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Gestione sostenibile dell'inquinamento da microplastiche da bottiglie in PET: panoramica e strategie di mitigazione

L'uso diffuso del polietilene tereftalato (PET) negli imballaggi per l'acqua in bottiglia rimane significativo e si prevede un ulteriore aumento nei prossimi anni. Questa tendenza solleva preoccupazioni a causa della generazione di grandi quantità di rifiuti. La degradazione del PET porta al rilascio di sostanze a basso peso molecolare e particelle di microplastica, che contaminano i prodotti alimentari e l'ambiente Una sezione chiave dell'articolo esplora le potenziali strategie di gestione della degradazione, concentrandosi sulle loro applicazioni e sui limiti esistenti.

applied sciences

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Review

Sustainable Management of Microplastic Pollutions from PET Bottles: Overview and Mitigation Strategies

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Abstract: The widespread use of polyethylene terephthalate (PET) in bottled water packaging remains significant and is expected to increase further in the coming years. This trend raises concerns due to the generation of large amounts of waste. The degradation of PET leads to the release of low-molecular-weight substances and microplastic particles, which contaminate food products and the environment. This work highlights the significance of microplastic pollution, summarizes the mechanisms of PET degradation, and discusses methods for microplastic detection. A key section of the paper explores potential degradation management strategies, focusing on their applications and existing limitations. The study underscores the need for coordinated action among the scientific community, industry, and policymakers to mitigate this pressing environmental challenge.

Keywords: waste management; sustainable development; polyethylene terephthalate; PET bottle; microplastic

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Una revisione sistematica della promozione della sostenibilità attraverso il marketing dell'economia circolare: approfondimenti e strategie per l'innovazione del marketing verde

Il marketing dell'economia circolare (CEM) rappresenta un approccio innovativo per allineare le strategie aziendali agli obiettivi di sostenibilità. Questo articolo esplora il ruolo del CEM come motore dell'innovazione del green marketing, enfatizzando strategie che minimizzano l'impatto ambientale sulla competitività aziendale, migliorando al contempo il coinvolgimento dei consumatori. Utilizzando una revisione sistematica della letteratura basata sulla metodologia PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), abbiamo identificato 39 studi ad alto impatto in diversi settori, categorizzando i risultati in temi chiave, quadri teorici e strategie di marketing.

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Systematic Review

A Systematic Review of Driving Sustainability Through Circular Economy Marketing: Insights and Strategies for Green Marketing Innovation

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Abstract: Circular economy marketing (CEM) represents an innovative approach to aligning business strategies with sustainability objectives. This paper explores the role of CEM as a driver of green marketing innovation, emphasising strategies that minimise environmental impact on business competitiveness while enhancing consumer engagement. Using a systematic literature review based on the PRISMA methodology, we identified 39 high-impact studies across multiple industries, categorising findings into key themes, theoretical frameworks, and marketing strategies. The analysis highlights emerging trends, including the shift toward product-service systems (PSSs), behavioural nudging, transparent sustainability branding, and integration of digital technologies such as AI and blockchain to enhance traceability and consumer trust. Findings reveal that while circular economy marketing presents opportunities for businesses to differentiate themselves and build long-term sustainability strategies, significant challenges remain, including scalability issues, consumer scepticism, and risks of greenwashing. Moreover, gaps in standardising impact measurement and industry-specific adaptation hinder wider implementation. Business model innovation, policy support, and collaborative efforts are crucial in overcoming these barriers. This study provides insights for businesses, policymakers, and researchers,

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Materiali in lega di seta-soia: influenza dei tipi di seta (Mori, Thai, Muga, Tussah ed Eri) sulla struttura, le proprietà e la funzionalità delle miscele proteiche di insetti e piante (II)

Le proteine naturali rappresentano un'alternativa sostenibile e biocompatibile alle plastiche convenzionali derivate da combustibili fossili, con applicazioni versatili in settori che spaziano dalla medicina al packaging alimentare. La stabilità strutturale e termica di questi film è stata confermata attraverso diverse tecniche di caratterizzazione, tra cui la spettroscopia infrarossa a trasformata di Fourier (FTIR), la calorimetria a scansione differenziale (DSC) e la microscopia elettronica a scansione (SEM).

