FIRST **CIRCUL-A-BILITY** CONFERENCE

Re-Thinking Packaging for *Circular* and *Sustainable* Food Supply Chains of the *Future*

26-29 September 2021

On-line

Organized by

UNIVERSITÀ DI FOGGIA

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CA19124

RETHINKING
PACKAGING FOR CIRCULAR AND SUSTAINABLE FOOD SUPPLY CHAINS OF THE FUTURE
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Aknowledgements

First Circul-a-bility Conference conveners wish to thank *Antonella Cammarelle* and *Annalisa Apicella* for effectively running the Conference Secretariat, *Signe Nørretranders* for creating and keeping the website updated, *Aysha Saleem* for the Book of Abstracts, and the team of *EcoAgriTech* for the technical support on the Zoom platform.

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CONFERENCE PROGRAM

Sunday, September 26th

17:00 – 17:15	**Opening/Greetings (*Milena Corredig*, Aarhus University, Chair of CA19124)**
17:15 – 18:00	**Prologue Talk 1: "Microplastics an invisible risk" *Margherita Ferrante* (University of Catania, Italy)**
18:00 – 18:45	**Prologue Talk 2: "Everything connects us to the Ocean" *Andrea Morello* (Sea Shepherd Italia)**

Monday, September 27th

09:00 – 09:30	**Greetings (*Pierpaolo Limone*, Rector of the University of Foggia)**
	Session 1A (Chair: *Giancarlo Colelli*)
09:30 – 10:00	**Keynote 1: "Packaging requirements for reducing food losses" Victor Rodov (ARO Volcani Institute, Israel)**
10:00 – 10:15	Impact of different packaging strategies on the shelf-life of semi-hard cheese - *Ana G. Azevedo*, Portugal (130)
10:15 – 10:30	Effects of retail compostable packages on retaining fruit and vegetable quality - *Ron Porat*, Israel (053)
10:30 – 10:45	Tailor-made packaging strategies to extend the shelf life of fresh pork belly - *Begonya Marcos-Muntal*, Spain (083)
10:45 – 11:00	The applicability of PHBV thermoformed trays to pack fresh food products under modified atmosphere packaging - *An Vermeulen*, Belgium (113)
11:00 – 11:30	**Coffee break**
	Session 2A (Chair: *Matthijs Dekker*)
11:30 – 12:00	**Keynote 2: "Active and intelligent packaging as tool to improve food quality and safety" *Rafael Gavara* (CSIC-IATA, Spain)**
12:00 – 12:15	A novel breathable package system to improve the fresh fig (Ficus carica 'Dottato') shelf life – *Attilio Matera*, Italy (070)
12:15 – 12:30	Bioactive antioxidant coating for active poly(lactic acid) film packaging- polyphenols affect coating structure and their release in a food simulant – *Frédéric Debeaufort*, France (052)
12:30 – 13:30	**Stakeholder Forum (Chair: *Emmanouil Tsochatzis*)** **Introduction: "Towards sustainable food packaging legislation from the prospective of EU policymakers" *Anna Trubetskaya* (University of Limerick, Ireland)** **Forum contributors:** ***Bastiaan Schupp*, DG Health and Food Safety - European Commission** ***Eddo Hoekstra*, JRC, EURL-FCM - European Commission**
13:30 – 14:30	**Lunch break**
14:30 – 15:00	**Poster session**
	Session 3A (Chair: *Loredana Incarnato*)
15:00 – 15:30	**Keynote 3: "Challenges on obtaining high oxygen and water barrier compostable films" *Rafael Auras* (*Michigan State University*, USA)**
15:30 – 15:45	Organocatalytic acetylation of pea starch - *Natalia Prieto Vidal*, Denmark (99)
15:45 – 16:00	Design and development of innovative high performance PVOH/PLA bio-coatings for food packaging - *Annalisa Apicella*, Italy (098)
16:00 – 16:15	Improving starch-based biomaterial properties by addition of spent frying potato oil - *Silvia Petronilho*, Portugal (090)
16:15 – 16:30	Multilayer barrier paperboard based on nanocellulose and biodegradable thermoplastics - *Johanna Lahti*, Finland (134)

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16:30 – 16:45	NeoPalea: bio-based material for packaging applications - *Leonardo Conti*, Italy (054)
16:45 – 17:00	Investigation of stereocomplexed poly(lactide acid)/layered double hydroxides for high-performance mono-material packaging solutions – *Qi Chen*, Denmark (128)
17:00 – 17:30	**Coffee break**
	Session 2B (Chair: *Begonya Marcos-Muntal*)
17:30 – 17:45	Use of gallic acid based oxygen scavenger to prevent the discoloration of processed meat products under industrial conditions - *Selcuk Yildirim*, Switzerland (116)
17:45 – 18:00	Influence of an innovative, biodegradable multilayer active packaging on "pesto" sauce characteristics during storage – *Virginia Glicerina*, Italy (097)
18:00 – 18:15	Bioactive complexes of chitosan and green coffee bean or artichoke extracts for food packaging applications - *Ramune Rutkaite*, Lithuania (105)
18:15 – 18:30	Diffusion of thyme, cinnamon and oregano essential oils in different nanocellulose matrices – *Sara Casalini*, Italy (059)

Tuesday, September 28th

	Session 4 (Chair: *Elena Arranz*)
09:00 – 09:30	**Keynote 4: "The challenge of NIAS migration from emerging food packaging materials" *Cristina Nerin* (University of Zaragoza, Spain)**
09:30 – 09:45	Deactivation kinetics of inoculated SARS-CoV-2 on a patented cardboard activated with natural antimicrobials - *Lorenzo Siroli*, Italy (103)
09:45 – 10:00	Next generation screening methodologies for the advanced and comprehensive monitoring of intentionally and non-intentionally added substances in food contact materials - *Chrysoula Kanakaki*, Greece (073)
10:00 – 10:15	Urinary levels of endocrine-disrupting chemicals, including triclosan and 4-nonylphenol in School-Aged Children of Southern Italy population with a Plastic-Free Lifestyle – *Francesco Sessa*, Italy (086)
10:13 – 10:30	Microplastics releases by packaging, a new risk for consumers – *Eloise Pulvirenti*, Italy (114)
10:30 – 10:45	Chemical testing of mechanically recycled polyethylene terephthalate – *Emmanouil D. Tsochatzis*, Denmark (055)
10:45 – 11:00	Risk assessment in use of recycled polyethylene from post-consumer waste as food contact material - *Tanja Radusin*, Norway (119)
11:00 – 11:30	**Coffee break**
	Session 5 (Chair: *Victoria Krauter*)
11:30 – 12:00	**Keynote 5: "Consumer Trends and Perceptions toward Sustainable Packaging Solutions" *Polymeros Chrysochou* (Aarhus University, Denmark)**
12:00 – 12:15	Science and media framing the future of plastics in a transition to the circular economy - *Ivanna Colijn*, The Netherlands (102)
12:15 – 12:30	Analysis of sustainable packaging attributes in the confectionary sector - *Anna-Sophia Bauer*, Austria (112)
12:30 – 12:45	Navigating sustainable packaging solutions for food waste minimization in downstream activities – *Carlos Martin-Rios*, Switzerland (096)
12:45 – 13:00	Sustainability message outlook impacts consumer response toward sustainable packaging - *Polymeros Chrysochou*, Denmark (084)
13:00 – 13:15	Twitter is garbage: what kind of packaging waste materials do people tweet about? Exploration of #zerowaste hashtag usage - *Greg Ganczewski*, Poland (133)
13:15 – 13:30	Intention to purchase milk packaged by biodegradable packaging: evidence from italian consumers – *Antonella Cammarelle*, Italy (068)
13:30 – 14:30	**Lunch break**
14:30 – 15:00	**Poster session**

