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PACKAGING SCIENCE

*E' la Rassegna Scientifica Internazionale della **Fondazione Carta Etica del Packaging**.*

Pubblicazione bimestrale in cui sono presentati 7 articoli multidisciplinari, afferenti al packaging, selezionati da diverse riviste del mondo scientifico digitale.

*Packaging Science attraverso le tematiche sempre attuali ed aggiornate dei suoi articoli in diverse discipline, concorre ampiamente alla promozione e all'evoluzione della corretta cultura del packaging e dei **10 Valori della Carta Etica** per accompagnare il packaging verso un futuro più consapevole.*

Esplorare l'interazione tra atteggiamenti pro-ambientali, scelte dietetiche e preferenze di imballaggio: uno scenario sullo studio di un ristorante in realtà virtuale (VR)

L'imperativo è affrontare le preoccupazioni ambientali, in particolare i rifiuti di plastica e le emissioni di gas serra, poiché riguardano i settori del comparto dei servizi alimentari. Questo studio cerca di comprendere i fattori che influenzano gli atteggiamenti e i comportamenti ambientali, con particolare attenzione alle preferenze dietetiche e alle scelte di confezionamento utilizzando uno scenario di ristorante VR. Sebbene i risultati suggeriscano correlazioni significative tra genere e atteggiamenti pro-ambientali e una potenziale connessione tra l'adozione di diete vegetariane e atteggiamenti pro-ambientali, il nostro studio sottolinea la natura sfumata di queste relazioni.



Article

Exploring the Interplay of Pro-Environmental Attitudes, Dietary Choices, and Packaging Preferences: A Virtual Reality Restaurant Scenario Study

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Abstract: This research paper delves into the complex relationship between pro-environmental attitudes, dietary preferences, and packaging choices using a Virtual Reality (VR) restaurant scenario. The imperative is to address environmental concerns, particularly plastic waste and greenhouse gas emissions, as they pertain to sectors of the food service sector. This study seeks to understand the factors influencing environmental attitudes and behaviors, with a focus on dietary preferences and packaging choices using a VR restaurant scenario. This study explores connections between gender, education, interventions, and pro-environmental attitudes, as well as the correlation between vegetarian diets and sustainable behaviors. While the results suggest significant correlations between gender and pro-environmental attitudes and a potential connection between adopting vegetarian diets and pro-environmental attitudes, our study emphasizes the nuanced nature of these relationships. The findings underline the importance of interdisciplinary research and strategic interventions for fostering sustainable behaviors and reducing environmental impact. The use of VR simulation adds a novel dimension to understanding individuals' choices in controlled environments, shedding light on the intricate dynamics of pro-environmental decision making. This paper contributes to the ongoing discourse on sustainable behavior by offering insights into the interplay between personal preferences, environmental awareness, and choices with significant environmental implications.



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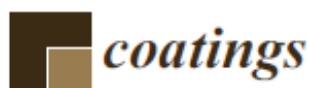
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Film e rivestimenti a base proteica: un approccio innovativo

Le pellicole e i rivestimenti a base proteica sono altamente biodegradabili e rappresentano alternative sostenibili ai materiali a base di petrolio. Questi materiali possiedono lodevoli proprietà barriera, proteggendo efficacemente da ossigeno, umidità e composti aromatici, rendendoli adatti a varie applicazioni di imballaggio alimentare. Oltre al loro ruolo nell'imballaggio alimentare, i rivestimenti e le pellicole hanno applicazioni significative nei settori biomedico e farmaceutico. Nonostante questi attributi promettenti, persistono sfide in termini di resistenza meccanica, resistenza all'acqua e scalabilità della lavorazione di film e rivestimenti a base proteica.



