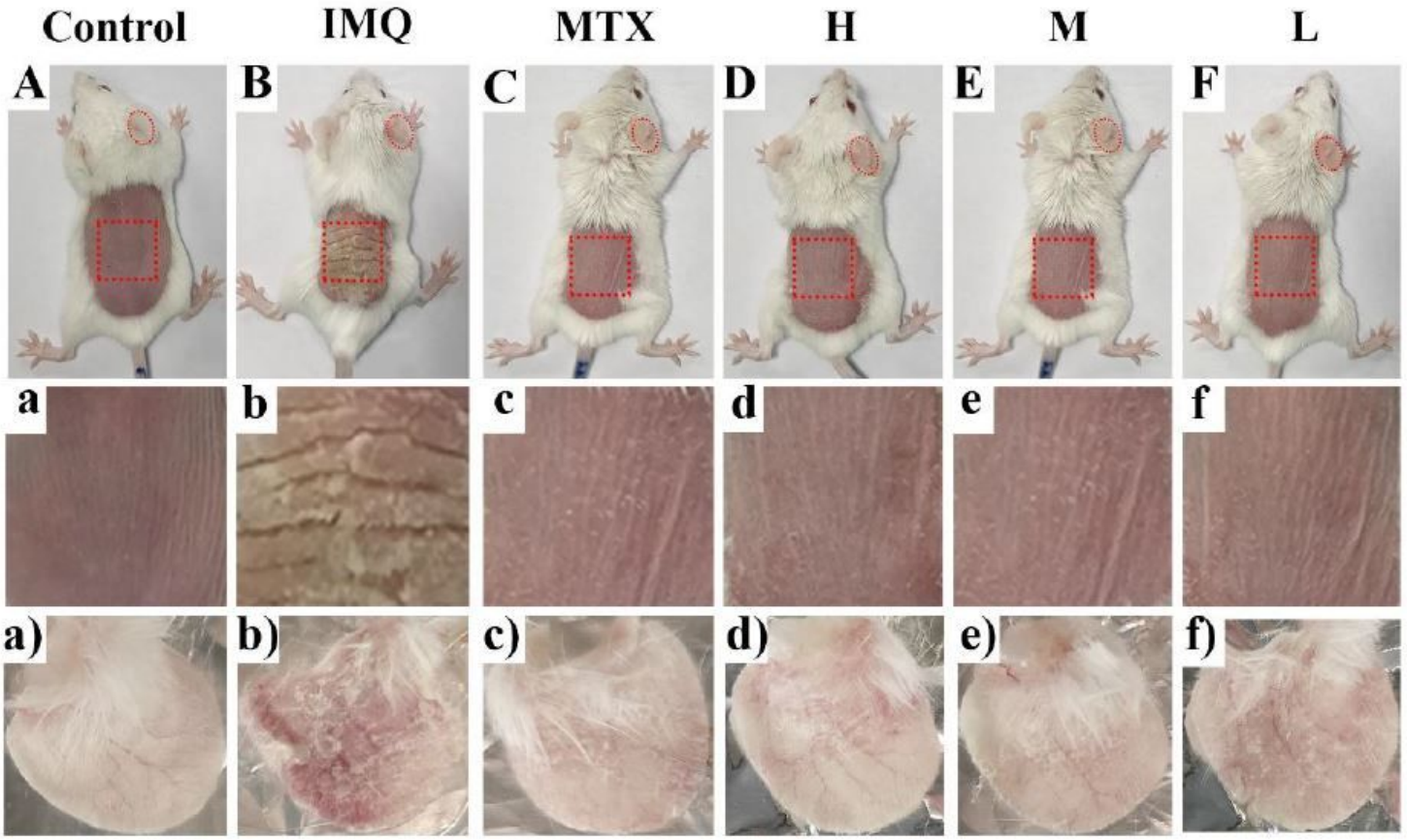

Figure 5

Effects of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) on appearance of the dorsal skin and right ears tissues in imiquimod (IMQ) -induced psoriasis-like mice on day 7. (A-F) Presentation of phenotype of animal entirety, (a-f) Magnification of dorsal skin and [a)-f)] right ear tissues. Mouse were assigned into six groups: control (Normal saline [NS], 0.5 mL), IMQ (NS,0.5 mL), methotrexate [MTX] (1.0 mg/kg), different doses of PCC-CDs groups (High[H]:0.86 mg/kg; Medium[M]:0.43 mg/kg; Low[L]:0.22 mg/kg). Expect for control group, IMQ and drug-treated group were received a daily application of IMQ.