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	Session 8 (*Chair: Selçuk Yildirim*)
15:00 – 15:30	**Keynote 8: "Disposable or Returnable Packaging: searching optimal solution using fuzzy mathematical approach" *Péter Böröcz* (Széchenyi István University, Hungary)**
15:30 – 15:45	Sense-Fruit: a fruit simulator for advanced monitoring of postharvest supply chains - *Seraina Schudel*, Switzerland (074)
15:45 – 16:00	The effect of transportation vibration to the microbiological status of bottled mineral water - *Renáta Tihanyi-Kovács*, Hungary (111)
16:00 – 16:15	Reducing food waste by quality controlled logistics using intelligent packaging - *Matthijs Dekker*, The Netherlands (075)
	Session 3B (Chair: *Selçuk Yildirim*)
16:15 – 16:30	Development of cellulose-based packaging films from the residues after alginate extraction - *Vera Cebrián-Lloret*, Spain (106)
16:30 – 16:45	ByPro3D – Can agri-food and forest byproducts be reused in the ecological production of 3D food packaging? - *Idalina Gonçalves*, Portugal (088)
16:45 – 17:00	Functional biobased barriers for sustainable and renewable packaging materials – *Samir Kopacic*, Austria (062)
17:00 – 17:30	**Coffee break**
	Session 2C (Chair: *Fátima Poças*)
17:30 – 17:45	Polysaccharide-based active coatings for fresh and minimally processed fruits - *Marina Ramos-Santonja*, Spain (104)
17:45 – 18:00	Design concept of an enzymatic time-temperature integrator device for chromatic quality prediction of cherries - *Pedro D. Gaspar*, Portugal (125)
18:00 – 18:15	Development of essential oil incorporated polymer PLA/PBAT active film for food packaging applications - *Kalpani Y. Perera*, Ireland (101)
18:15 – 18:30	When nanochemistry meets food packaging: development of active materials based on polyoxymetalates and nanocelluloses - *Filomena Silva*, Spain (107)

Wednesday, September 29th

	Session 7 (Chair: *Philip Scholten*)
09:00 – 09:30	**Keynote 7: "One Bin To Rule Them All" *Michael Shaver* (University of Manchester, UK)**
09:30 – 09:45	Recycling of polypropylene by supercritical CO_2 for extraction of contaminants from beverage cups - *Srishti Singh*, Portugal (072)
09:45 – 10:00	Deinking efficiency of industrial waste and invasive plant papers for paper bags - *Mija Sežun*, Slovenia (071)
	Session 1B (Chair: *Frédéric Debeaufort*)
10:00 – 10:15	Impact of polylactic acid packages on microbiological spoilage of fresh produce: A case study with cherry tomatoes – *Salvatore D'Aquino*, Italy (121)
10:15 – 10:30	Effect of humidity on ethylene removal kinetics of various scavengers in active packaging - *Spoorthy Shenoy*, Germany (117)
10:30 – 10:45	Advances to save the packaging plastic film in Grapefruits - Rafael Torregrosa-Coque, Spain (056)
10:45 – 11:00	Zein based antimicrobial edible coating for 'granny smith' apple quality - *Zinash A. Belay*, South Africa (060)
11:00 – 11:30	**Coffee break**
	Session 3C (Chair: *Ilke Unalan*)
11:30 – 11:45	Biopolymer-based electrically conductive biocomposite films for food packaging applications - *Ana Barra*, Portugal (092)
11:45 – 12:00	Utilization of chestnut shell lignin in alginate films - *Ece Sogut*, Turkey (064)
12:00 – 12:15	High solids, solvent free modification of engineered poly-saccharides for food packaging applications - *Athanasios D. Porfyris*, Greece (109)

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12:15 – 12:30	Bio-based platelet-shaped biochars as reinforcements in biopolymers for food packaging applications – *Jon Trifol*, Finland (079)
12:30 – 13:30	**Industry forum (Chair: *Milena Corredig*)** **Contributors:** ***Thomas Bak Thellesen*, Faerch A/S, Denmark** ***Tim Van Caelenberg*, Puratos, Belgium**
13:30 – 14:30	**Lunch break**
14:30 – 15:00	**Poster session**
	Session 6 (Chair: *Marit Kvalvåg Pettersen*)
15:00 – 15:30	**Keynote 6: "The most sustainable packaging: how to define your best individual solution" *Peter Désilets* (Pacoon GmbH, Germany)**
15:30 – 15:45	Assessing the environmental sustainability of packaging on seafood supply chains: A critical review - *Cheila Almeida*, Portugal (115)
15:45 – 16:00	Food waste and eco-design: synergy between food and packaging LCA – *Andrea Casson*, Italy (076)
16:00 – 16:30	**Final Remarks & Conference conclusions (*Milena Corredig* & *Giancarlo Colelli*)**

POSTER PRESENTATION PROGRAM

Date	Room	Poster title
Sep 27	**1**	***Poster Session Room Chair: Maria L. Amodio*** – Use of compostable plastic biomaterials for modified atmosphere packaging of minimally processed onions from Apulia Region – *Maria L. Amodio*, Italy (118) – Natural pectin-based edible composite coatings with antifungal properties to control postharvest decay and reduce losses of 'Valencia' oranges – *María V. Alvarez*, Spain (080)
	2	***Poster Session Room Chair: Maria L.V. De Chiara*** – Cellulose acetate based antimicrobial film as active packaging for pomegranate arils – *Andrea Sorrentino*, Italy (057) – Use of active packaging filled with anion salicylate to preserve the shelf-life of seedless table grape – *Laura Quintieri*, Italy (058)
	3	***Poster Session Room Chair: Annalisa Apicella*** – Antioxidant biobased blisters derived from agrifood byproducts – *Joana Lopes*, Portugal (089) – Biodegradable nanocomposite multifunctional packaging film for fruits - *Kalpani Y. Perera*, Ireland (100)
	4	***Poster Session Room Chair: Paola Scarfato*** – Effect of the extrusion process conditions on the generation of "Non-intentionally added substances" in polyethylene films - *Arianna Pietrosanto*, Italy (095) – Study on the chemical transfer of Silver Nanoparticles (Ag-NPs) and Zinc Oxide (ZnO-NPs) from packaging of seafood products and characterization of NPs with Single Particle ICP-MS – *Alfina Grasso*, Italy (122)
	5	***Poster Session Room Chair: Antonella Cammarelle*** – Diffusional behaviors of some antimicrobial agents from active multilayer films and their antimicrobial abilities – *Sevgin Diblan*, Turkey (065) – Evaluation of water barrier properties of film from different film composing materials by comparing their sorption behavior and water transmission rate - *Sevgin Diblan*, Turkey (066)
Sep 28	**1**	***Poster Session Room Chair: Maria L. Amodio*** – Cold plasma treatment for coated and packed strawberries – *Oluwafemi J. Caleb*, South Africa (061) – Research trends in food packaging: a bibliometric comparative analysis utilizing text mining - *Melekşen Akin*, Turkey (085)
	2	***Poster Session Room Chair: Maria L.V. De Chiara*** – Development of novel materials for active food packaging based on starch and biochar-zinc oxide composites – *Zélia Alves*, Portugal (094) – What's the role of active packaging in the future of food sustainability? A systematic review - *Joel Alves*, Portugal (124)
	3	***Poster Session Room Chair: Annalisa Apicella*** – Fabrication and simulation of a colorimetric pH-sensitive TVBN indicator for use in food packaging - *Amal Al Obaidi*, Turkey (129)