Review

Protein-Based Films and Coatings: An Innovative Approach

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Abstract: Protein-based films and coatings are highly biodegradable and represent sustainable alternatives to petroleum-based materials. These materials possess commendable barrier properties, effectively safeguarding against oxygen, moisture, and aroma compounds, rendering them well-suited for various food packaging applications. Beyond their role in food packaging, coatings and films have significant applications in the biomedical and pharmaceutical domains. Their inherent biocompatibility and controlled release properties make them valuable for applications such as drug-delivery systems, wound dressings, and tissue-engineering scaffolds. Moreover, the adaptability of these films to exhibit stimuli-responsive behavior opens avenues for on-demand drug release and sensing capabilities. Despite these promising attributes, challenges persist in terms of the mechanical strength, water resistance, and scalability of the processing of protein-based films and coatings. Ongoing research endeavors are dedicated to refining protein extraction methods, incorporating reinforcing agents, and implementing strategies to optimize the overall performance of these materials. Such efforts aim to overcome existing limitations and unlock the full potential of protein-based films and coatings in diverse applications, contributing to the advancement of sustainable and versatile biomaterials.



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Preparazione di un film attivo bifunzionale a base di idrogel a doppio strato e antociani di cavolo rosso per il mantenimento e il monitoraggio della freschezza della carne di maiale

In questo studio è stato creato un film composito con il duplice obiettivo di prolungare la durata di conservazione della carne suina e mostrarne la freschezza. I materiali idrogel come film di base solida sono stati selezionati da gelatina (G), alginato di sodio (SA) e carbossimetilcellulosa (CMC). Inoltre, sono stati studiati gli effetti di diverse concentrazioni di antociani di cavolo rosso (R) (3%, 6%, 12% e 24%). Studiando a fondo l'effetto del film composito sulla conservazione della carne suina e combinandolo con l'algoritmo K-nearest neighbor (KNN), è stato stabilito il modello discriminativo del grado di freschezza della carne suina e il tasso di riconoscimento del set di previsione è stato fino al 93,3%.



Article

Preparation of a Dual-Functional Active Film Based on Bilayer Hydrogel and Red Cabbage Anthocyanin for Maintaining and Monitoring Pork Freshness

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Abstract In this study, a composite film was created with the dual goal of prolonging pork shelf life and showing freshness. Hydrogel materials as solid base films were selected from gelatin (G), sodium alginate (SA) and carboxymethyl cellulose (CMC) based on their antioxidant activity, water vapor permeability, mechanical properties, as well as their stability, antimicrobial activity, and freshness, which indicates effectiveness when combined with anthocyanins. Furthermore, the effects of several concentrations of red cabbage anthocyanin (R) (3%, 6%, 12%, and 24%) on freshness indicators and bacteriostasis were investigated. The antimicrobial activity of the composite films was evaluated against *Escherichia coli*, *Bacillus subtilis*, and *Staphylococcus aureus*. Likewise, the freshness indicates effectiveness was evaluated for NH₃. Considering the mechanical properties, antibacterial ability, freshness indicator effect, and stability of the composite film, CS film combined with 12% R was selected to prepare a dual-functional intelligent film for pork freshness indicator and preservation. By thoroughly investigating the effect of composite film on pork conservation and combining with it KNN, the discriminative model of pork freshness grade was established and the recognition rate of the prediction set was up to 93.3%. These results indicated that CSR film can be used for the creation of active food packaging materials.

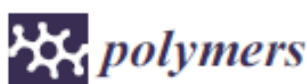
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Soluzioni innovative di imballaggio in polimeri biobased e sostenibili per prolungare la durata di conservazione del pane: una revisione

Gli imballaggi sostenibili stanno guadagnando costantemente importanza nell'industria alimentare, con i materiali a base biologica che emergono come un promettente sostituto delle plastiche convenzionali derivate dal petrolio. Questa review è dedicata all'esame di materiali biobased innovativi nel contesto del packaging del pane. Ha lo scopo di fornire una panoramica completa delle recenti scoperte, delle proprietà fondamentali e delle potenziali applicazioni. Iniziando con un esame delle sfide poste dai vari tipi di pane e dall'imperativo di prolungare la durata di conservazione, la revisione sottolinea il ruolo benefico dei biopolimeri come rivestimenti interni o strati esterni nel preservare la freschezza del prodotto mantenendo l'integrità strutturale.



