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PACKAGING SCIENCE

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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.*

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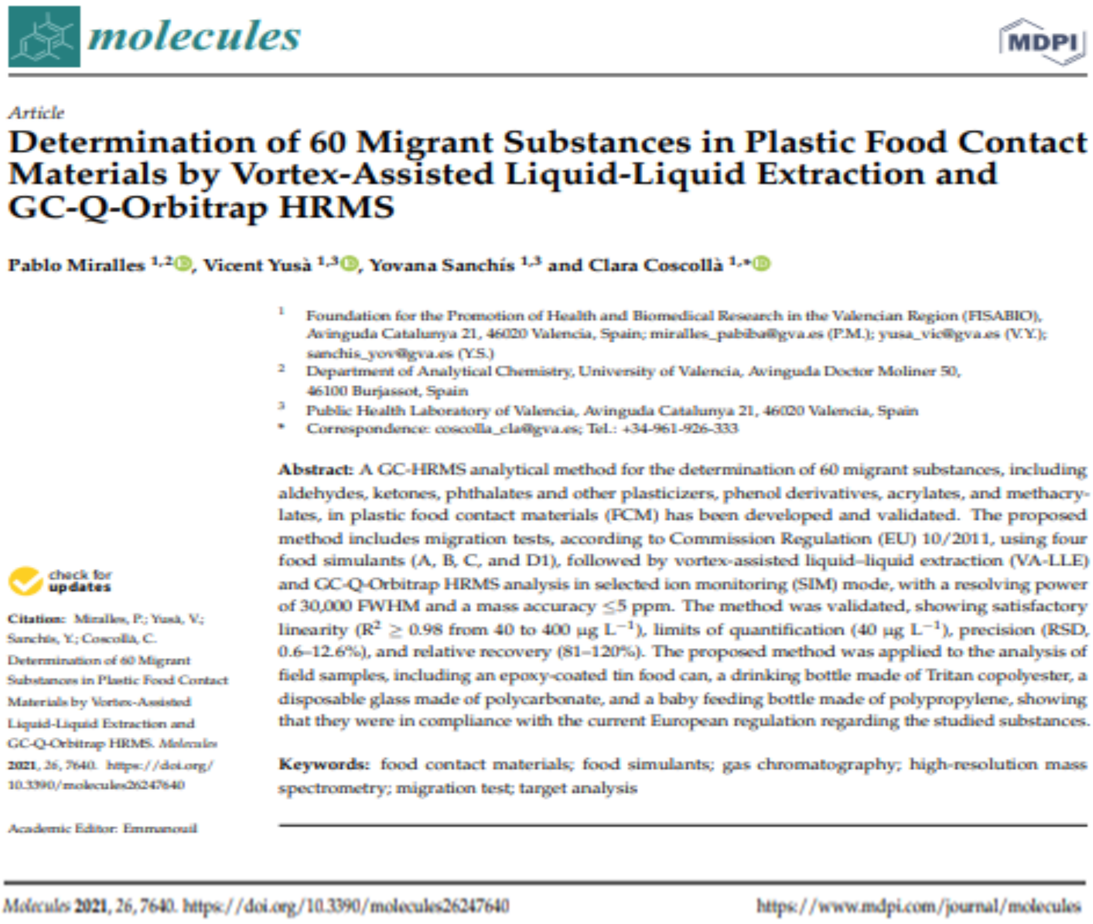
Determinazione di 60 sostanze migranti nei materiali plastici a contatto con gli alimenti.

È stato sviluppato e convalidato un metodo analitico GC-HRMS per la determinazione di 60 sostanze migranti, tra cui aldeidi, chetoni, ftalati e altri plastificanti, derivati fenolici, acrilati e metacrilati, nei materiali plastici a contatto con gli alimenti (FCM). Il metodo proposto include test di migrazione, secondo il regolamento (UE) n. 10/2011 della Commissione, utilizzando quattro simulanti alimentari (A, B, C e D1), seguiti dall′estrazione liquido-liquida assistita da vortice (VA-LLE) e dall′analisi HRMS GC-Q-Orbitrap in modalità di monitoraggio ionico (SIM) selezionato, con un potere risolutivo di 30.000 FWHM e una precisione di massa ≤5 ppm. Il metodo proposto è stato applicato all′analisi di campioni di mercato, tra cui una lattina di stagno rivestita di resina epossidica, un biberon in copoliestere tritano, un bicchiere monouso in policarbonato e un biberon in polipropilene, dimostrando che erano conformi alla normativa europea vigente in materia di sostanze studiate.



molecules

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Article

Determination of 60 Migrant Substances in Plastic Food Contact Materials by Vortex-Assisted Liquid-Liquid Extraction and GC-Q-Orbitrap HRMS

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Citation: Miralles, P.; Yusà, V.; Sanchís, Y.; Coscollà, C. Determination of 60 Migrant Substances in Plastic Food Contact Materials by Vortex-Assisted Liquid-Liquid Extraction and GC-Q-Orbitrap HRMS. *Molecules* **2021**, *26*, 7640. https://doi.org/10.3390/molecules26247640