		– Zein-based food packaging with bioactive organic compounds – *Magda Janalíková*, Czech Republic (077)
	4	***Poster Session Room Chair: Paola Scarfato*** – Effect of edible lipid-based coatings on the shelf life and quality of horticultural products and their consumer acceptance – *Christian Labude*, Germany (110) – Lignin/PLA based sustainable composites for food packaging applications - *Esakkiammal S. Esakkimuthu*, Slovenia (082)
	5	***Poster Session Room Chair: Antonella Cammarelle*** – Development of bacterial nanocellulose-poly(3-hydroxybutyrate-co-3-hydroxyvalerate) composite for food packaging - *Francisco A.G. Soares Silva*, Portugal (081) – Potato chips brownish residues as additives for developing antioxidant and UV-protective starch-based films - *Ana M. Fernandes Peixoto*, Portugal (091)
Sep 29	**1**	***Poster Session Room Chair: Maria L. Amodio*** – Smart Packaging: challenges and opportunities in agro-industry subsectors. a systematic review - *Carlos M. Fernandez*, Portugal (132) – Albanian legislation and challenges related to food packaging waste management - *Edlira Shahinasi*, Albania (078)
	2	***Poster Session Room Chair: Maria L.V. De Chiara*** – Compostable packaging: sustainability, suitability and safety are a challenge to win: from bioplastics to paper from a shelf life/food waste perspective - *Andrea Vittadello*, Italy (063) – The potential of bionanocomposites as sustainable food packaging – *Cláudia Nunes*, Portugal (093)
	3	***Poster Session Room Chair: Annalisa Apicella*** – Improvement of surface and barrier properties of PLA films by gelatin-based coatings - *Frédéric Debeaufort*, France (051) – Toward sustainable PHBV-chitosan biobased multilayer films with improved properties - *Nasreddine Benbettaieb*, France (067)
	4	***Poster Session Room Chair: Paola Scarfato*** – Nano and micro fibrous edible materials for food packaging applications – *Zane Zelca*, Latvia (123) – The effects of artichoke outer petal leaves lignocellulosic extract on potato starch-based biodegradable film properties – *Hulya Cakmak*, Turkey (069)
	5	***Poster Session Room Chair: Antonella Cammarelle*** – Terms and sentiments in Twitter messages related to sustainable food packaging - *Salvador Ruiz-de-Maya*, Spain (127) – How neuroscience-based research methodologies can deliver new insights to marketers - *Hedda M. Šola*, Croatia (131)

LECTURES

041

TOWARDS SUSTAINABLE FOOD PACKAGING LEGISLATION FROM THE PROSPECTIVE OF EU POLICYMAKERS

Anna Trubetskaya[1], Ana Dotan[2], Paul Horton[3], Grzegorz Ganczewski[4], Milena Corredig[5]
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[2]Shenkar SHENKAR Engineering, Design, Art, Israel
[3]Brandprintcolour™ LTD, UK
[4]Kozminski University, Poland
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European Commission advocates for sustainable systems and redesign of our relationship with resources, to accelerate transition towards zero waste for the benefit of citizens, industry, public organizations, and biodiversity. The Circular Economy Packaging has set targets high targets referred to recycling, reusing, and repurposing. The results from interviews of EU policymakers underline the overall European Strategy for food packaging to foster sustainable principles along the global plastic value chain that includes production, transport, storage, conversion, brand owners, retailers, recyclers, and waste collection. The EU policymakers strive to become the world's first climate-neutral society by supporting developing countries with all challenges within the global supply chain infrastructure. The present results show that despite high targets of sustainability goals, the update of industrial and societal policy is needed in the EU. The Directive on Single-Use-Plastics with the goal to reduce the impact of certain plastic products on the environment is not sufficient to include production and consumption patterns of each individual EU country. The common infrastructure for the collection and utilization of waste packaging was desired by Baltic countries, whereas innovation and research on novel plastic utilization processes. e.g., for laminates were of interest in Norway and Switzerland. Additional restrictions concerning transportation and utilization of toxic plastic types from the EU to developing countries were suggested by the policymakers. The main challenge in the EU policy with respect to sustainability of food packaging is how to combine the functionality of plastics with its recyclable properties using a circular efficient process. The interviews also showed that policymakers and industrial stakeholders have established an excellent collaboration with respect to circular economy goals. This provides the potential to enable a framework for EU policy innovation and successful implementation worldwide.

042

DECISION ON DISPOSABLE OR RETURNABLE PACKAGING: SEARCHING OPTIMAL SOLUTION USING FUZZY MATHEMATICAL APPROACH

Péter Böröcz
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Any kind of goods distributed from suppliers to consumers need packaging that is able to satisfy various requirements for the transaction parties. In the modern supply chain this means a relatively optimal situation among variables such as cost, protection mechanism, waste management aspects, CO2 footprint, and so on. The companies and packaging engineers have to make decisions to find that optimal and sustainable product-packaging system that has got adequate protection along the suitable cost. Decisions are most often based on traditional knowledge, habits, or industry benchmarking. This decision most often involves a decision option between disposable (single-trip) and reusable (returnable or refillable) packaging solutions. In practice, in most cases, this decision is based on only personalized experience or existing historical data or such traditions that only consider the packaging material cost itself and necessary investment expenses. Although cost is an important factor, it is not the only one needed to find the optimal solution. Of course, several other alternative factors complicate further the right solution and decision situation. The traditional (two-valued) logic is not perfectly able to model this problem. This presentation tries to deliver a novel technique to help the decision-making process using the application of fuzzy approach, more precisely fuzzy signatures model. Fuzzy signature is introduced to handle complex structured data, and can also be used in cases where the exact data are partly or totally missing or unknown. In product-packaging decision situations there are many aspects where factors with very complex and mostly interdependent features are to be defined; similarities and dissimilarities are to be evaluated. These, of course, lead to a complex decision problem and model that has to be constructed in the practice. This keynote presentation delivered three different fuzzy signatures connected by fuzzy rules to model the mentioned disposable/returnable packaging decision, which was based on logistics and packaging expert's opinions. Two examples are presented concerning a customer packaging (primary packaging) and an industrial transport packaging (secondary packaging) as well. The recommended fuzzy signature model can help to do a more effective decision process in industrial practice.

043

ONE BIN TO RULE THEM ALL

Michael Shaver
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David Attenborough in Blue Planet II did what many polymer scientists in my field have been trying to do for years: Convince the public and government that the challenges of plastic waste are real and need to be fixed. But is this as simple as doing away with single use plastic? This talk will explore the complex nature of our plastic environment, the interdependency of plastics on our goals for lowering our carbon footprint and increasing our expected lifespan, while also showcasing our own work on how polymer chemistry has the opportunity to shape a new sustainable future by developing interdisciplinary solutions that work for all actors.