International Journal of *Molecular Sciences*

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Article

Silk-Soy Alloy Materials: Influence of Silk Types (Mori, Thai, Muga, Tussah, and Eri) on the Structure, Properties, and Functionality of Insect–Plant Protein Blends (II)

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Abstract: Natural proteins present a sustainable and biocompatible alternative to conventional fossil fuel-derived plastics, with versatile applications in fields ranging from medicine to food packaging. Extending our previous research on silk–corn zein composites, this study utilizes soy protein—another plant protein extensively employed within biomedical applications—in conjunction with silk fibroin proteins extracted from a variety of domestic (Mori and Thai) and wild (Muga, Tussah, and Eri) silkworm species. By combining these proteins in varying ratios (0%, 10%, 25%, 50%, 75%, 90%, and 100%), silk–soy films were successfully fabricated with high miscibility. The structural and thermal stability of these films was confirmed through various characterization techniques, including Fourier transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), and scanning electron microscopy (SEM). Structural refinements were then achieved through post-water annealing treatments. After annealing, it was observed that when soy protein was introduced into both types of silk, the silks exhibited a greater amount of intermolecular and intramolecular β-sheet content. This phenomenon can be attributed to soy's intrinsic ability to self-assemble into β-sheets through electrostatic and hydrophobic interactions, which also improved the overall thermal stability and morphology of the composite films. The unique self-assembling properties of soy and its ability to promote

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Valutazione della resistenza chimica e delle prestazioni dei polimeri termocromici per l'imballaggio alimentare

L'uso di pigmenti termocromici negli imballaggi alimentari offre diversi vantaggi, tra cui una maggiore sicurezza alimentare, la riduzione degli sprechi e il monitoraggio delle variazioni di temperatura. Tuttavia, si sa ancora poco sulla resilienza chimica di questi materiali, in particolare per quanto riguarda la stabilità ottica, l'attivazione termocromica e l'integrità meccanica in seguito all'esposizione ad ambienti acidi, alcalini, oleosi e neutri a contatto con gli alimenti. Questo studio valuta la resistenza chimica, gli effetti dei cicli termici e la durabilità meccanica di miscele di polimeri e pigmenti termocromici.

materials

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Artide

Evaluating the Chemical Resistance and Performance of Thermochromic Polymers for Food Packaging

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Abstract: The use of thermochromic pigments in food packaging offers several advantages, including improved food safety, waste reduction, and temperature change monitoring. However, little is known about how chemically resilient these materials are, especially regarding optical stability, thermochromic activation, and mechanical integrity following exposure to acidic, alkaline, oil-based, and neutral food-contact environments. This study evaluates the chemical resistance, thermal cycling effects, and mechanical durability of thermochromic pigment–polymer blends. Thermochromic polymer samples were subjected to multiple chemical environments, repeated thermal cycling, and mechanical analysis to assess degradation behavior. The findings show that virgin food-grade polymer with no thermochromic pigment sustains its performance stability throughout chemical exposure with little degradation. However, thermochromic polymer blends experienced reduced thermochromic functionality. This study offers insight into how well thermochromic pigment can be incorporated into intelligent food packaging despite the limitations associated with chemical exposure.

Keywords: thermochromic pigments; food packaging; chemical resistance; thermal cycling; mechanical durability

