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PACKAGING SCIENCE

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LCA delle bottiglie di acqua minerale in vetro vs PET: un caso di studio italiano

A causa del grave problema dell'inquinamento da plastica nell'ambiente acquatico, molte persone rifiutano gli imballaggi in plastica a favore di contenitori di vetro considerati più sostenibili. Per evitare giudizi errati, la valutazione della sostenibilità delle alternative di imballaggio dovrebbe essere effettuata con un approccio basato sul ciclo di vita. A questo proposito, lo studio presenta un Life Cycle Assessment (LCA) comparativo di due sistemi di imballaggio alternativi per l'acqua potabile: bottiglie di vetro riutilizzabili e bottiglie in polietilene tereftalato (PET). Lo studio è stato eseguito considerando i dati reali di un'azienda italiana di acqua minerale che imbottiglia e distribuisce sia acqua naturale che frizzante.

recycling

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Article

LCA of Glass Versus PET Mineral Water Bottles: An Italian Case Study

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Abstract: Due to the serious problem of plastic pollution in aquatic environment, many people reject plastic packaging in favour of glass containers which are considered more sustainable. To avoid misjudgements, the sustainability assessment of packaging alternatives should be carried out with a life cycle thinking approach. In this regard, the study presents a comparative Life Cycle Assessment (LCA) of two alternative packaging systems for drinking water: reusable glass bottles and polyethylene (PET) bottles. The case study was performed considering the real data of an Italian mineral water company that bottles and distributes both natural and sparkling water. The environmental impacts of the two packaging systems were estimated with the ReCiPe 2016 (H) evaluation method adopting both midpoint and endpoint approaches. The results showed that the PET bottle is the most sustainable alternative for natural water for many impact categories; while, in the case of sparkling water, the environmental impacts of the two packaging systems are similar and the most environmentally sound solution can vary depending on the impact category. The following are the most significant aspects of the analysis: (1) the number of reuses of a single glass bottle; (2) the distribution distance. Their variation can determine which packaging is the most sustainable. Therefore, a life cycle assessment approach is needed for each specific case.

Keywords: sustainability; reusable glass bottle; PET bottle; beverage packaging; bottled water

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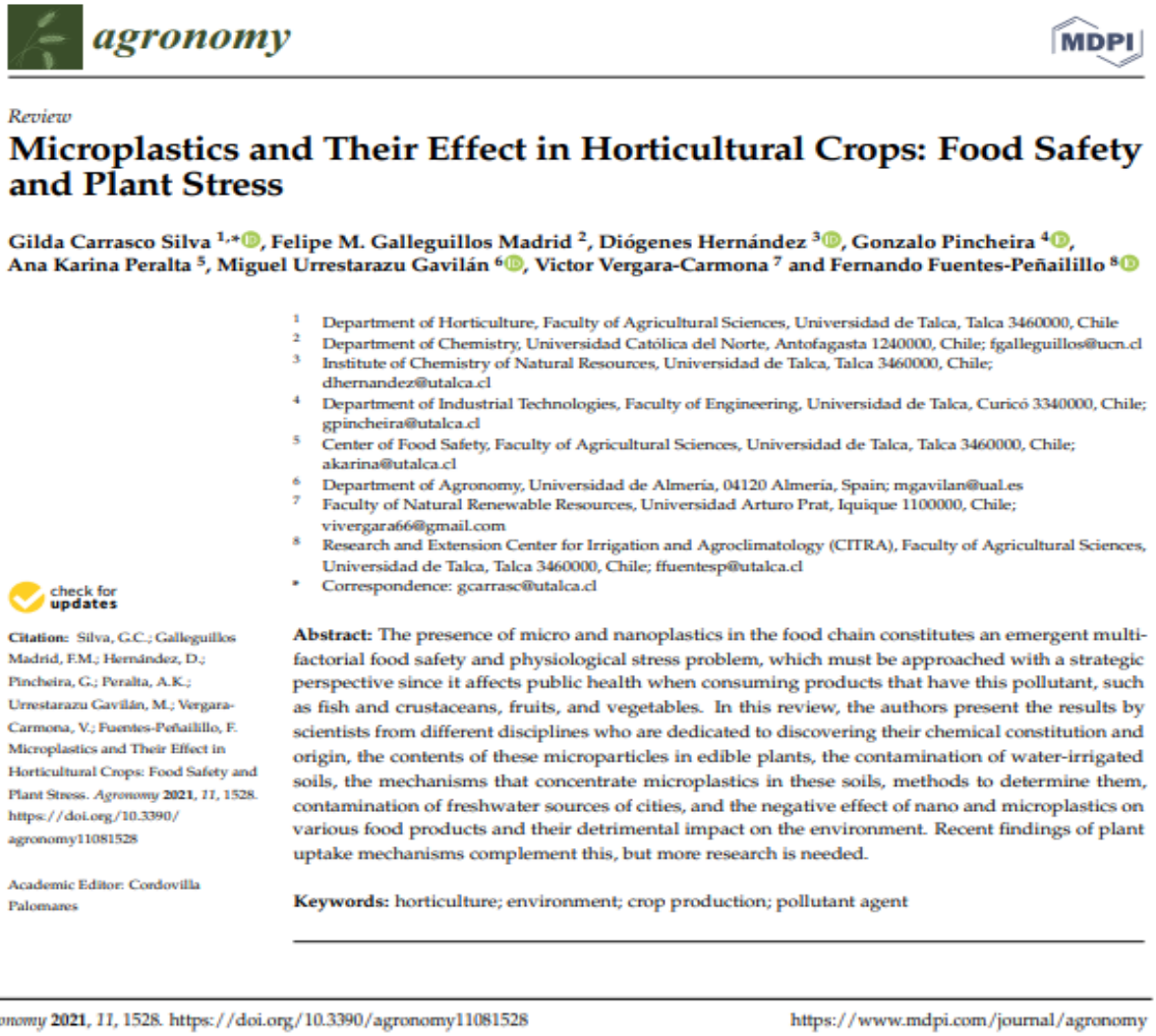
Microplastiche ed effetto nelle colture orticole: sicurezza alimentare e stress delle piante