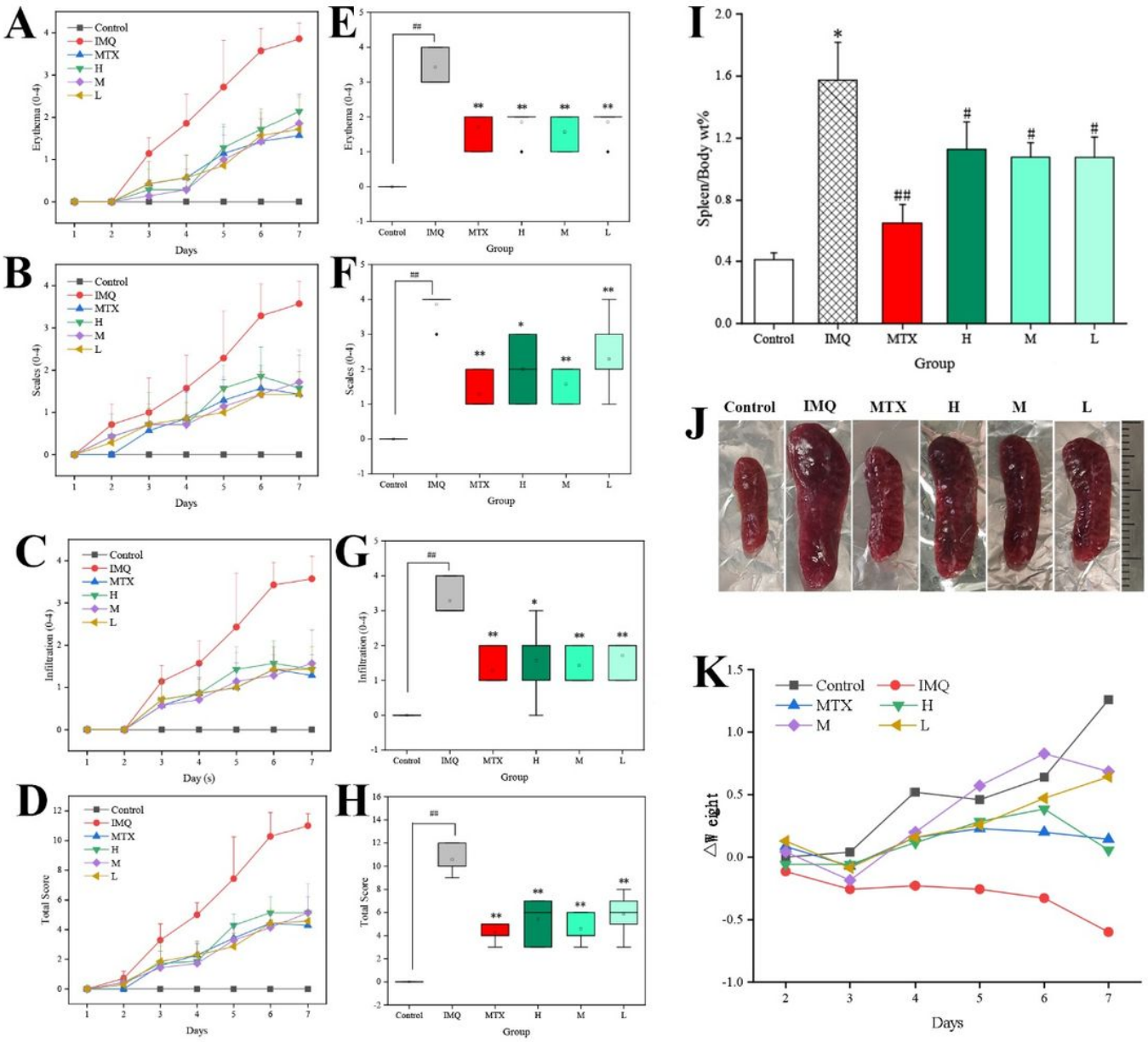

Figure 6

Effects of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) on PASI scores (Erythema, scales, infiltration and total scores) of (A-D) skin and (E-H) right ears, (I) weight ratio of spleen to body [Spleen/body wt %], (J) size of spleen organ and (K) body weight loss (△ weight). Mouse were assigned into six groups: control (Normal saline [NS], 0.5 mL), imiquimod [IMQ] (NS,0.5 mL), methotrexate [MTX] (1.0 mg/kg), different doses of PCC-CDs groups (High[H]:0.86 mg/kg; Medium[M]:0.43 mg/kg; Low[L]:0.22 mg/kg). Expect for control group, IMQ and drug-treated group were received a