Story 1: Ring opening polymerisation of structurally diverse 1, 3-dioxolan-4-ones (DOX monomers) affords isotactic and atactic polymers depending upon catalyst and reaction conditions, where avoiding epimerization is essential when deriving stereoregularity from enantiopure α-hydroxy acids. Scale up and optimisation of these materials, as well as broadening monomer scopes, yields a family of commodity plastics with desirable thermal properties whilst retaining hydrolytic and enzymatic degradability.

Story 2: Why do we struggle to recycle? Is this due to the nature of the material, or how we value it? Our new work focuses on developing value chains in waste management solutions, looking at how all actors in a supply chain can derive this value from participating in innovation. Our "One Bin to Rule Them All" solution will be introduced as a model for how to develop a hierarchy of materials.

044

CHALLENGES ON OBTAINING HIGH OXYGEN AND WATER BARRIER COMPOSTABLE FILMS

Rafael AURAS
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High oxygen and water barrier industrial and backyard-compostable polymer films can help create flexible packages containing oxygen and water-sensitive consumer products, such as sauces, spices, and dairy powders. These soiled flexible packages can be recovered after use with the organic waste disposed of by industrial and backyard composting, helping to improve organic recycling and to create a plastic circular economy. However, the creation of high oxygen and water barrier industrial and backyard-compostable polymer films has eluded present science since the requirements of high barrier properties and compostability are divergent. High oxygen barrier compostable polymer films are mainly sensitive to water, so they must be further from the film surface and protected from the environment. On the other hand, isotropic high-water barrier compostable polymer films do not exist yet since available compostable polymer films are largely based on polyesters, which are sensitive to hydrolysis. If we replace these polymers with less sensitive water polymers, compostability is diminished or unattainable. Thus, this dichotomy of creating high barrier water barrier polymer films, which are compostable in industrial and hopefully in backyard composting environments, has been challenging. This talk will discuss the main approaches to overcome these technical challenges. Mainly, it will explore the use of laminar, filler, modified, and blend polymer structures able to approach these requirements. The presentation will be based on available US and European Union certification requirements for industrial and backyard compostable plastic products. Finally, potential paths to create high oxygen and water barrier polymer films that are industrial and backyard compostable will be examined.

045

PACKAGING REQUIREMENTS FOR REDUCING FOOD LOSSES

Victor Rodov
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According to the recent estimations, almost 40% of the globally produced food is lost or wasted without human consumption. For perishable foods like fresh fruits and vegetables, these figures are even higher. Food is lost or wasted along a value chain due to mismatches related to a variety of factors, biological, physicochemical, technological, economic, and social. Optimal packaging can alleviate many of these mismatches, thus reducing the food losses. Protective in-package microenvironment (e.g., optimal atmosphere composition and humidity) inhibits physiological and microbial spoilage of perishable foods extending their life. Furthermore, modern smart (interactive) materials can maintain such a beneficial atmosphere under changeable ambient conditions by adjusting the package barrier properties to environment temperature. Nowadays, the communication function of packaging becomes increasingly important for reducing food losses. Data transmitters such as RFID tags integrated into 'Internet of Packaging' (IoP) improve coordination between supply chain stakeholders: packers, shippers, and retailers. Communication with consumers is also utterly important. Misinterpretation of "best-before" or "use-by" labels often results in wastage of usable foods.

Real-time objective information on product safety and quality provided by biosensors and indicators can render support to consumer's decision to use or to reject the package contents. On-package QR codes ensure product's traceability and provide vast additional information about the product. For decades, plastics were the ultimate food packaging materials, lightweight, inert, stable, moisture-barrier, having adjustable oxygen barrier, mechanical and optical properties. However, the very stability of plastics made them one of the major environment pollutants. Nowadays, it becomes clear that attempts to solve separately the "food losses" and the "plastic pollution" problems aggravate the both. Only recyclable, reusable or compostable packaging solutions with consumer-friendly disposal instructions and clear life cycle can be accepted as means to reduce the food losses. Promotion of such solutions is the mission of the CIRCUL-A-BILITY action.

046

ACTIVE AND INTELLIGENT PACKAGING AS TOOL TO IMPROVE FOOD QUALITY AND SAFETY

Rafael Gavara, Pilar Hernandez-Muñoz
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Traditionally, the functions of packaging have been product containment, protection, information, convenience, and promotion. Traditional food packages are containers which passively limit the interaction of products with external factors (vapors, gases, living organisms…), acting as barriers to these factors. Smart packaging is a novel technology that improves two functions of packaging, protection and information, by actively interacting with the food product. Active packaging uses packaging systems that adsorb or release substances whose presence or absence improves product's stability or quality. Intelligent packaging provides relevant information to consumers to help their consumption decision. In this presentation, several examples of active and intelligent packaging are presented. They are designed to target the required variable, keeping it at a specific value range. The components which provide the active or intelligent function are of different types but, in their manufacture, most of the main components are natural and can be obtained from food industry residues. In general, the inclusion of the active or intelligent function results in an increase of materials, processes and costs, since they imply an addition to conventional packages. Nevertheless, the improvement in quality, the increase in shelf life, and the ease of consumption decision, result in reductions of food losses, making smart packaging a technology that helps in reducing the carbon footprint.

047

CONSUMER TRENDS AND PERCEPTIONS TOWARD SUSTAINABLE PACKAGING SOLUTIONS

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The packaging sector has entered the phase of an environmental transition, in line with market and general public expectations. A vast number of sustainable packaging solutions are being proposed and developed. However, only a few of them end up being adopted and having an actual impact. One of the reasons is that such efforts lack consumer understanding at the early stages of their development. In this keynote presentation, I will provide an overview of the recent consumer and marketing research on sustainable packaging, by addressing consumer trends and perceptions toward sustainable packaging solutions. In addition, I will discuss ways that help lift possible barriers and approaches that enhance communication efforts. Finally, I will discuss how consumer and marketing research can facilitate the adoption process of sustainable packaging solutions.

048

MICROPLASTICS AN INVISIBLE RISK

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One of the most emergent problems today is linked to microplastics. There is a pressing need to improve the knowledge on occurrence, effects and risks on human health of plastic particles present in the environment. We have to bridge many gaps of knowledge regarding: the way to identify plastic particles, mainly small sized (>10 μm)! How can plastic particles reach humans through the food web chain? Can plastic particles be vehicles of chemicals and pathogens? What are the health impacts (Humans) of exposure to micro- and/or nano-plastics? The few risk assessments studies carried out in recent years shown that there is evidence that humans are exposed to micro- and nano-plastics through their diet, tap and mineral water, inhalation, dermic contact (Zuccarello et al., 2019; Oliveri Conti et al., 2020; Zitouni et al., 2020). There is not a large qualitative and quantitative data about micro-nano-plastics on the topic due the absence of effective and efficient methodologies able to detect in vegetal and animal tissues, including human tissues, micro- and nano-plastics lower than10 microns (μm). In