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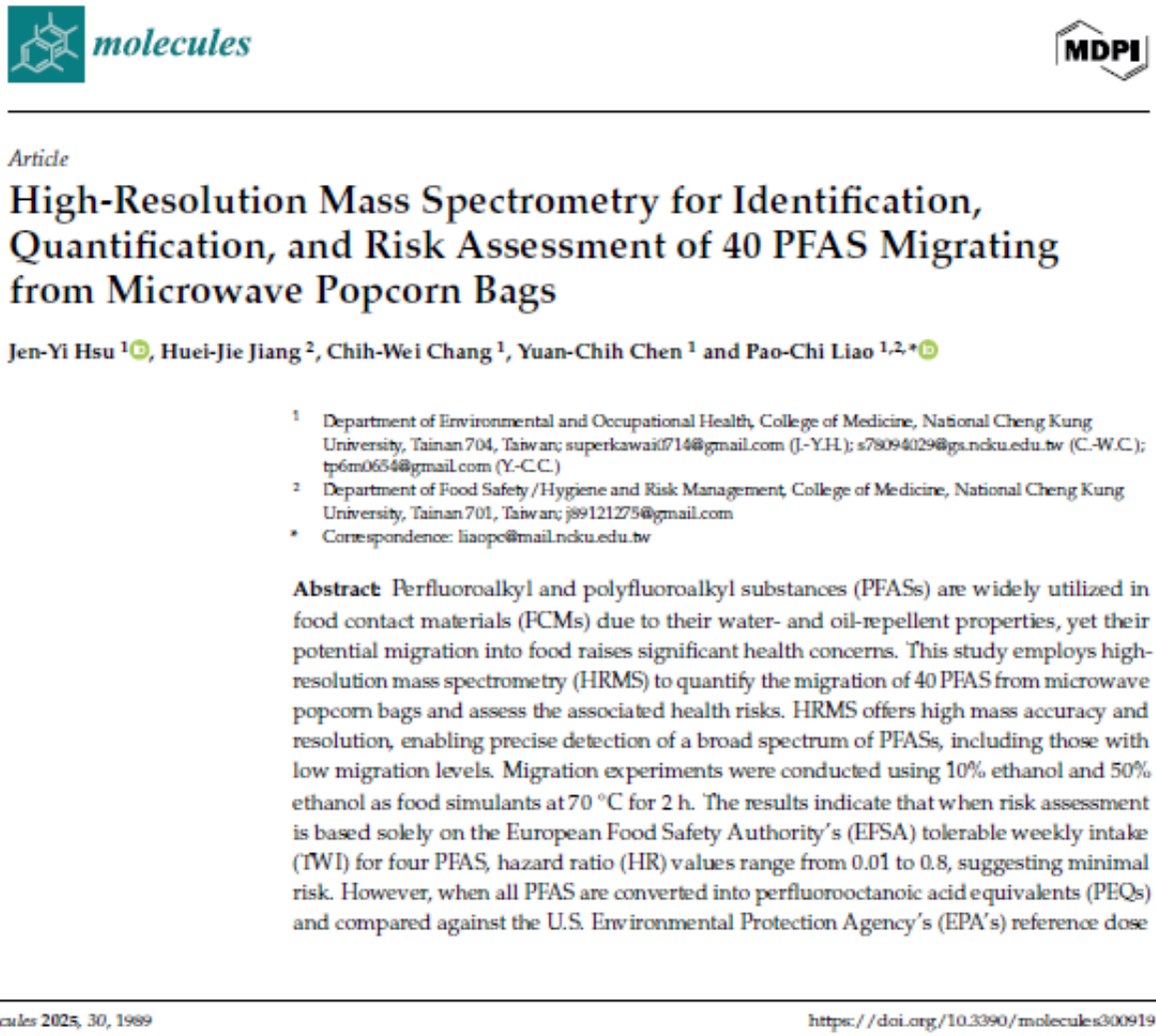
Spettrometria di massa ad alta risoluzione per l'identificazione, la quantificazione e la valutazione del rischio di 40 PFAS che migrano dai sacchetti di popcorn per microonde

Le sostanze perfluoroalchiliche e polifluoroalchiliche (PFAS) sono ampiamente utilizzate nei materiali a contatto con gli alimenti (FCM) grazie alle loro proprietà idrorepellenti e oleorepellenti, ma la loro potenziale migrazione negli alimenti solleva notevoli preoccupazioni per la salute. Questo studio utilizza la spettrometria di massa ad alta risoluzione (HRMS) per quantificare la migrazione di 40 PFAS dai sacchetti per popcorn per microonde e valutare i rischi per la salute associati. L'HRMS offre elevata accuratezza e risoluzione in termini di massa, consentendo il rilevamento preciso di un ampio spettro di PFAS, compresi quelli con bassi livelli di migrazione.



molecules

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Article

High-Resolution Mass Spectrometry for Identification, Quantification, and Risk Assessment of 40 PFAS Migrating from Microwave Popcorn Bags