daily application of IMQ. Data were expressed as means ± standard deviation (SD). *P < 0.05 and **P < 0.01 vs. control group, #P < 0.05 and ##P < 0.01 vs. IMQ group.

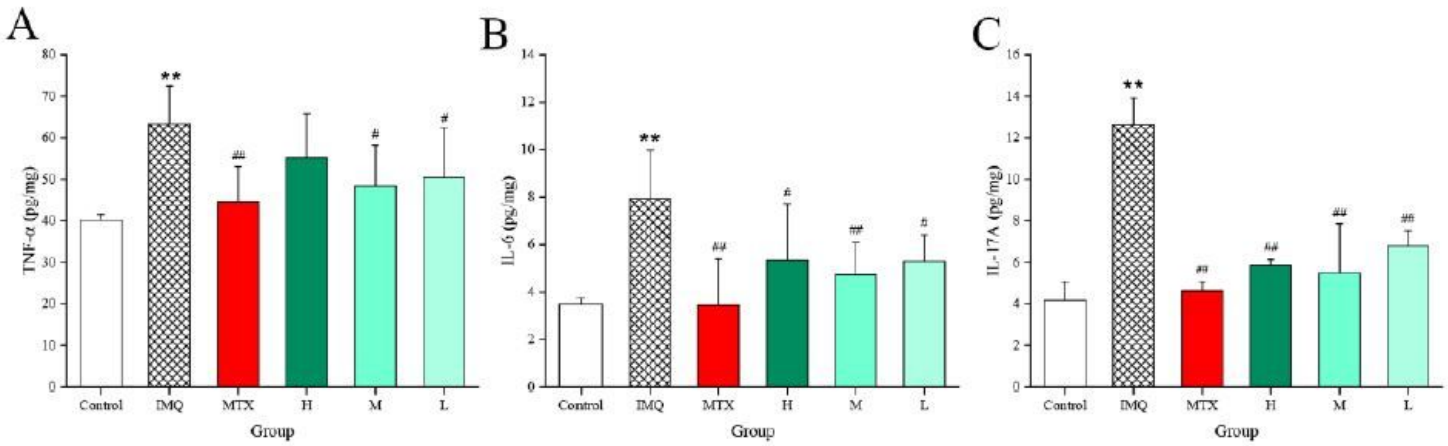

Figure 7

Effects of Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) on the serum levels of TNF-α, IL-6 and IL-17A. Control: control group; imiquimod (IMQ): IMQ-treated model group; MTX: methotrexate-treated positive group; H, M, L: high-, medium- and low doses of PCC-CDs group. Data were expressed as means ± standard deviation (SD). *P < 0.05 and **P < 0.01 vs. control group, #P < 0.05 and ##P < 0.01 vs. IMQ group.