fact, very scarce number of papers focused the micro- and nano-plastics < 10 µm on human health effects, although, the micro- and nano-plastics in this size range are able to cross the vegetal and animal cell membranes or are uptaken through cellular pores and channels (Oliveri Conti et al., 2020). We patented a new methodology that can allow us to overcome the limit of filtration step in the preparative phase of treatment of the samples (loss of all microparticles with size less than that one of the filter). Thanks to this innovative methodology developed by Unict "METHOD FOR THE EXTRACTION AND DETERMINATION OF MICROPLASTICS IN SAMPLES OF ORGANIC AND INORGANIC MATRICES" (Italian patent of Unict n. 102018000003337-07 March 2018, submitted also for the release of International patent PCT/IB2019/051838), the total plastic micro and nanoparticles with size up to 100 nm can be measured in all organic and inorganic samples collected and analyzed. Our methodology was yet applied in mineral Poly Ethylene Terephthalate (PET) bottled waters permitting for the first time the EDIs calculation (for adults and children) of the risk assessment of consumed PET bottled mineral water (Zuccarello et al., 2019a; 2019b). The same method was applied in fruit, vegetables and fishes permitting the first worldwide EDIs estimation for the risk assessment of these edible vegetables (Oliveri Conti et al., 2020). Therefore, the application of this patented method in environmental and biological samples, that will be sampled and tested, will allow both the determination and calculation of the total number and the average diameter per category of size of the microplastics present in many types of samples and to evaluate, in the case of their detection in edible plants and animals, their transfer through the various environmental compartments and, finally, to evaluate the risk of intake and transfer to humans through the diet and inhalation. In addition, the possible detection of nano- and micro-plastics in animals and human biological tissues and liquids in correlation with any exposure and damage markers will allow to give a first answer based on the evidence on the capacity of microplastics to exert pathological effects in humans given the current lack of scientific data about biological damage by exposure to microplastics in animals and humans. In the literature, several studies have demonstrated the wide range of applications of the Bio impedance spectroscopy (BIS) from the estimation of body composition to cancerous tissue detection, or blood characterization. BIS has also been found suitable for food analysis, cell or tissue culture studies and disease detection. The combined use of the numerous ready technologies will permit to close the circle between plastic spread and micro- and nanoplastics exposure.

049

THE CHALLENGE OF NIAS MIGRATION FROM EMERGING FOOD PACKAGING MATERIALS

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The increasing concern about toxic substances coming from plastic packaging to the food together with the circular economy are changing the food packaging materials. Recycled materials of conventional plastics and also natural materials and compostable biopolymers are now in the market. Materials of natural origin are also processed and recycled plastics need to be cleaned and safe for food contact. However, the main requirements for their safety are always applicable to them. As happens to any polymer, oligomers and other substances are also present in these emerging materials and can also migrate. And most of the migrants are non-intentionally added substances (NIAS). The analysis of NIAS is very complex and requires sophisticated laboratories and a lot of experience to identify the migrants. Screening procedures and high resolution mass spectrometry (HRMS) are applied, but even though some compounds are missing and require specific search. Migration of several food contact materials made from wheat pulp, PLA, new compostable materials and some recycled polyolefins will be shown and discussed. Advanced analytical tools to help in the identification will also be shown.

050

THE MOST SUSTAINABLE PACKAGING – HOW TO DEFINE YOUR BEST INDIVIDUAL SOLUTION

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Companies often ask us ‘which is the most sustainable packaging solution’ – the answer is as individual as the company’s business. PACOON wants to show how producers can define their way to sustainable packaging solutions in 6 steps and find their objectives and strategies. Peter Désilets will show cases and tools to empower companies to start their way.

ORAL & POSTER PRESENTATIONS

051

IMPROVEMENT OF SURFACE AND BARRIER PROPERTIES OF PLA FILMS BY GELATIN-BASED COATINGS

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The use of PLA for food packaging is limited due to its poor barrier properties in moist environments. Thin coatings based on fish gelatin (by-products or waste from the seafood industry) have been applied to commercial PLA films. A tanning treatment with 0.5% tannic acid was applied or not to the gelatin solution before application. The gelatin layer reduced the oxygen permeability of the films by up to 600 times when exposed to 10% RH, but only by 30 times at 85% RH. Water vapour permeability is reduced by 20% only if the gelatin layer is exposed to the lowest humidity. Exposure of the coated side to a wetter environment affects water and oxygen transfer through coated PLA films differently. The surface free energy as well as the wettability of the film (contact angle of various liquids) were characterised and related to barrier and structural properties. The coatings do not significantly alter the surface hydrophobicity of PLA films, despite a slightly faster wetting rate. This higher wettability of gelatin may partly explain the low efficiency of the gelatin coating in slowing down water vapour transfer. The addition of tannic acid, used not for its antioxidant properties, but for its protein tanning (cross-linking) properties, did not really lead to an optimisation of the properties of the coated PLA films.

052

BIOACTIVATION OF PLA FILM BY NATURAL COATING FOR ANTIOXIDANT ACTIVE PACKAGING: POLYPHENOL AFFECT COATING STRUCTURE AND ITS RELEASE IN A FOOD SIMULANT

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The use of PLA for food packaging is limited because of its insufficient barrier properties in wet environments. One of the strategies to overcome these drawbacks is the deposition of thin coatings that can either reduce transfer through the films or serve as a support for bioactive molecules to provide active functions. The choice of using natural biopolymers incorporating bioactive agents on PLA makes it possible to develop active packaging materials while maintaining biodegradability and allowing for food contact. Fish gelatin coatings containing two phenolic acids (tannic and gallic) have been tested, both as antioxidants and for their ability to cross-link proteins. The coated PLA films show reduced moisture permeability and proven antioxidant properties. The release kinetics in a simulating medium were modelled. The incorporation of phenolic acids modifies the interactions with gelatin and the network structure which affects the release kinetic parameters. A synergistic effect of the antioxidant activity of the two phenolic acids was observed when they were mixed, due to a sequential release of gallic acid followed by tannic acid. Furthermore, the order of mixing of the two acids has a significant impact on the barrier and thermal properties of the films. The partition coefficient (KF/S) depends both on interactions with gelatin (tannic acid) but also of the solubility in the simulant (gallic acid) whereas the diffusivity only varied by two between the two acids, related to both interactions and molecular size. Molecular interactions, solubility of antioxidants in the simulant and structural properties of the gelatin network affect the transfer parameters.The design of an active packaging based on natural substances is a complex process for which a multidisciplinary knowledge (chemistry, physical chemistry, engineering, biochemistry...) is necessary.

053

EFFECTS OF RETAIL COMPOSTABLE PACKAGES ON RETAINING FRUIT AND VEGETABLE QUALITY

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Fresh fruit and vegetables (F&V) are perishable food items with short postharvest storage lives. One of the most effective technologies to retain F&V quality after harvest is the use of modified atmosphere packaging (MAP), which creates a high-humidity environment that reduces water loss and shrivelling, and modified oxygen and carbon dioxide levels that may retard ripening, senescence and decay development. However, most retail packages are made of plastic, which is poorly degradable and pollutes the environment. In order to address the issue of plastic pollution, more than 850 organizations have signed the New Plastics Economy

Global Commitment endorsing that by 2025 all plastic packaging will be reusable, recyclable, or compostable.
The aim of our current study was to examine the efficacy of compostable packages in order to evaluate whether they may replace the current use of conventional petroleum-based plastic materials for retaining postharvest quality of F&V. The performance of retail packages made of biodegradable polyester blends (Tipa Corp., Israel) was tested with various F&V including cucumber, tomato, pepper, eggplant, grapes, pear and banana. The results indicated that perforated compostable packages effectively retained postharvest quality and extended postharvest storage lives of F&V. However, their effectiveness greatly depended on the perforation rates, which had to be adjusted to each product. On the other hand, using non-perforated compostable packages often harms production quality resulting in enhanced decay and accumulation of off-flavors. The beneficial effects of perforated compostable packages were demonstrated following simulation of retail marketing and home storage conditions, as well under real market conditions. Furthermore, our studies indicated that the compostable packages tested had a pronounced advantage over polypropylene plastic packages by having much less water condensation. Overall, we suggest that compostable packages may provide a suitable environmentally friendly replacement for the current use of petroleum-based plastic materials.