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Abstract: Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are widely utilized in food contact materials (FCMs) due to their water- and oil-repellent properties, yet their potential migration into food raises significant health concerns. This study employs high-resolution mass spectrometry (HRMS) to quantify the migration of 40 PFAS from microwave popcorn bags and assess the associated health risks. HRMS offers high mass accuracy and resolution, enabling precise detection of a broad spectrum of PFASs, including those with low migration levels. Migration experiments were conducted using 10% ethanol and 50% ethanol as food simulants at 70 °C for 2 h. The results indicate that when risk assessment is based solely on the European Food Safety Authority's (EFSA) tolerable weekly intake (TWI) for four PFAS, hazard ratio (HR) values range from 0.01 to 0.8, suggesting minimal risk. However, when all PFAS are converted into perfluorooctanoic acid equivalents (PEQs) and compared against the U.S. Environmental Protection Agency's (EPA's) reference dose

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Composito completamente biobased da scarti lignocellulosici di platano con potenziale utilizzo nella produzione di bastoncini di lecca-lecca

I bastoncini per lecca-lecca sono stati sviluppati con materiali completamente biobased ottenuti da diversi sottoprodotti della platano, utilizzando un processo di estrusione seguito da stampaggio a compressione a caldo. La matrice termoplastica era costituita da farina e amido ricavati dalla polpa dei mazzi di platano e dalla torta di buccia di platano. I bastoncini per lecca-lecca biobased sono stati caratterizzati nel test di migrazione, riscontrando una maggiore stabilità strutturale negli alimenti lipofilici, con il cioccolato scelto come prodotto da sottoporre a caratterizzazione fisico-chimica, strutturale, meccanica e dinamico-meccanica durante l'interazione con i due bastoncini per lecca-lecca biobased fino al raggiungimento del post-consumo

polysaccharides

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Artide

Fully Biobased Composite from Lignocellulosic Plantain Waste with Potential Use in the Manufacture of Lollipop Sticks

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Abstract: Lollipop sticks were developed with fully biobased materials made of different plantain by-products, using extrusion processing followed by hot compression molding. The thermoplastic matrix was constituted of flour and starch from plantain bunch pulp and plantain peel cake. At the same time, two types of reinforcement were used, one of them being yarn from the lignocellulosic fibers of the pseudostem sheaths to constitute the BC1 lollipop stick and the other directly from the plantain pseudostem treated sheath to establish the BC2 lollipop stick. The biobased lollipop sticks were characterized in the migration test, finding a higher structural stability in lipophilic foods, with chocolate chosen as a confection to undergo physicochemical, structural, mechanical, and dynamic–

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Ripensare il riciclo delle bottiglie in PE-HD: gli impatti della riduzione della varietà del design

Poiché i gravi impatti ambientali dell'inquinamento da plastica richiedono interventi, l'Unione Europea (UE) ha incluso il riciclo al centro delle sue politiche. Di conseguenza, l'attuale giurisdizione mira a raggiungere un tasso di riciclo del 65% per le bottiglie in plastica non PET entro il 2040. Tuttavia, l'uso diffuso di riciclati in polietilene ad alta densità post-consumo (rPE-HD) nei contenitori per prodotti chimici domestici è ancora limitato dalla contaminazione da PP, dalle scarse proprietà meccaniche e dalla bassa resistenza alle cricche da stress ambientale (ESCR).

recycling

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Artide

Rethinking PE-HD Bottle Recycling—Impacts of Reducing Design Variety

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Abstract As the severe environmental impacts of plastic pollution demand determined action, the European Union (EU) has included recycling at the core of its policies. Consequently, evolving jurisdiction now aims to achieve a recycling rate of 65% for non-PET plastic bottles by 2040. However, the widespread use of post-consumer high-density polyethylene (rPE-HD) recyclates in household chemical containers is still limited by PP contamination, poor mechanical properties, and low environmental stress cracking resistance (ESCR). Although previous studies have explored the improvement of regranulate properties through additives, few have examined whether reducing the variety of extrusion blow-moulded PE-HD packaging could offer similar benefits. Therefore, two sorted fractions of rPE-HD hollow bodies were processed into regranulates under industrial conditions, including hot washing, extrusion, and deodorisation. Subsequently, both materials underwent comprehensive characterisation regarding their composition and performance. The opaque material, which was sourced from milk bottles in the UK, exhibited greater homogeneity with minor impurities, leading to improved ductility and melt strain hardening at moderate strain rates compared to the mixed material stream, which contained

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