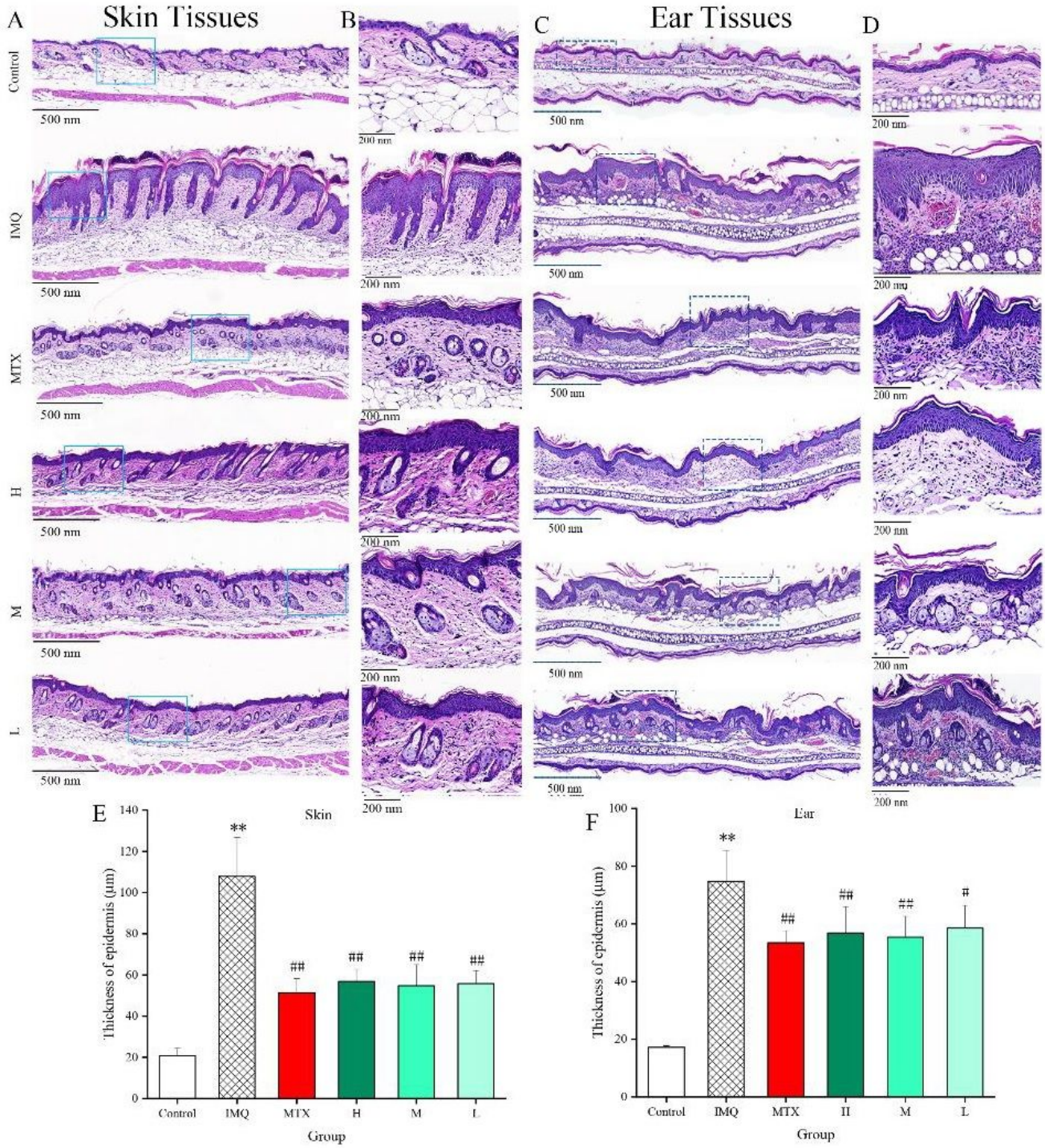

Figure 8

Representative microphotographs and epidermal thickness of (A, B,E) dorsum skin and (C, D,F) right ear tissues of mouse. Animals were divided into control, model (only treated with imiquimod [IMQ]), positive (treated with methotrexate [MTX]), Phellodendri Chinensis Cortex - based carbon dots (PCC-CDs) at high[H]- (0.86 mg/kg), medium[M]- (0.43 mg/kg) and low[L] (0.22 mg/kg) doses groups (A and C: H & E staining; magnification×5; B and D: H & E staining; magnification×10). Data were expressed as means ±

standard deviation (SD). *P < 0.05 and **P < 0.01 vs. control group, #P < 0.05 and ##P < 0.01 vs. IMQ group.

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