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Abstract: A GC-HRMS analytical method for the determination of 60 migrant substances, including aldehydes, ketones, phthalates and other plasticizers, phenol derivatives, acrylates, and methacrylates, in plastic food contact materials (FCM) has been developed and validated. The proposed method includes migration tests, according to Commission Regulation (EU) 10/2011, using four food simulants (A, B, C, and D1), followed by vortex-assisted liquid–liquid extraction (VA-LLE) and GC-Q-Orbitrap HRMS analysis in selected ion monitoring (SIM) mode, with a resolving power of 30,000 FWHM and a mass accuracy ≤5 ppm. The method was validated, showing satisfactory linearity ($R^2 \geq 0.98$ from 40 to 400 μg L^{-1}), limits of quantification (40 μg L^{-1}), precision (RSD, 0.6–12.6%), and relative recovery (81–120%). The proposed method was applied to the analysis of field samples, including an epoxy-coated tin food can, a drinking bottle made of Tritan copolyester, a disposable glass made of polycarbonate, and a baby feeding bottle made of polypropylene, showing that they were in compliance with the current European regulation regarding the studied substances.

Keywords: food contact materials; food simulants; gas chromatography; high-resolution mass spectrometry; migration test; target analysis

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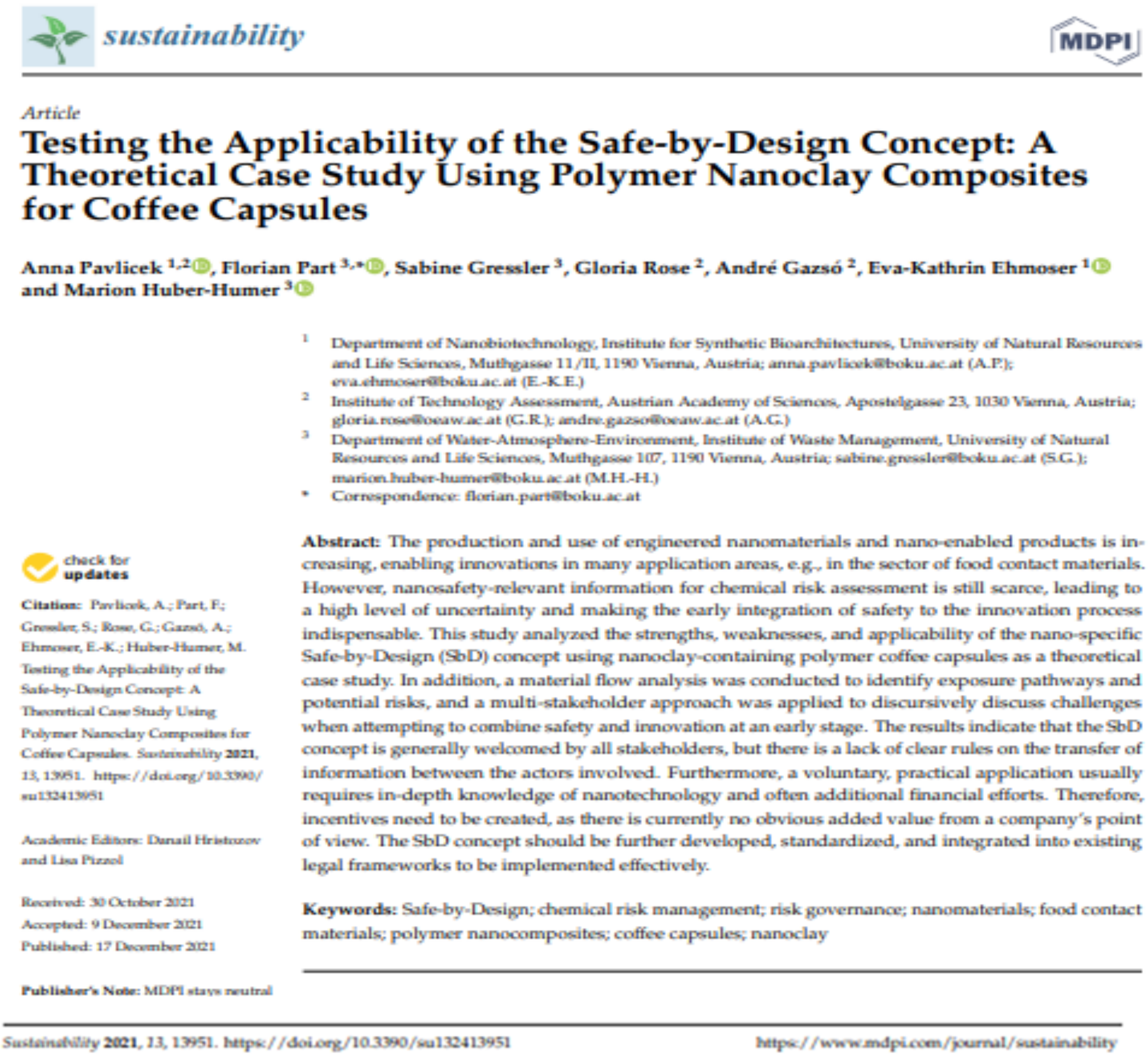
Applicabilità concetto Safe-by-Design: un caso di studio teorico con compositi polimerici nanoclay per capsule di caffè