054

NEOPALEA: BIO-BASED MATERIAL FOR PACKAGING APPLICATIONS

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This research aimed to replace conventional packaging derived from fossil resources with sustainable composite material (named NeoPalea) to produce tertiary packaging based on the combination of natural organic fibrous material (i.e., straw, leaves, Posidonia Oceanica) and biodegradable biopolymers. The manufacturing process is focused on obtaining pre-compressed products made of fibrous material in a state of compression and bioplastic permanently in tension. The use of straw, in particular, is due to this material being considered a waste of cereal production (in 2020, 21 109 tons globally), with a minimal market value. At the same time, Mater-Bi is a biodegradable and compostable bioplastic produced from corn starch by Novamont S.p.A (UNI EN 13432: 2002). The NeoPalea forming procedure involved the following phases: rolling straw into Mater-Bi sheets, placing rolls into the mould, pressing the mould (the fibrous material acquires a state of compression between 1 N/mm2 and 13 N/mm2, according to the final uses), heating (about 80°C in a high-frequency electromagnetic radiation generator for a time ranging from 300s to 900s), cooling and extraction of the composite material. The invention, patented by UNIFI both for the material and way of production, has many strengths: versatility of the material in terms of shapes (flat, angular, etc.) and densities, low cost both of the producing material and the production process (i.e., the procedure will be carried out without the use of water); high sustainability (at the end of its life cycle, the product can be used as mulch). The use of this new product may reduce the costs for disposal of packaging and particularly a substantial modification in the ways of packaging, able to change the social habits, reduce the waste significantly and generally the human impact, with huge economic, ecological and environmental benefits.

055

CHEMICAL TESTING OF MECHANICALLY RECYCLED POLYETHYLENE TEREPHTHALATE

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Polyethylene terephthalate (PET) is a polymer that has been deemed safe to be mechanically recycled. Its recycled form (rPET) has also been safe when used as a food contact material (FCM). Although this is a positive step towards a more circular economy, the development of an appropriate analytical toolbox to experimentally assess and evaluate the various steps during mechanical recycling, such as initial processing (sorting, washing, grinding) as well as the decontamination, is still at its infancy. Hence, decontamination safety is currently evaluated following an accepted modelling approach for a specific number of compounds (challenge test), additional compounds and quality markers are needed, with respect to migrating substances, potential non intentionally added substances (NIAS), contaminants and known degrading compounds. This would allow for the application of appropriate methods when ensuring full compliance with safety standards, in regards to rPET.
All packaging development requires safety evaluations, compliance testing and risk assessment. Novel recycling procedures also need to be validated, and can be based on extensive and in some cases complex analytical methods. As we move to a more “circular” and “sustainable” future, recycling of the same materials, it may also be of importance to have new solutions to ensure traceability, to validate the history of the product, and to ensure final packed food safety. Both PET and rPET are currently considered as an example of circularity

when it comes to plastic food packaging. However, the current knowledge gained for PET/rPET, in terms of analytical methodologies, can be adopted in the future for more types of recycled materials. This work aims to present the current regulatory framework and the most recent developments in analytical methodologies related to compliance testing. Some of the chemical substances that can be identified in rPET are also highlighted.

056

ADVANCES TO SAVE THE PACKAGING PLASTIC FILM IN GRAPEFRUITS

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The use of plastic in the food industry has been widespread for a long time. These plastics extend food shelf-life by protecting it from water loss and attack by external agents (microorganisms, UV radiation, etc.). The big problem with these materials is the generation of waste that is difficult to recycle. The indiscriminate use of plastics in the food industry is generating a great waste problem in large cities and in the world in general. For instance, just one container with plastic wrapped grapefruit produces around 40 kg of plastic waste. For this reason, it is necessary to look for more ecological alternatives that maintain the properties of these plastics. For decades, the citrus industry has used natural and artificial waxes for coating citrus fruits that avoided the use of plastics. The most used products are: oxidized polyethylene wax, carnauba wax and shellac. These materials provide a physical barrier against attack by external agents, prevent the loss of water from the fruit and allow gas exchange. CITROSOL has developed an organic and vegan officially certified coating based on carnauba wax that has excellent benefits extending the useful life of the fruit: PLANTSEAL. To check the effectiveness of Plantseal as coating, a comparative test in grapefruit was carried out. Different coatings and a control of uncoated grapefruit were compared with plastic film wrapped grapefruit. The results showed a weight loss control of 40% for Plantseal compared to 25% for conventional coating (oxidized polyethylene and shellac) and 80% for grapefruits with film. Despite the high weight loss control of the film, the appearance of the Plantseal waxed grapefruits was very good at destination. Therefore, the Plantseal coating is a good alternative to replace the plastic film used to wrap fruits and vegetables, avoiding the generation of plastic waste that is bad for the environment.

057

CELLULOSE ACETATE BASED ANTIMICROBIAL FILM AS ACTIVE PACKAGING FOR POMEGRANATE ARILS

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Active packaging interacts with foods, acting directly on their conservation, which is thus improved from the point of view of shelf-life and quality. In this work, novel sustainable active packaging films were developed using thermoplastic cellulose acetate as matrix and modified layered double hydroxide (LDH) as filler. The active molecule, ionically bonded to the LDH, was sorbate. Thermal and mechanical properties of the composites were analyzed. In order to evaluate a potential application in the field of fresh fruit packaging, release kinetics of the active molecule were followed using UV spectrophotometry. The thermal degradation behavior and mechanical properties resulted slightly influenced by the filler content. The presence of complex LDH-sorbate induced, instead, a delayed and controlled release of the active molecule to fruit by increasing filler concentration. Bags (6 x 20 cm) were manually made using the active film (active), the acetate film without active molecule (acetate-control) and a commercial polyethylene film (PE-Control). These bags, in triplicate, were used for packaging pomegranate arils (about 50 g for each bag). All samples were stored for 10 days at 8 °C. During storage, the visual quality, evaluated using a scoring system from 5 to 1, the total bacterial count and the development of mould and yeast were evaluated. Results showed a slight positive effect of acetate in preserving visual quality and controlling microbial growth during storage.

058

USE OF ACTIVE PACKAGING FILLED WITH ANION SALICYLATE TO PRESERVE THE SHELF-LIFE OF SEEDLESS TABLE GRAPE

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Table grape is a non-climacteric fruit highly appreciated by consumers for its pleasant sensory attributes and high nutritional value. Unfortunately, this fruit is considerably perishable during postharvest handling due to mechanical damage, water loss and microbial decay.
Active packaging is an innovative approach among traditional postharvest technologies. It is a package incorporated with antimicrobial or/and antioxidant substances that interact with the food by releasing or absorbing these substances inside the package; it avoids rapid decay and prolongs the storability of the product. It could be a valid tool to increase the shelf-life and preserve the quality of table grape. Thus, in this research work, an active packaging based on PET coated with a Layered Double Hydroxide (LDH) filled with the antimicrobial 2-acetoxybenzoic anion (salicylate) was prepared and characterized. Then, seedless table grape (CV Egnathia) was packed into active (Active Tray) or non-active (Tradition Tray) packaging and stored under thermal stress conditions (20 °C) for 7 days. During storage, decay of table grape was evaluated on the base of a 1 to 5 rating scale (1=no decay; 2=slight decay, but product saleable, <2% affected; 3=moderate decay, product useable but not saleable, <5% affected; 4=moderately severe, <15% affected; and 5=severe, unusable). As result, the Active Tray showed a significant inhibition of mold development (slight decay, but product saleable) compared to the Tradition Tray (moderate decay, product not-saleable), keeping the samples marketable until the end of storage.

