Design and Comprehensive Evaluation of a Gallic Acid-Loaded Chitosan-Based Topical Gel: A Multifunctional Drug Delivery System with Antioxidant and Antimicrobial Properties

Pervin SOYER[1*], Tilbe ÇEVİKELLİ[2], A. Alper ÖZTÜRK[3], Elif KAYA TİLKİ[4]
[1]Anadolu University, Faculty of Pharmacy, Department of Pharmaceutical Microbiology 26470, Eskisehir, Türkiye.
[2]Bahçeşehir University, Faculty of Pharmacy, Department of Pharmaceutical Technology, 34353, Istanbul, Türkiye.
[3]Anadolu University, Faculty of Pharmacy, Department of Pharmaceutical Technology, 26470, Eskisehir, Türkiye.
[4]Anadolu University, Faculty of Pharmacy, Department of Pharmacology, 26470, Eskisehir, Türkiye.
*Main author: pervinsoyer@anadolu.edu.tr

Topical pharmaceutical formulations require multifunctional properties, including antioxidant protection, antimicrobial activity, and support for tissue regeneration. In this context, gallic acid, a potent phenolic compound, and chitosan, a biocompatible and mucoadhesive polymer with wound healing potential, offer significant advantages. This study aimed to evaluate the physicochemical, biological, and microbiological properties of a gallic acid-loaded chitosan-based topical gel. A formulation containing 1% (w/w) gallic acid was prepared and investigated as a topical drug delivery system. Antimicrobial activity was determined using the broth microdilution method against Bacillus subtilis NRRL B478, Staphylococcus aureus ATCC 29213, Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 27853, Candida krusei ATCC 6258, and Candida albicans ATCC 90028. Both antimicrobial (MIC) and antioxidant (DPPH radical scavenging) activities were evaluated using the same concentration range (8–256 mg/mL) [1,2]. In addition, the mechanical properties of the gel were assessed by texture profile analysis, demonstrating low hardness (0.043±0.006 N) and gumminess (0.027±0.006 N), along with moderate adhesiveness (0.250±0.026 mJ), indicating a soft, easily spreadable formulation with adequate skin retention. The formulation exhibited measurable antimicrobial activity, with MIC values ranging between 128–256 mg/mL for bacterial strains and antifungal activity observed at 256 mg/mL. The gel demonstrated concentration-dependent antioxidant activity, reaching 62.33±1.66% DPPH radical scavenging at 256 mg/mL and 18.26±1.61% at 8 mg/mL. These findings indicate that the incorporation of gallic acid into the chitosan matrix successfully preserves its bioactivity while potentially benefiting from the structural and biological properties of chitosan. The developed gel system provides a suitable platform for localized delivery, offering prolonged retention and enhanced interaction with the application site. The gallic acid-loaded chitosan gel represents a promising multifunctional topical formulation combining antioxidant and antimicrobial properties with the inherent wound healing potential of chitosan. This system may serve as an effective candidate for dermal applications requiring protective and regenerative support. This study was supported by Anadolu University Scientific Research Projects Commission (Grant No: YTT-2025-3095).

Literature:

[1] B. Solak, et al. J. Drug Deliv. Sci. Technol. 2025, 106, 106721.
[2] Öztürk A.A., et al. Assay. Drug. Dev. Technol. 2021, 19(3):156-175

EUFEPS
European Federation for Pharmaceutical Sciences

SITELF
Società Italiana di Tecnologia e Legislazione Farmaceutiche



CERTIFICATE OF ATTENDANCE

This hereby acknowledges that

A. ALPER ÖZTÜRK

has attended the

JOINT EUFEPS - SITELF MEETING

“Advances in Pharmaceutical Sciences”

May 27-29, 2026

CESTEV, Naples (Italy)