

PRESERVATION STRATEGY FOR CHEESE: A SYSTEMATIC REVIEW AND META-ANALYSIS OF EDIBLE FILMS AND COATINGS

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**FOOD TECHNOLOGY MASTER STUDY PROGRAM
FACULTY OF ENGINEERING AND TECHNOLOGY
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Bogor, August 2026

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SUMMARY

ANNISA DHABITA. Preservation Strategy for Cheese: A Systematic Review and Meta Analysis of Edible Films and Coatings. Supervised by NUGRAHA EDHI SUYATMA and FALEH SETIA BUDI.

Cheese is a highly perishable dairy product prone to microbial and physicochemical spoilage due to its high moisture and nutrient content. Implementing biopolymer-based edible films and coatings offered a promising natural packaging alternative, utilizing thin, biodegradable surface layers designed to block oxygen, limit moisture transfer, and inhibit surface contamination. While numerous individual experiments evaluated their application between 2010 and 2024, variations in experimental methods and cheese varieties yielded highly inconsistent conclusions. Executing a meta-analysis, which served as a rigorous statistical method to quantitatively pool separate research datasets into unified trends, was therefore critical to resolve these contradictions and establish valid, macro-level evidence. Consequently, this study aimed to systematically evaluate the global effectiveness of edible packaging as a cheese preservation strategy and to identify the most successful formulations across different dairy systems. Utilizing a standardized seven-stage systematic review protocol combined with mixed-effects modeling across sixteen core parameters, the pooled data confirmed that edible packaging was highly effective at preserving cheese quality. The most pronounced benefits occurred in physical, chemical, and sensory metrics, specifically by retaining matrix moisture, preserving structural fat percentage, suppressing lipid oxidation (TBARS), and improving overall sensory acceptability while maintaining baseline optical lightness (L^*). Concurrently, these biopolymers and essential oil delivered powerful antimicrobial control against primary spoilage and pathogenic vectors, specifically total bacteria, psychrotrophic bacteria, and coliform proliferation. These primary preservation gains occurred despite expected formulation trade-offs observed in weight loss, hardness, pH, titratable acidity, and surface discoloration (a^* and b^*). Furthermore, integrating all sixteen parameters through De Garmo's Multi-Criteria Decision Analysis identified Zein incorporated with *Heracleum persicum* essential oil as the top-performing overall formulation (score: 0.875). Conclusively, these biopolymer coatings provided an advanced packaging solution to replace conventional plastics. Future studies were strongly recommended to evaluate the exact economic and production cost efficiencies between these active composite coatings and traditional plastics to successfully bridge the gap between academic research and industrial cheese application.

Keywords: cheese, edible film and coating, meta-analysis, preservation, systematic review

RINGKASAN

ANNISA DHABITA. *Preservation Strategy for Cheese: A Systematic Review and Meta Analysis of Edible Films and Coatings*. Dibimbing oleh NUGRAHA EDHI SUYATMA dan FALEH SETIA BUDI.

Keju merupakan produk olahan susu yang mudah rusak (*perishable*) dan rentan terhadap kerusakan mikrobiologis serta fisikokimia akibat kandungan air dan nutrisinya yang tinggi. Penerapan edible film dan coating berbasis biopolimer menawarkan alternatif kemasan alami yang menjanjikan, dengan memanfaatkan lapisan permukaan tipis yang dapat terurai secara hayati (*biodegradable*) untuk menahan oksigen, membatasi perpindahan kelembapan, dan menghambat kontaminasi permukaan. Meskipun telah banyak penelitian eksperimental yang mengevaluasi penerapannya antara tahun 2010 dan 2024, variasi dalam metode eksperimen dan varietas keju menghasilkan kesimpulan yang sangat tidak konsisten. Oleh karena itu, pelaksanaan meta-analisis—yang berfungsi sebagai metode statistik ketat untuk menggabungkan himpunan data penelitian secara kuantitatif menjadi tren terpadu—sangat penting untuk mengatasi kontradiksi ini dan menetapkan bukti yang valid pada tingkat makro. Penelitian ini bertujuan untuk mengevaluasi efektivitas kemasan edible secara sistematis pada skala global sebagai strategi pengawetan keju serta mengidentifikasi formulasi paling berhasil pada berbagai sistem olahan susu. Menggunakan protokol tinjauan sistematis tujuh tahap yang terstandarisasi dan dikombinasikan dengan pemodelan efek campuran (*mixed-effects modeling*) pada enam belas parameter utama, data gabungan mengonfirmasi bahwa kemasan edible sangat efektif dalam mempertahankan kualitas keju. Manfaat paling signifikan terlihat pada metrik fisik, kimia, dan sensori, khususnya dalam mempertahankan kelembapan matriks, menjaga persentase lemak struktural, menekan oksidasi lipid (TBARS), dan meningkatkan penerimaan sensori secara keseluruhan dengan tetap mempertahankan kecerahan optik awal (L^*). Secara bersamaan, biopolimer dan minyak atsiri ini memberikan kontrol antimikroba yang kuat terhadap vektor pembusuk dan patogen utama, khususnya total bakteri, bakteri psikrotrofik, dan proliferasi koliform. Manfaat pengawetan utama ini diperoleh meskipun terdapat kompromi (*trade-off*) formulasi yang telah diperkirakan pada susut bobot, kekerasan, pH, keasaman tertitrasi, dan perubahan warna permukaan (a^* dan b^*). Lebih lanjut, penggabungan seluruh enam belas parameter melalui Analisis Keputusan Multikriteria De Garmo mengidentifikasi Zein yang diinkorporasikan dengan minyak atsiri *Heracleum persicum* sebagai formulasi dengan kinerja terbaik secara keseluruhan (skor: 0,875). Kesimpulannya, pelapis biopolimer ini memberikan solusi pengemasan tingkat lanjut untuk menggantikan plastik konvensional. Penelitian selanjutnya sangat direkomendasikan untuk mengevaluasi efisiensi biaya produksi dan ekonomi yang tepat antara pelapis komposit aktif ini dan plastik tradisional guna menjembatani kesenjangan antara penelitian akademis dan aplikasi pada industri keju.

Keywords: cheese, edible film and coating, meta-analysis, preservation, systematic review



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ANNISA DHABITA

Thesis
as one of the requirements to obtain a
Master's degree in
Food Technology Master Study Program

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FOREWORD

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Bogor, August 2026

Annisa Dhabita

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