La produzione e l'uso di nanomateriali ingegnerizzati e prodotti nano-abilitati è in aumento, consentendo innovazioni in molte aree di applicazione, ad esempio nel settore dei materiali a contatto con gli alimenti. Tuttavia, le informazioni rilevanti per la nanosicurezza per la valutazione del rischio chimico sono ancora scarse, il che porta a un elevato livello di incertezza e rende indispensabile l'integrazione precoce della sicurezza nel processo di innovazione. Questo studio ha analizzato i punti di forza, i punti deboli e l'applicabilità del concetto nano-specifico Safe-by-Design (SbD) utilizzando capsule di caffè polimerico contenenti nanoargilla come caso di studio teorico.



sustainability

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Article

Testing the Applicability of the Safe-by-Design Concept: A Theoretical Case Study Using Polymer Nanoclay Composites for Coffee Capsules

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Abstract: The production and use of engineered nanomaterials and nano-enabled products is increasing, enabling innovations in many application areas, e.g., in the sector of food contact materials. However, nanosafety-relevant information for chemical risk assessment is still scarce, leading to a high level of uncertainty and making the early integration of safety to the innovation process indispensable. This study analyzed the strengths, weaknesses, and applicability of the nano-specific Safe-by-Design (SbD) concept using nanoclay-containing polymer coffee capsules as a theoretical case study. In addition, a material flow analysis was conducted to identify exposure pathways and potential risks, and a multi-stakeholder approach was applied to discursively discuss challenges when attempting to combine safety and innovation at an early stage. The results indicate that the SbD concept is generally welcomed by all stakeholders, but there is a lack of clear rules on the transfer of information between the actors involved. Furthermore, a voluntary, practical application usually requires in-depth knowledge of nanotechnology and often additional financial efforts. Therefore, incentives need to be created, as there is currently no obvious added value from a company's point of view. The SbD concept should be further developed, standardized, and integrated into existing legal frameworks to be implemented effectively.

Keywords: Safe-by-Design; chemical risk management; risk governance; nanomaterials; food contact materials; polymer nanocomposites; coffee capsules; nanoclay

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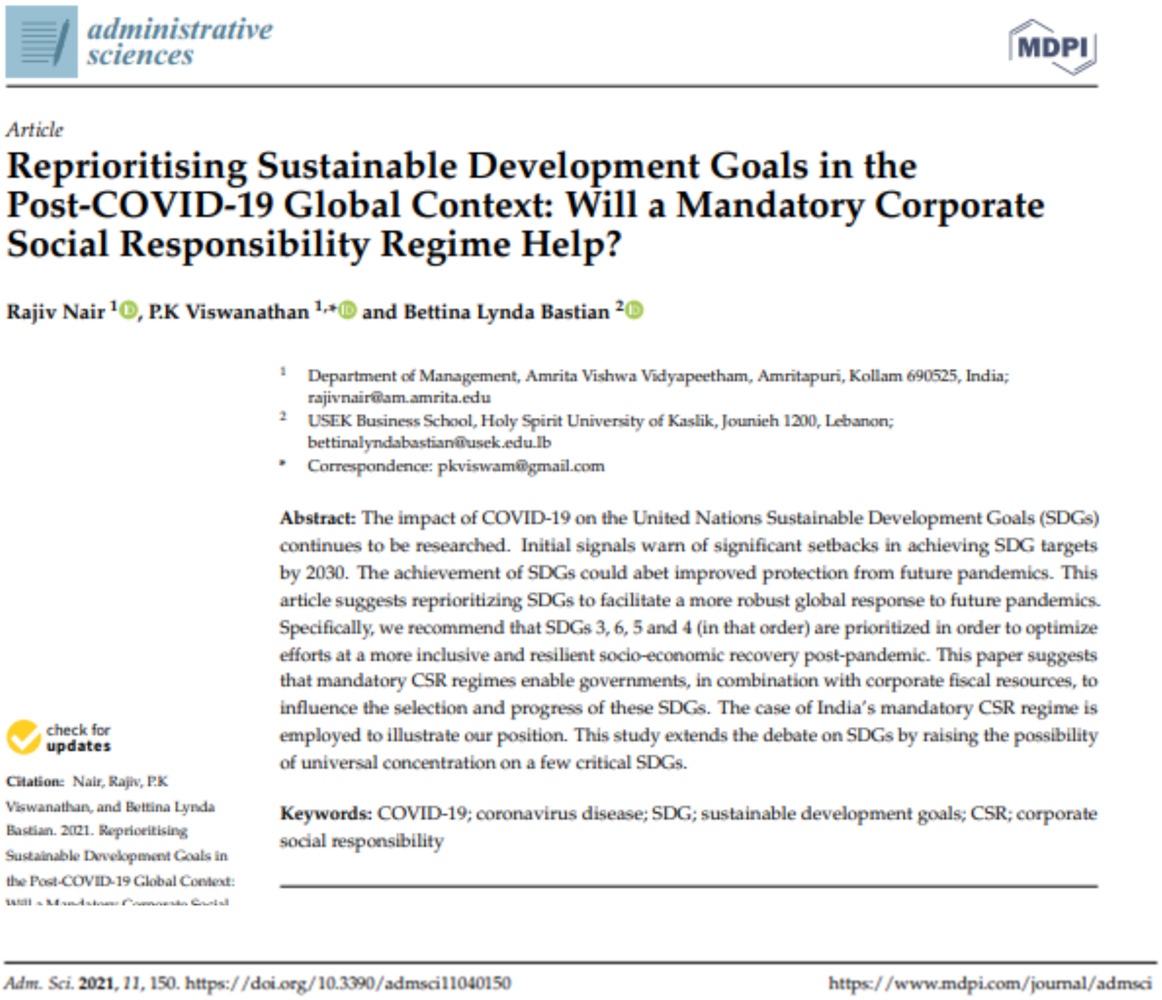
Ridefinire le priorità degli obiettivi di sviluppo sostenibile post-COVID-19: un regime obbligatorio di responsabilità sociale d'impresa aiuterà?