La presenza di micro e nano plastiche nella catena alimentare costituisce un emergente problema di sicurezza alimentare multifattoriale e di stress fisiologico, che deve essere affrontato con una prospettiva strategica poiché influisce sulla salute pubblica quando si consumano prodotti che hanno questo inquinante, come pesce e crostacei, frutta e verdura. In questa recensione, gli autori presentano i risultati di scienziati di diverse discipline che si dedicano a scoprire la loro costituzione chimica e origine, il contenuto di queste micro particelle nelle piante commestibili, la contaminazione dei terreni irrigati dall'acqua, i meccanismi che concentrano le microplastiche in questi terreni, i metodi per determinarle, la contaminazione delle fonti di acqua dolce delle città e l'effetto negativo delle nano e microplastiche su vari prodotti alimentari e il loro impatto dannoso sull'ambiente.



agronomy

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Review

Microplastics and Their Effect in Horticultural Crops: Food Safety and Plant Stress

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Abstract: The presence of micro and nanoplastics in the food chain constitutes an emergent multi-factorial food safety and physiological stress problem, which must be approached with a strategic perspective since it affects public health when consuming products that have this pollutant, such as fish and crustaceans, fruits, and vegetables. In this review, the authors present the results by scientists from different disciplines who are dedicated to discovering their chemical constitution and origin, the contents of these microparticles in edible plants, the contamination of water-irrigated soils, the mechanisms that concentrate microplastics in these soils, methods to determine them, contamination of freshwater sources of cities, and the negative effect of nano and microplastics on various food products and their detrimental impact on the environment. Recent findings of plant uptake mechanisms complement this, but more research is needed.

Keywords: horticulture; environment; crop production; pollutant agent

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Copolimeri verdi a base di poli (acido lattico).

L'acido poli-lattico (PLA) è un polimero biodegradabile e biocompatibile che può essere applicato nel campo del packaging e della medicina. Il suo substrato di partenza è l'acido lattico e, per questo motivo, il PLA può anche essere considerato un materiale ecologico prodotto da risorse rinnovabili. Oltre a diversi vantaggi, l'acido poli-lattico presenta inconvenienti come la fragilità e le temperature di transizione vetrosa e di fusione relativamente elevate. Tuttavia, la copolimerizzazione del PLA con altri polimeri migliora le caratteristiche del PLA e si può ottenere un materiale desiderabile caratterizzato da proprietà fisiche preferibili. Presentare una panoramica dettagliata sui risultati della copolimerizzazione del PLA è l'innovazione di questa breve review.