059

DIFFUSION OF THYME, CINNAMON AND OREGANO ESSENTIAL OILS IN DIFFERENT NANOCELLULOSE MATRICES

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The sorption and diffusion of essential oils in different nanocellulose matrices has been studied in view of potential use in active packaging applications. In particular, the diffusivity of Thyme, Cinnamon and Oregano essential oils in three different types of nanocellulose, with increasing carboxymethylation degree (surface charge ranging from 30 to 1600 μeq/mol) have been measured and compared. The behavior is investigated through both liquid absorption and vapor desorption tests, thus obtaining the diffusion coefficients in different conditions, relevant for the active film preparation and for the essential oil release. The diffusion coefficient of the oils estimated from liquid absorption increases with the increase of the carboxymethylation degree, starting from 2.3 × 10^ (-9) cm^2/s in the pure nanocellulose, to 1.0 × 10^(-8) cm^2/s in the most charged one. The desorption in the gas phase, on the other hand, shows a complex release kinetics, which is rather fast at short times and slows down at long time, when the amount of the oil in the sample is reduced. Different approaches were considered to describe the observed behavior, with the best results obtained by considering two diffusion processes having different diffusion coefficients: the faster one, ranging from 1.1 × 10^(-9)cm^2/s to 3.0 × 10^(-11) cm^2/s for the different oils and nanocelluloses investigated, and the slower one, one order of magnitude lower (from 4.0 × 10^(-11) cm^2/s to 1.0 × 10^(-12) cm^2/s), which becomes prevalent at long times. Interestingly, both diffusion coefficients resulted lower than the ones related to the liquid absorption process, thus suggesting a non-negligible plasticization effect of the liquid oils on the nanocellulose films. The existence of strong interaction between the oils and the different types of nanocellulose was also confirmed by the FTIR analysis, which showed the existence of irreversible modifications of the nanocellulose materials after being saturated with the essential oils.

060

ZEIN BASED ANTIMICROBIAL EDIBLE COATING FOR 'GRANNY SMITH' APPLE QUALITY

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Apple fruit has high nutritional value and antioxidant properties desirable for human health. However, apples are susceptible to quality loss and microbial decay during postharvest. Thus, numerous methods such as modified atmosphere packaging (MAP) have been used to maintain the quality. The MAP however, could lead to possible development of anaerobic pathogens and off flavors. Furthermore, the plastics used in MAP have a significant impact on the environment. Recent studies proposed application of coatings as an alternative approach to overcome the drawbacks of plastic films. Therefore, this study evaluates the efficacy of zein and zein-nisin coating to inhibit the proliferation of total aerobic mesophilic bacteria, yeast and mould as well as maintaining physicochemical quality and physiological responses of

'Granny Smith' apples. A total of 117 fruits were sorted into three categories, for each treatment, fruits were dipped into the coating solutions for 1min. Coated fruit were allowed to dry at room temperature (23 °C) in the laboratory bench. Apple fruit without any coating was designated as control. All samples were stored at 15 °C and sampling was done at day 0, 7, 14 and 21. According to the results, the change in quality parameters such as weight loss, hue angle (h°), titratable acidity, total soluble solids, pH and firmness was similar between the coated (zein and zein-nisin) and control (uncoated) fruit. However, the application coating significantly ($p < 0, 05$) inhibited microbial growth during storage. Zein and zein-nisin coating significantly inhibited yeast and mound as well as aerobic mesophilic bacteria growth to the extent of around 3 log CFU mL-1 by the end of the storage. However, the zein-nisin coated apple had less growth compared to the zein alone. The results of this study could be useful for apple packaging industries to use edible coating as an alternative to plastic packaging.

061

COLD PLASMA TREATMENT FOR COATED AND PACKED STRAWBERRIES

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Postharvest spoilage of strawberries is attributed to high incidence of microbial growth. The current trends of postharvest treatments suggested the use of non-thermal technologies to eliminate the need to maintain the safety of the fruit with less or no detrimental effects on the quality. In this aspect, the use of cold plasma technology is emerging as novel postharvest techniques can be used for surface decontamination. Therefore, this study evaluated the decontamination potential of cold plasma (CP) for coated and packed strawberries using sodium alginate and polyethylene film, respectively. Coated, packaged and unpacked strawberries without CP treatment were used as a control. In general, five samples were prepared with two samples designated as coated fruit with and without cold plasma treatments. Another two samples were prepared as packed fruit with and without cold plasma treatments. The last sample without packaging and coating were used as a control. Cold plasma treatment was done using Dinere atmospheric cold plasma system with 80 kV for 5 min. After treatments, fruit were stored at cold storage and samples were taken every week for microbial and visual quality analysis. The results indicated that Cold plasma treatment reduced the microbial growth compared to the control samples. However, a significant inhibition was observed for in package CP treated strawberries. There were no visual quality differences among treated and control samples during storage.

062

FUNCTIONAL BIOBASED BARRIERS FOR SUSTAINABLE AND RENEWABLE PACKAGING MATERIALS

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In European countries, a large quantity of food is wasted because of the insufficient protection performances of packages. Among the different characteristics of packaging material, resistance to water, grease, flavor and gas are the most critical factors when it comes to food conservation. Such barrier properties can be ensured either by extrusion coating using petroleum-based polymers or by barrier coating (dispersing coating) using renewable and sustainable coating materials. Consumers and producers of food packaging materials are increasingly aware of the advantages of using bio-based materials and their utilization in barrier coatings for paper-based food packaging. Indeed, paper products have been increasingly used as packaging over the last years for their environmentally friendly and biodegradable nature. Our work proposes to use novel bio-based materials in the application of newly developed barrier coating technology. Bio-based materials such as technical biopolymers have a potential to substitute petroleum barriers used for coating of paper-based packaging materials. These bio-based materials, applied on packaging paper could provide interesting functionalities while still maintaining the environmentally friendly characteristics of the paper. Different types of paper were coated using renewable materials (more than 10) and comprehensive barrier measurements showed multifunctional barrier properties of biomaterials. Gas permeability of the coated samples was significantly reduced (0 cm^3/min). Grease resistance (KIT12) was improved, while it was possible to reduce water vapor transmission rate (<100g/m^2day), the migration of mineral oils (<15%), and the permeation of organic volatile compounds for packaging papers, when compared with uncoated substrates. In summary, industrially produced paperboard was upgraded by coating it with the naturally biodegradable biopolymers, thus achieving extraordinary barrier performance for various applications within the packaging industry.