L'impatto del COVID-19 sugli obiettivi di sviluppo sostenibile (SDG) delle Nazioni Unite continua a essere studiato. I segnali iniziali avvertono di battute d'arresto significative nel raggiungimento degli obiettivi di sviluppo sostenibile entro il 2030. Il raggiungimento degli OSS potrebbe favorire una migliore protezione da future pandemie. Questo articolo suggerisce di ridefinire le priorità degli SDG per facilitare una risposta globale più robusta alle future pandemie. In particolare, raccomandiamo che gli SDG 3, 6, 5 e 4 (in quest'ordine) siano prioritari al fine di ottimizzare gli sforzi per una ripresa socioeconomica più inclusiva e resiliente dopo la pandemia. Questo documento suggerisce che i regimi obbligatori di RSI consentono ai governi, in combinazione con le risorse fiscali aziendali, di influenzare la selezione e il progresso di questi SDG.



administrative sciences

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Article

Reprioritising Sustainable Development Goals in the Post-COVID-19 Global Context: Will a Mandatory Corporate Social Responsibility Regime Help?

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Abstract: The impact of COVID-19 on the United Nations Sustainable Development Goals (SDGs) continues to be researched. Initial signals warn of significant setbacks in achieving SDG targets by 2030. The achievement of SDGs could abet improved protection from future pandemics. This article suggests reprioritizing SDGs to facilitate a more robust global response to future pandemics. Specifically, we recommend that SDGs 3, 6, 5 and 4 (in that order) are prioritized in order to optimize efforts at a more inclusive and resilient socio-economic recovery post-pandemic. This paper suggests that mandatory CSR regimes enable governments, in combination with corporate fiscal resources, to influence the selection and progress of these SDGs. The case of India's mandatory CSR regime is employed to illustrate our position. This study extends the debate on SDGs by raising the possibility of universal concentration on a few critical SDGs.

Keywords: COVID-19; coronavirus disease; SDG; sustainable development goals; CSR; corporate social responsibility

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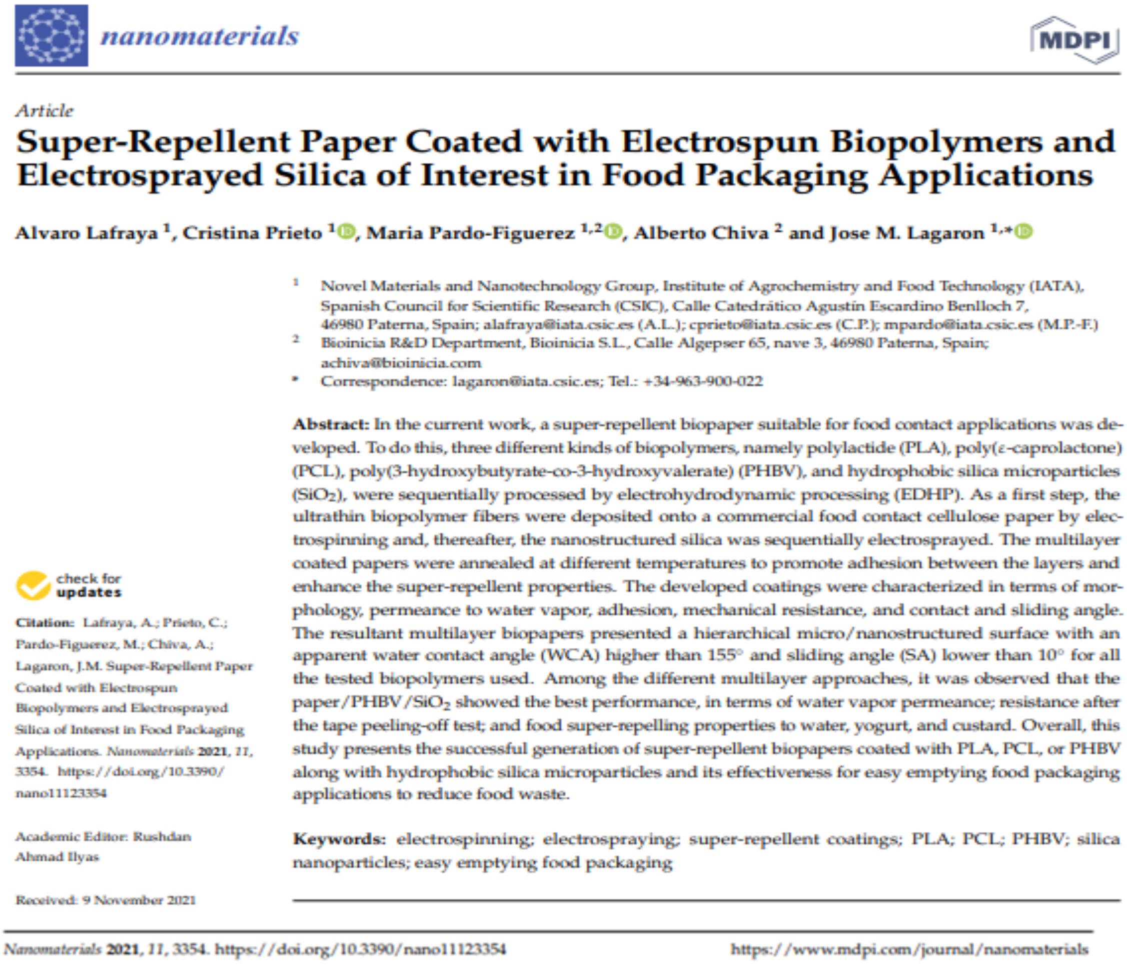
Carta super repellente rivestita con biopolimeri elettrofilati e silice elettrospray di interesse nelle applicazioni di confezionamento alimentare.