materials

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Review

Green Copolymers Based on Poly(Lactic Acid)—Short Review

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Abstract: Polylactic acid (PLA) is a biodegradable and biocompatible polymer that can be applied in the field of packaging and medicine. Its starting substrate is lactic acid and, on this account, PLA can also be considered an ecological material produced from renewable resources. Apart from several advantages, polylactic acid has drawbacks such as brittleness and relatively high glass transition and melting temperatures. However, copolymerization of PLA with other polymers improves PLA features, and a desirable material marked by preferable physical properties can be obtained. Presenting a detailed overview of the accounts on the PLA copolymerization accomplishments is the innovation of this paper. Scientific findings, examples of copolymers (including branched, star, grafted or block macromolecules), and its applications are discussed. As PLA copolymers can be potentially used in pharmaceutical and biomedical areas, the attention of this article is also placed on the advances present in this field of study. Moreover, the subject of PLA synthesis is described. Three methods are given: azeotropic dehydrative condensation, direct poly-condensation, and ring-opening polymerization (ROP), along with its mechanisms. The applied catalyst also has an impact on the end product and should be adequately selected depending on the intended use of the synthesized PLA. Different ways of using stannous octoate ($Sn(Oct)_2$) and examples of the other inorganic and organic catalysts used in PLA synthesis are presented.

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Citation: Stefaniak, K.; Masek, A. Green Copolymers Based on Poly(Lactic Acid)—Short Review. *Materials* **2021**, *14*, 5254. https://

Keywords: polylactic acid; copolymers; catalysts; polymer synthesis; ring-opening polymerization; medical application

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Raccolta di peptidi antimicrobici da insetti (Hermetia illucens) e sue applicazioni nel packaging alimentare.

Contemporaneamente all'aumento della popolazione, la domanda di cibo è in aumento, il che può portare alla scarsità. Un imballaggio adeguato è uno dei modi per evitare il deterioramento degli alimenti e prevenire gli sprechi. Negli ultimi anni, il packaging attivo ha raggiunto interesse grazie ai suoi lodevoli risultati nella conservazione degli alimenti. Diversi studi hanno dimostrato che l'incarnazione di componenti antimicrobici nel materiale di imballaggio ha la capacità di prevenire la contaminazione microbica. I peptidi antimicrobici (AMP) sono agenti antimicrobici di recente scoperta per l'inserimento nel materiale di imballaggio. Gli agenti che causano malattie negli esseri umani sono gli stessi che si trovano negli insetti. Quindi, gli AMP estratti dagli insetti hanno il potenziale per combattere i microrganismi che agiscono come pericoli per la salute umana

applied sciences

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Review

Harvesting of Antimicrobial Peptides from Insect (*Hermetia illucens*) and Its Applications in the Food Packaging

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Abstract: About one-third of the total food produced is wasted, rising the concern to adopt proper management. Simultaneously with the increase in population, demand for food is increasing which may lead to scarcity. Adequate packaging is one of the ways to avoid deterioration of food and prevent wastage. In recent years, active packaging has attained interest due to its commendable results in food preservation. Several studies proved that the embodiment of antimicrobial components into the packaging material has the ability to prevent microbial contamination. Antimicrobial peptides (AMP) are newly discovered antimicrobial agents for impregnation into packaging material. Among various sources for AMP, insects have shown great resistivity against a wide spectrum of microorganisms. Insects feed on substances consisting of a varying range of contaminations, which often results in infections. Insects synthesise AMPs to fight such infections and survive in that atmosphere. The disease-causing agents in humans are the same as those found in insects. Hence, AMPs extracted from insects have the potential to fight the microorganisms that act as hazards to human health. This review highlights the harvesting and synthesis of AMPs from *Hermetia illucens*, which is a promising source for AMP and its applications in the food packaging industry.