Review

Innovative Biobased and Sustainable Polymer Packaging Solutions for Extending Bread Shelf Life: A Review

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Abstract: Sustainable packaging has been steadily gaining prominence within the food industry, with biobased materials emerging as a promising substitute for conventional petroleum-derived plastics. This review is dedicated to the examination of innovative biobased materials in the context of bread packaging. It aims to furnish a comprehensive survey of recent discoveries, fundamental properties, and potential applications. Commencing with an examination of the challenges posed by various bread types and the imperative of extending shelf life, the review underscores the beneficial role of biopolymers as internal coatings or external layers in preserving product freshness while upholding structural integrity. Furthermore, the introduction of biocomposites, resulting from the amalgamation of biopolymers with active biomolecules, fortifies barrier properties, thus shielding bread from moisture, oxygen, and external influences. The review also addresses the associated challenges and opportunities in utilizing biobased materials for bread packaging, accentuating the ongoing requirement for research and innovation to create advanced materials that ensure product integrity while diminishing the environmental footprint.



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Valutazione di un contenitore a base di carbonato di calcio per il trasporto e lo stoccaggio di pesce fresco come alternativa sostenibile alle scatole in polistirolo

Il presente studio mirava a valutare l'effetto di materiali di imballaggio alternativi sul mantenimento della qualità e sulla durata di conservazione del pesce intero in condizioni di bassa temperatura e di abuso. L'orata (*Pagrus major*) è stata raccolta e conservata in diversi contenitori di imballaggio, ad esempio una scatola di polistirene convenzionale (PS), un CaCO_3 -scatola a base di carta e una scatola di cartone (testata come semplice contenitore alternativo per il trasporto e la conservazione a breve termine degli alimenti). La sostituzione dei materiali di imballaggio in plastica convenzionali con sistemi di imballaggio alternativi e rispettosi dell'ambiente, senza influire sulla durata di conservazione del pesce, può ridurre i rifiuti di plastica, garantendo al contempo l'elevata qualità e la durata di conservazione dei prodotti alimentari deperibili.



sustainability



Article

Evaluation of a Calcium Carbonate-Based Container for Transportation and Storage of Fresh Fish as a Sustainable Alternative to Polystyrene Boxes

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Abstract The present study aimed to assess the effect of alternative packaging materials on the quality retention and shelf-life of whole fish under low and abuse temperature conditions. Red sea bream (*Pagrus major*) was harvested and stored in different packaging containers, i.e., a conventional polystyrene (PS) box, a CaCO_3 -based box and a cardboard box (tested as a simple alternative container for transportation and short-term storage of food). After harvesting and transportation, fish was stored in the tested containers at 2 °C for 11 days and periodically kept at room temperature (25 °C) to simulate potential temperature fluctuations in the actual supply chain. The effect of temperature fluctuations and packaging materials on the quality and remaining shelf-life of fish was determined by microbial enumeration (total viable counts, *Pseudomonas* spp. and Enterobacteriaceae). PS retained fish quality and maintained a low temperature of fish for longer periods of time during storage at ambient conditions. The CaCO_3 -based containers also showed satisfactory performance, resulting in a similar microbial load in fish flesh to the samples stored in PS boxes after 11 days of simulated transportation and storage (TVC load 7.8–8.0 logcfu/g). Cardboard resulted in a rapid increase in the internal temperature during the temperature fluctuations at ambient conditions, resulting in higher microbial loads of fish flesh at all stages of the simulated cold chain. The replacement of conventional plastic packaging materials with alternative, environmentally friendly packaging systems without affecting the shelf-life of fish may reduce plastic waste while ensuring the high quality and shelf-life of perishable food products.