Nel lavoro attuale, è stato sviluppato un biocarta super-repellente adatto per applicazioni a contatto con gli alimenti. Per fare questo, tre diversi tipi di biopolimeri, vale a dire polilattide (PLA), poli(ε-caprolattone) (PCL), poli(3-idrossibutirrato-co-3-idrossivalerato) (PHBV) e microparticelle di silice idrofoba (SiO2),sono stati elaborati sequenzialmente mediante elaborazione elettroidrodinamica (EDHP). Come primo passo, le fibre di biopolimero ultrasottile sono state depositate su una carta di cellulosa commerciale a contatto con gli alimenti mediante elettrofilatura e, successivamente, la silice nanostrutturata è stata sequenzialmente con elettrospray. Le carte patinate multistrato sono state ricotte a diverse temperature per favorire l′adesione tra gli strati e migliorare le proprietà super-repellenti.



nanomaterials MDPI

Article

Super-Repellent Paper Coated with Electrospun Biopolymers and Electrosprayed Silica of Interest in Food Packaging Applications

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Abstract: In the current work, a super-repellent biopaper suitable for food contact applications was developed. To do this, three different kinds of biopolymers, namely polylactide (PLA), poly(ε-caprolactone) (PCL), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and hydrophobic silica microparticles (SiO_2), were sequentially processed by electrohydrodynamic processing (EDHP). As a first step, the ultrathin biopolymer fibers were deposited onto a commercial food contact cellulose paper by electrospinning and, thereafter, the nanostructured silica was sequentially electrosprayed. The multilayer coated papers were annealed at different temperatures to promote adhesion between the layers and enhance the super-repellent properties. The developed coatings were characterized in terms of morphology, permeance to water vapor, adhesion, mechanical resistance, and contact and sliding angle. The resultant multilayer biopapers presented a hierarchical micro/nanostructured surface with an apparent water contact angle (WCA) higher than 155° and sliding angle (SA) lower than 10° for all the tested biopolymers used. Among the different multilayer approaches, it was observed that the paper/PHBV/SiO_2 showed the best performance, in terms of water vapor permeance; resistance after the tape peeling-off test; and food super-repelling properties to water, yogurt, and custard. Overall, this study presents the successful generation of super-repellent biopapers coated with PLA, PCL, or PHBV along with hydrophobic silica microparticles and its effectiveness for easy emptying food packaging applications to reduce food waste.

Keywords: electrospinning; electrospraying; super-repellent coatings; PLA; PCL; PHBV; silica nanoparticles; easy emptying food packaging

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Citation: Lafraya, A.; Prieto, C.; Pardo-Figuerez, M.; Chiva, A.; Lagaron, J.M. Super-Repellent Paper Coated with Electrospun Biopolymers and Electrosprayed Silica of Interest in Food Packaging Applications. *Nanomaterials* **2021**, *11*, 3354. https://doi.org/10.3390/nano11123354

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Rischi per la sicurezza dei compositi in fibra vegetale/plastica (PPC) destinati al contatto con gli alimenti.