Keywords: antimicrobial peptides; synthesis; isolation; harvesting; food packaging; active packaging; impregnation

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Citation: Sultana, A.; Luo, H.; Ramakrishna, S. Harvesting of Antimicrobial Peptides from Insect (*Hermetia illucens*) and Its Applications in the Food Packaging. *Appl. Sci.* **2021**, *11*, 6991. https://doi.org/10.3390/app11156991

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Alternative alla plastica: alghe nei materiali a contatto con gli alimenti (imballaggi attivi, imballaggi intelligenti, film commestibili e rivestimenti)

La plastica, che è un importante materiale di imballaggio alimentare, danneggia l'ecosistema, la fauna selvatica e l'ambiente. Di conseguenza, sono in corso numerose ricerche sui polimeri alternativi, che hanno proprietà simili alla plastica ma sono anche rispettosi dell'ambiente (biodegradabili). Negli ultimi anni, l'utilizzo di polisaccaridi di alghe ha suscitato interesse a causa della sua biodegradabilità, non tossicità, capacità antiossidanti e eccellente capacità di formazione del film. Tuttavia, presenta una serie di inconvenienti come bassa resistenza alla trazione, solubilità in acqua e caratteristiche antibatteriche moderate, tra gli altri. L'aggiunta di altri biopolimeri, nanoparticelle o agenti attivi naturali migliora queste caratteristiche.

foods

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Review

Seaweed Polysaccharide in Food Contact Materials (Active Packaging, Intelligent Packaging, Edible Films, and Coatings)

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Abstract: Food contact materials (FCMs) are materials that come in contact with food products such as food packaging which play a significant role in the food quality and safety. Plastic, which is a major food packaging material, harms the eco-system, wildlife, and the environment. As a result, numerous researches have been in progress on alternative polymers, which has similar properties as plastic but is also environmentally friendly (biodegradable). In recent years, the utilization of seaweed polysaccharides has piqued interest due to its biodegradability, non-toxicity, antioxidant capabilities, and excellent film formation ability. However, it has a number of drawbacks such as low tensile strength, water solubility, and moderate antibacterial characteristics, among others. The addition of other biopolymers, nanoparticles, or natural active agents improves these features. In this review article, we have summarized the current state of seaweed polysaccharide research in active packaging, intelligent packaging, edible films, and coatings. It also highlights the physical, thermal, antioxidant, and other properties of these materials. Finally, the article discusses the relevant legislation as well as the field's future prospects. Research shows that seaweeds polysaccharide looks promising as a sustainable food contact material, but there is always a potential for development to make it market feasible.

Keywords: seaweeds; polysaccharide; active packaging; intelligent packaging; edible films; coating; legislations

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Citation: Perera, K.Y.; Sharma, S.; Pradhan, D.; Jaiswal, A.K.; Jaiswal, S. Seaweed Polysaccharide in Food Contact Materials (Active Packaging, Intelligent Packaging, Edible Films, and Coatings). *Foods* **2021**, *10*, 2088. https://doi.org/10.3390/foods10092088

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Rivestimenti e film di caseina attiva per alimenti deperibili: proprietà strutturali ed estensione della shelf - life

C'è un urgente bisogno di aumentare le scorte alimentari per soddisfare le esigenze delle generazioni future, poiché si prevede che la popolazione del mondo crescerà oltre i 10 miliardi entro il 2050. I rivestimenti e i film commestibili attivi sono una promettente tecnologia di conservazione sostenibile per l'estensione della durata di conservazione dei prodotti alimentari. Tra i biopolimeri a base di proteine, la caseina e i suoi derivati come film di imballaggio sono stati ampiamente studiati a causa del loro basso costo, completa biodegradabilità e disponibilità. Attualmente, non esiste uno studio di revisione incentrato sul rivestimento attivo a base di caseinato e sul film, quindi, questa revisione mira a fornire approfondimenti sulla composizione, la reologia, la struttura e le proprietà delle formulazioni a base di caseinato discutendo criticamente i risultati presentati in letteratura.

coatings

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Review

Active Casein Coatings and Films for Perishable Foods: Structural Properties and Shelf-Life Extension

