Title: Solvent effects on quercetin incorporation, release behavior, and antibacterial efficacy in gelatin/dialdehyde cellulose composite films: A comparative study

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Abastact: As quercetin has poor solubility in water, a solvent or surfactant is required to ensure its dissolution and homogeneous distribution within a biopolymer matrix. This study systematically compares the effects of two solvents, dimethyl sulfoxide (DMSO) and ethanol, on the physicochemical properties, quercetin distribution, release behavior, and antibacterial efficacy of gelatin/dialdehyde cellulose (GD) films loaded with quercetin. Films were prepared with quercetin dissolved in DMSO (GDQ-D) or ethanol (GDQ-E). Scanning electron microscopy images revealed that both quercetin-loaded films contained a mixture of rod-like and spherical quercetin formations; cross-sectional images showed a distinct dendrimer-like structure. FTIR analysis confirmed the presence of residual DMSO in GDQ-D, accounting for 25 ± 2.6 % of the initially loaded solvent. This residual DMSO constituted approximately 4–6 % of the total film weight. Its retention promoted a more homogeneous distribution of quercetin, minimized recrystallization, and enhanced antibacterial performance (achieving 77 % and 35 % reduction against *S. aureus* and *E. coli,* respectively). Conversely, ethanol evaporation during the film drying process led to densely packed quercetin aggregates in GDQ-E. This led to a significant reduction in quercetin release (2 μg/mL vs. 20 μg/mL in GDQ-D), thereby diminishing antibacterial efficacy (55 % reduction against *S. aureus* with no observable activity against *E. coli*). Overall, these findings demonstrate that solvent type and retained residue, quercetin morphology, and release kinetics collectively contributed to the observed functional properties.

Keywords: Quercetin Gelati Dialdehyde cellulose Dimethyl sulfoxide Ethanol

10.1016/j.foodhyd.2026.112461

https://www.sciencedirect.com/science/article/abs/pii/S0268005X26000433