I compositi in fibra vegetale / plastica (PPC), con i vantaggi del basso costo e della facilità di lavorazione, sono stati ampiamente utilizzati nella produzione di vari prodotti a contatto con gli alimenti. Sono generalmente considerati economici e rispettosi dell'ambiente a causa delle loro materie prime naturali (fibre vegetali) e raccomandati per essere una delle alternative ideali alle tradizionali plastiche a base petrolchimica. Tuttavia, oltre alle resine plastiche e alle fibre vegetali, alcuni additivi indispensabili sono coinvolti nel processo di produzione dei PPC, che possono comportare rischi per la sicurezza alimentare. La conclusione mostra che i PPC utilizzati per il contatto con gli alimenti possono attualmente presentare potenziali rischi per la sicurezza.

toxics MDPI

Review

Safety Risks of Plant Fiber/Plastic Composites (PPCs) Intended for Food Contact: A Review of Potential Hazards and Risk Management Measures

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Abstract: Plant fiber/plastic composites (PPCs), with the benefits of low cost and easy processing, have been widely used in the production of various food contact products. They are generally considered to be economical and environmentally friendly because of their natural raw materials (plant fibers) and recommended to be one of the ideal alternatives to traditional petrochemical-based plastics. However, in addition to plastic resins and plant fibers, some indispensable additives are involved in the production process of PPCs, which may pose food safety risks. To date, excessive migration of hazardous substances (such as melamine) has been reported in some products made of PPCs, and the safety and applicability of PPCs as food contact materials need to be further studied. In this paper, the main raw materials of PPCs used for food contact are taken as the pointcut to analyze the possible hazards, sources of hazards, and existing risk management measures in various countries. The conclusion shows that PPCs used for food contact may have potential safety risks at present. However, systematic research on migration methods and safety assessment are still insufficient, and further studies are needed regarding the main safety risks and migration patterns.

Keywords: safety risk; plant fiber/plastic composite; food contact materials; potential hazards

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Citation: Zhang, H.; Weng, Y. Safety Risks of Plant Fiber/Plastic Composites (PPCs) Intended for Food Contact: A Review of Potential Hazards and Risk Management Measures. *Toxics* **2021**, *9*, 343. https://doi.org/10.3390/toxics9120343

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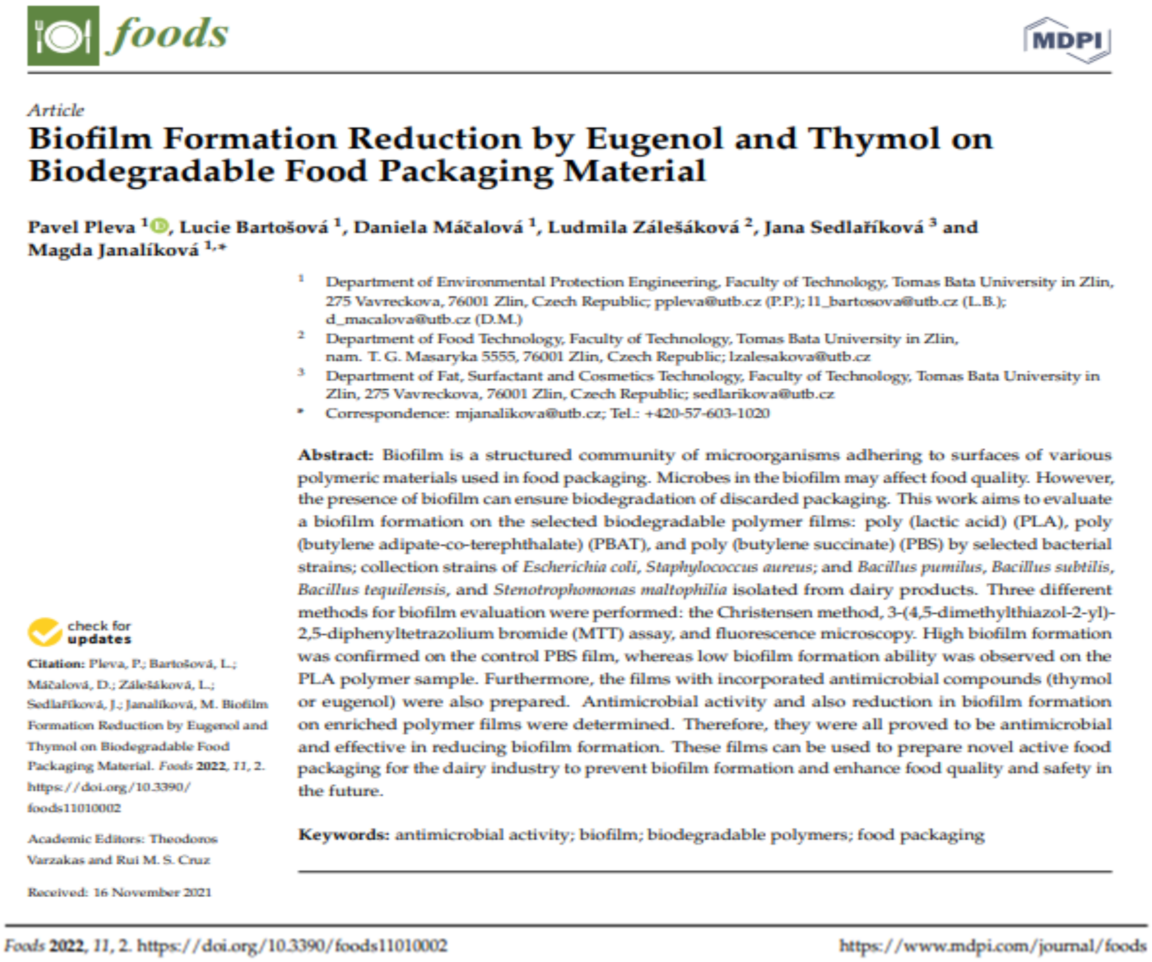
Riduzione della formazione di biofilm da eugenolo e timolo su materiale di imballaggio alimentare biodegradabile.