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Abstract: There is an urgent need to increase the food supplies to fulfil the demands of future generations as the population of the world is expected to grow beyond 10 billion by 2050. An essential component for ensuring global food security is to reduce food losses during the post-harvest stage. Active edible coatings and films are a promising sustainable preservation technology for shelf-life extension of food products by hindering decay kinetics of minimally processed fruits and vegetables (F&V), by restricting the mass transfer of moisture, aroma, or gases and carrying an active compound, such as an antioxidant or antimicrobial. Active protein-based coatings and films have the potential to extend the shelf-life of food products by decreasing their respiration rates, as they exhibit an excellent gas barrier and good mechanical properties as compared to other biopolymeric packaging. Among protein-based biopolymers, casein and its derivatives as packaging films have been extensively studied due to their low cost, complete biodegradability, and availability. Currently, there is no review study focusing on caseinate-based active coating and film, thus, this review aims to give insights on the composition, rheology, structure, and properties of caseinate-based formulations by critically discussing the results presented in the literature. A methodological approach was followed to obtain relevant literature to discuss the influence of additives on the shelf-life of F&V. Furthermore, changes in secondary structure of casein were observed after incorporation of bioactive compounds (i.e., phenolic acids). Likewise, there is a need to explore chemical interactions among bioactive compounds and biopolymer material by using in silico and laboratory trials as food additives have shown to influence the physicochemical properties of film and shelf-life of food products.

Keywords: active coatings; films; proteins; shelf-life; caseinate; structural properties; fruits and vegetables

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Citation: Khan, M.R.; Volpe, S.; Valentino, M.; Miele, N.A.; Cavella, S.; Torrieri, E. Active Casein Coatings and Films for Perishable Foods: Structural Properties and Shelf-Life Extension. *Coatings* **2021**, *11*, 899. https://doi.org/10.3390/coatings11080899

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Sicurezza degli imballaggi alimentari in plastica: valutazione del rischio di sostanze aggiunte non intenzionalmente (NIAS)

Diversi materiali a contatto con gli alimenti (MCA) contengono sostanze aggiunte non intenzionalmente (NIAS) e la maggior parte delle sostanze che migrano dagli imballaggi alimentari in plastica sono sconosciute. Questa review mira a valutare le principali sfide che coinvolgono NIAS sconosciuti negli imballaggi alimentari in plastica in termini di identificazione, test di migrazione, previsione, preparazione del campione, metodi di determinazione e studi di valutazione del rischio. I prodotti di degradazione sono quasi la fonte primaria di NIAS negli FCM plastici.

polymers

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Review

Safety of Plastic Food Packaging: The Challenges about Non-Intentionally Added Substances (NIAS) Discovery, Identification and Risk Assessment

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Abstract: Several food contact materials (FCMs) contain non-intentionally added substances (NIAS), and most of the substances that migrate from plastic food packaging are unknown. This review aimed to situate the main challenges involving unknown NIAS in plastic food packaging in terms of identification, migration tests, prediction, sample preparation, determination methods and risk assessment trials. Most studies have identified NIAS in plastic materials as polyurethane adhesives (PU), polyethylene terephthalate (PET), polyester coatings, polypropylene materials (PP), multilayers materials, plastic films, polyvinyl chloride (PVC), recycled materials, high-density polyethylene (HDPE) and low-density polyethylene (LDPE). Degradation products are almost the primary source of NIAS in plastic FCMs, most from antioxidants as Irganox 1010 and Irgafos 168, following by oligomers and side reaction products. The NIAS assessment in plastics FCMs is usually made by migration tests under worst-case conditions using food simulants. For predicted NIAS, targeted analytical methods are applied using GC-MS based methods for volatile NIAS and GC-MS and LC-MS based methods for semi- and non-volatile NIAS; non-targeted methods to analyze unknown NIAS in plastic FCMs are applied using GC and LC techniques combined with QTOF mass spectrometry (HRMS). In terms of NIAS risk assessment and prioritization, the threshold of toxicological concern (TTC) concept is the most applied tool for risk assessment. Bioassays with sensitive analytical techniques seem to be an efficient method to identify NIAS and their hazard to human exposure; the combination of genotoxicity testing with analytical chemistry could allow the Cramer class III TTC application to prioritize unknown NIAS. The scientific justification for implementing a molecular weight-based cut-off (<1000 Da) in the risk assessment of FCMs should be reevaluated. Although official guides and opinions are being issued on the subject, the whole chain's alignment is needed, and more specific legislation on the steps to follow to get along with NIAS.

Keywords: food packaging additives; food contact materials (FCMs); food safety; additives in polymers; migration study; food contact articles (FCAs)

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Citation: Kato, L.S.; Conte-Junior, C.A. Safety of Plastic Food Packaging: The Challenges about Non-Intentionally Added Substances (NIAS) Discovery, Identification and Risk Assessment. *Polymers* **2021**, *13*, 2077. https://doi.org/10.3390/polym13132077

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