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Immaginare un'economia BHET: aggiungere valore ai rifiuti di PET

Il polietilene tereftalato, il quinto polimero più prodotto, genera ogni anno una notevole quantità di rifiuti. Questo aumento della produzione di rifiuti ha stimolato l'interesse per i percorsi chimici e meccanici per il riciclo. Il passaggio da ambienti di laboratorio a un'implementazione su larga scala crea opportunità per esplorare il valore e il recupero dei prodotti di riciclaggio. Derivato dalla glicolisi del PET, il bis(2-idrossietil) tereftalato (BHET) presenta versatilità come prodotto di depolimerizzazione e monomero prezioso. BHET mostra versatilità e trova applicazione in diversi settori come resine, rivestimenti, schiume e impalcature di tessuti. Questa revisione mette in luce le opportunità per BHET come materia prima preziosa per un'economia più circolare dei materiali polimerici.



sustainable
chemistry



Review

Envisioning a BHET Economy: Adding Value to PET Waste

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Abstract: Poly(ethylene terephthalate), the fifth most produced polymer, generates significant waste annually. This increased waste production has spurred interest in chemical and mechanical pathways for recycling. The shift from laboratory settings to larger-scale implementation creates opportunities to explore the value and recovery of recycling products. Derived from the glycolysis of PET, bis(2-hydroxyethyl) terephthalate (BHET) exhibits versatility as a depolymerization product and valuable monomer. BHET exhibits versatility and finds application across diverse industries such as resins, coatings, foams, and tissue scaffolds. Incorporating BHET, which is a chemical recycling product, supports higher recycling rates and contributes to a more sustainable approach to generating materials. This review illuminates the opportunities for BHET as a valuable feedstock for a more circular polymer materials economy.

Keywords: poly(ethylene terephthalate); chemical recycling; glycolysis; unsaturated polyesters; polyurethanes

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Valutazione rapida della migrazione degli ftalati di di(2-etilesile) dai prodotti di consumo in PVC

Il policloruro di vinile (PVC) è ampiamente utilizzato per produrre vari beni di consumo, tra cui imballaggi alimentari, giocattoli per bambini, materiali da costruzione e prodotti cosmetici. Tuttavia, nonostante il loro uso diffuso, i plastificanti ftalati sono stati identificati come interferenti endocrini, che causano effetti negativi sulla salute, portando così a crescenti preoccupazioni per quanto riguarda la loro migrazione dai prodotti in PVC all'ambiente. Questo studio ha proposto un metodo per misurare rapidamente la migrazione degli ftalati, in particolare del di(2-etilesil) ftalato (DEHP), dai prodotti in PVC ai liquidi comunemente incontrati.



toxics



Communication

Rapid Assessment of Di(2-ethylhexyl) Phthalate Migration from Consumer PVC Products

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Abstract Poly(vinyl chloride) (PVC) is widely used to produce various consumer goods, including food packaging, toys for children, building materials, and cosmetic products. However, despite their widespread use, phthalate plasticizers have been identified as endocrine disruptors, which cause adverse health effects, thus leading to increasing concerns regarding their migration from PVC products to the environment. This study proposed a method for rapidly measuring the migration of phthalates, particularly di(2-ethylhexyl) phthalate (DEHP), from PVC products to commonly encountered liquids. The release of DEHP under various conditions, including exposure to aqueous and organic solvents, different temperatures, and household microwaves, was investigated. The amount of DEHP released from both laboratory-produced PVC films and commercially available PVC products was measured to elucidate the potential risks associated with its real-world applications. Furthermore, tests were performed to evaluate cytotoxicity using estrogen-dependent and -independent cancer cell lines. The results revealed a dose-dependent impact on estrogen-dependent cells, thus emphasizing the potential health implications of phthalate release. This comprehensive study provides valuable insights into the migration patterns of DEHP from PVC products and forms a basis for further research on the safety of PVC and plasticizers.

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