Biofilm è una comunità strutturata di microrganismi che aderiscono alle superfici di vari materiali polimerici utilizzati negli imballaggi alimentari. I microbi nel biofilm possono influenzare la qualità del cibo. Tuttavia, la presenza di biofilm può garantire la biodegradazione degli imballaggi scartati. Questo lavoro mira a valutare una formazione di biofilm sui film polimerici biodegradabili selezionati: poli (acido lattico) (PLA), poli (butilene adipato-co-tereftalato) (PBAT) e poli (butilene succinato) (PBS) da ceppi batterici selezionati; ceppi di raccolta di Escherichiacoli, Staphylococcusaureus; e Bacillus pumilus, Bacillussubtilis, Bacillustequilensise Stenotrophomonasmaltophilia isolati dai latticini. Sono stati eseguiti tre diversi metodi per la valutazione del biofilm: il metodo Christensen, il saggio 3-(4,5-dimetiltiazol-2-il)-2,5-difeniltetrazolio bromuro (MTT) e la microscopia a fluorescenza.



foods MDPI

Article

Biofilm Formation Reduction by Eugenol and Thymol on Biodegradable Food Packaging Material

Pavel Pleva [1], Lucie Bartošová [1], Daniela Máčalová [1], Ludmila Zálešáková [2], Jana Sedlaříková [3] and Magda Janalíková [1,*]

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Abstract: Biofilm is a structured community of microorganisms adhering to surfaces of various polymeric materials used in food packaging. Microbes in the biofilm may affect food quality. However, the presence of biofilm can ensure biodegradation of discarded packaging. This work aims to evaluate a biofilm formation on the selected biodegradable polymer films: poly (lactic acid) (PLA), poly (butylene adipate-co-terephthalate) (PBAT), and poly (butylene succinate) (PBS) by selected bacterial strains; collection strains of *Escherichia coli*, *Staphylococcus aureus*; and *Bacillus pumilus*, *Bacillus subtilis*, *Bacillus tequilensis*, and *Stenotrophomonas maltophilia* isolated from dairy products. Three different methods for biofilm evaluation were performed: the Christensen method, 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay, and fluorescence microscopy. High biofilm formation was confirmed on the control PBS film, whereas low biofilm formation ability was observed on the PLA polymer sample. Furthermore, the films with incorporated antimicrobial compounds (thymol or eugenol) were also prepared. Antimicrobial activity and also reduction in biofilm formation on enriched polymer films were determined. Therefore, they were all proved to be antimicrobial and effective in reducing biofilm formation. These films can be used to prepare novel active food packaging for the dairy industry to prevent biofilm formation and enhance food quality and safety in the future.

Keywords: antimicrobial activity; biofilm; biodegradable polymers; food packaging

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Citation: Pleva, P.; Bartošová, L.; Máčalová, D.; Zálešáková, L.; Sedlaříková, J.; Janalíková, M. Biofilm Formation Reduction by Eugenol and Thymol on Biodegradable Food Packaging Material. *Foods* **2022**, *11*, 2. https://doi.org/10.3390/foods11010002

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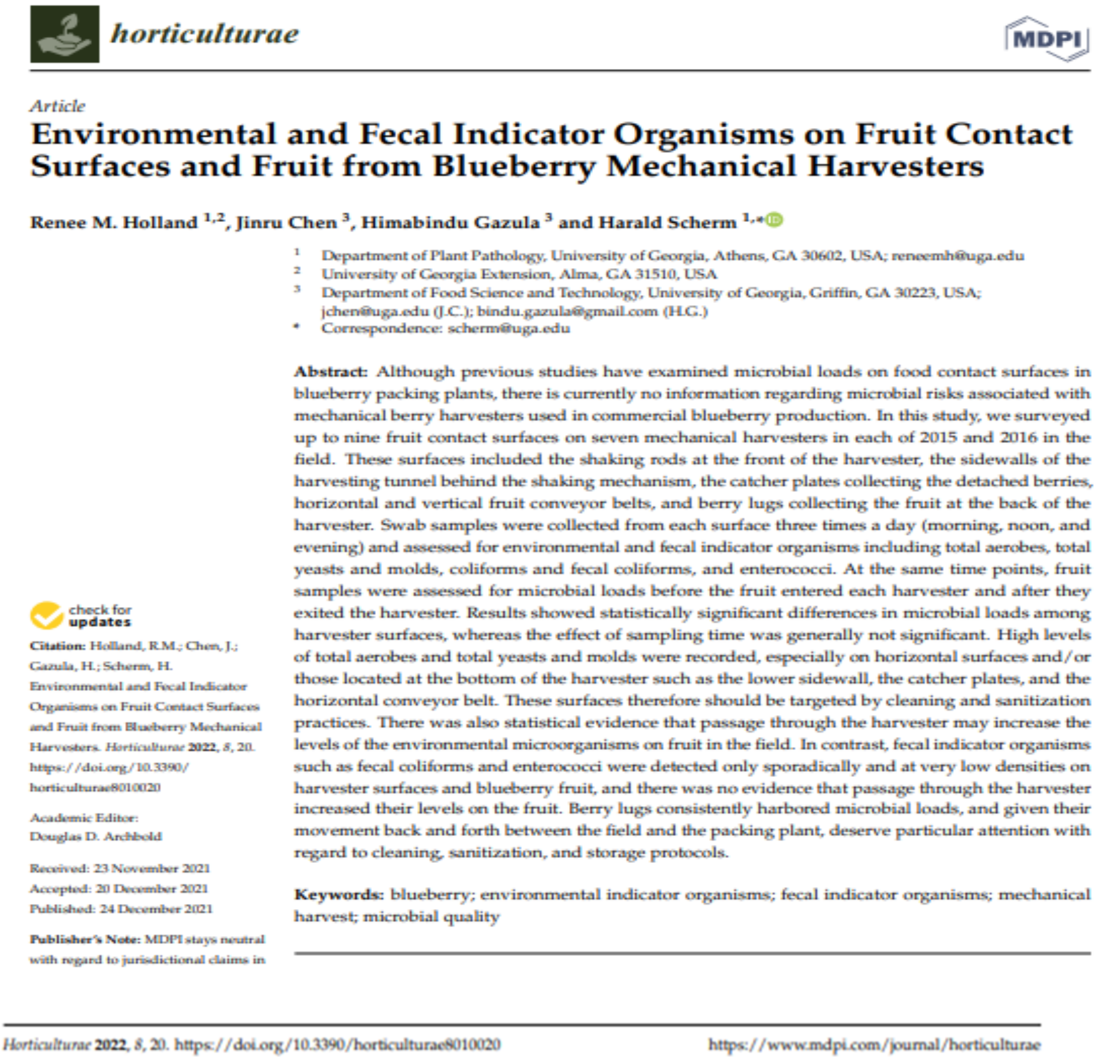
Organismi indicatori ambientali e fecali su superfici a contatto con frutta e frutta da mietitrici meccaniche di mirtilli.

Sebbene studi precedenti abbiano esaminato le cariche microbiche sulle superfici a contatto con gli alimenti negli impianti di confezionamento dei mirtilli, attualmente non ci sono informazioni sui rischi microbici associati alle raccoglitrici meccaniche di bacche utilizzate nella produzione commerciale di mirtilli. In questo studio, abbiamo esaminato fino a nove superfici di contatto con i frutti su sette mietitrici meccaniche in ciascuna delle 2015 e 2016 sul campo. Queste superfici includevano le aste di scuotimento nella parte anteriore della mietitrice, le pareti laterali del tunnel di raccolta dietro il meccanismo di scuotimento, le piastre di raccolta che raccoglievano le bacche staccate, i nastri trasportatori di frutta orizzontali e verticali e le anse di bacche che raccoglievano il frutto sul retro della mietitrice.



horticulturae

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Article

Environmental and Fecal Indicator Organisms on Fruit Contact Surfaces and Fruit from Blueberry Mechanical Harvesters

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Abstract: Although previous studies have examined microbial loads on food contact surfaces in blueberry packing plants, there is currently no information regarding microbial risks associated with mechanical berry harvesters used in commercial blueberry production. In this study, we surveyed up to nine fruit contact surfaces on seven mechanical harvesters in each of 2015 and 2016 in the field. These surfaces included the shaking rods at the front of the harvester, the sidewalls of the harvesting tunnel behind the shaking mechanism, the catcher plates collecting the detached berries, horizontal and vertical fruit conveyor belts, and berry lugs collecting the fruit at the back of the harvester. Swab samples were collected from each surface three times a day (morning, noon, and evening) and assessed for environmental and fecal indicator organisms including total aerobes, total yeasts and molds, coliforms and fecal coliforms, and enterococci. At the same time points, fruit samples were assessed for microbial loads before the fruit entered each harvester and after they exited the harvester. Results showed statistically significant differences in microbial loads among harvester surfaces, whereas the effect of sampling time was generally not significant. High levels of total aerobes and total yeasts and molds were recorded, especially on horizontal surfaces and/or those located at the bottom of the harvester such as the lower sidewall, the catcher plates, and the horizontal conveyor belt. These surfaces therefore should be targeted by cleaning and sanitization practices. There was also statistical evidence that passage through the harvester may increase the levels of the environmental microorganisms on fruit in the field. In contrast, fecal indicator organisms such as fecal coliforms and enterococci were detected only sporadically and at very low densities on harvester surfaces and blueberry fruit, and there was no evidence that passage through the harvester increased their levels on the fruit. Berry lugs consistently harbored microbial loads, and given their movement back and forth between the field and the packing plant, deserve particular attention with regard to cleaning, sanitization, and storage protocols.

Keywords: blueberry; environmental indicator organisms; fecal indicator organisms; mechanical harvest; microbial quality

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Citation: Holland, R.M.; Chen, J.; Gazula, H.; Scherm, H. Environmental and Fecal Indicator Organisms on Fruit Contact Surfaces and Fruit from Blueberry Mechanical Harvesters. *Horticulturae* **2022**, *8*, 20. https://doi.org/10.3390/horticulturae8010020

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