063

COMPOSTABLE PACKAGING: SUSTAINABILITY, SUITABILITY AND SAFETY ARE A CHALLENGE TO WIN FROM BIOPLASTICS TO PAPER FROM A SHELF LIFE/FOOD WASTE PERSPECTIVE

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The international scenario regarding sustainability, both from legislative and people's perception point of view, is still evolving and is very variegated. Compostable materials have the chance to be a tangible alternative to traditional ones and a strategic option for many industries. Therefore, environment and sustainability are increasingly linked to safety and health: the use of new materials leads to a reassessment of the exposure approach, given their characteristics, and to prove conformity is the key.
What should a food packaging producer look at when shifting from traditional to compostable plastic? What is the comparison with traditional plastics and recyclable paper-based products?
• Testing compostability according to international recognised standards
• Testing for safety in contact with food, monitoring intentional and unintentional, predictable and non-predictable contaminants.
• Verify any changes in shelf-life
The latter point is crucial if the aim is to realize sustainable packaging. A long shelf life means a better conservation of food and hopefully, less food waste. The fight against food waste is one of the UN's crucial goals for global sustainable development between now and 2030. In Europe it is included in the Farm to Fork Strategy. Food companies can contribute in a concrete way: the evaluation of the right food contact packaging and a thorough work on the shelf-life of products are good starting points. We propose to present the possible approach to all these themes, from an analytical but also pragmatic point of view.

064

UTILIZATION OF CHESTNUT SHELL LIGNIN IN ALGINATE FILMS

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Lignocellulosic structures obtained from agricultural wastes are alternative energy sources, which may also contribute to the re-design of sustainable packaging materials. In this study, the utilization of lignocellulose (LS), alkali lignin (L), and hydroxymethylated (modified) lignin (ML) separated from chestnut shells in alginate (AL) films were investigated. Lignin-based structures were then added to AL film at 10 and 20% (w/w based on AL) as reinforcing agents. The effects of chemical modification of lignin and lignin concentration on the AL films were characterized by water vapor permeability (WVP), FTIR, mechanical, optical, and antioxidant properties. FTIR results showed that extracted L and LS had different structures, and the modification of L resulted in a peak shift and a decrease in peak intensities between 1250-800 cm-1. FTIR results of films also indicated a potential hydrogen bonding between AL and lignin-based structures. DPPH radical scavenging activity test showed that films containing L had higher values ($p<0.05$), while AL control film had no antioxidant activity. Besides, L, LS, and ML themselves presented similar results with films to indicate that the activity of lignin-based structures was not affected by interaction with AL. WVP of the films containing ML was the lowest ($p<0.05$), and the results revealed that 20% (w/w) concentration had an adverse effect on the WVP of films, which might be due to the aggregation of lignin in the polymeric matrix. The addition of L, LS, and ML increased the tensile strength and elastic modulus ($p<0.05$) when compared to AL control films. Films containing L-based structures showed higher opacity and relatively lower L* values with increasing concentration ($p<0.05$). These results presented that the addition of lignin into biopolymeric films is a promising method to improve biopolymers' properties and provide functional attributes such as antioxidant activity.

065

DIFFUSIONAL BEHAVIORS OF SOME ANTIMICROBIAL AGENTS FROM ACTIVE MULTILAYER AND ANTIMICROBIAL ABILITIES

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Diffusion of an antimicrobial agent from active food packaging is important to evaluate if the released antimicrobial concentration is within the allowed limits and to provide antimicrobial efficiency and food safety. Since the diffusion might be affected with pH and water activity of the food products packed and its storage temperature, the aim of the study was to investigate effect of pH (3.0 – 7.0), water activity (0.65 – 0.95) and storage temperatures (5 – 25°C) on diffusion of antimicrobials from active multilayer plastic films (LDPE/polyamide/LDPE-2% antimicrobial agent) into a model system which was adjusted to simulate a food system. The antimicrobials used were nisin, potassium sorbate, silver substituted

zeolite, and chitosan. It was found that diffusivity constants of nisin and silver substituted zeolite were affected by pH or temperature; however, diffusivity of potassium sorbate was found to be the highest and depended on all factors. No chitosan was released from the film matrix. The antimicrobial effectiveness of the films against microorganisms that were S. aureus, E.coli, C. albicans, A. niger were shown at different ratios according to the film type and antimicrobial activities of the films were verified in a real model food, which was kaşar cheese. Among the films, AgZeo- and N-films showed great potential to inhibit both two microorganism groups: bacteria, and yeast and molds. Hence, it was possible to state that all active films studied could be used as a food packaging material. It is necessary to state that using specific agents for the kind of microbial deterioration will be helpful to improve the food shelf life.

066

EVALUATION WATER BARRIER PROPERTIES BY COMPARING SORPTION BEHAVIOUR AND WATER TRANSMISSION RATE OF FILM FROM DIFFERENT FILM COMPOSING MATERIALS

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The sorption, barrier, mechanical and thermal properties of whey protein isolate (WPI), soy protein isolate (SPI), and carboxymethyl cellulose (CMC) based films were investigated. It was found that CMC films had the highest water vapor transmission rate (WVTR) and monolayer moisture content value. However, diffusion coefficients of water vapor (D) of CMC film measured at 30, 50 and 75% RH were lower than those of WPI and SPI films. The hydrophilicity of CMC films, deduced from its high water vapor adsorption capacity, might lead to the lowest D among the studied films, and this might result in swelling of film matrix and reduction of the film porosity. The hardness of the films from high to low was CMC, WPI, and SPI in order. SPI-film was the finest with the lowest WVTR, OTR, and excellent film properties in terms of its Tg, ΔH, and E% values. The D and solubility of the edible films should be examined together to estimate the whole water vapor barrier property. Moreover, in edible films, the simple relationship of P=DS was worked fine in both ways either from measuring permeability and diffusion to calculate solubility or, by calculating diffusion and solubility from sorption data to predict permeability of the films.

067

TOWARD SUSTAINABLE PHBV-CHITOSAN BIOBASED MULTILAYER FILMS WITH IMPROVED PROPERTIES

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(3-hydroxybutyrate-co-3-hydroxyvalérate) or PHBV is currently considered as one of the most promising substitutes of conventional plastics, with low environmental impact, especially for food packaging applications. Nevertheless, individually PHBV have serious disadvantages when compared to currently used thermoplastics. Indeed, high permeability to oxygen, high costs and thermal instability are still limiting its industrial applications. The objective of this study was to improve the oxygen barrier performance of PHBV without compromising its sustainability (biodegradation, circularity,). Byproducts coming from seafood industries, such as chitosan, were used to produce PHBV-Chitosan-PHBV multilayer films with improved barrier and thermal efficiencies. In this study, PHBV films were prepared by the solvent casting method (3% w/v in chloroform). Chitosan film was also prepared by wet casting methods (2% w/v in an aqueous 1% acetic acid) solution plasticized with glycerol at 15% (w/wt). Hot-press technique was used for assembling and shaping the multilayers (PHBV-Chitosan and PHBV-Chitosan-PHBV). Barrier (WVP and PO2, PCO2,…), mechanical, surface, thermal and adhesion properties were investigated on the single constituent layers as well as on the final laminate. The hot-press process allowed a good adhesion between the two biopolymers. The most efficient multilayer enhanced the barrier properties to gases and to the water vapor (more than 10 times). Thermal stability of multilayer films is also enhanced compared to single films. This study certainly evidenced the potential of PHBV-Chitosan-PHBV complexes as a valid sustainable substitute for high performing conventional plastics. It also could open an unexplored PHBV market opportunity. In addition, further investigations on PHBV-based laminates using other biopolymers from agroindustrial waste or byproducts will be of great industrial interest.

068

INTENTION TO PURCHASE MILK PACKAGED BY BIODEGRADABLE PACKAGING: EVIDENCE FROM ITALIAN CONSUMERS

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The dairy industry yearly generates a large volume of liquid wastes, including a large amount of whey proteins. Liquid wastes produced by the European dairy sector are sized at 50 Mt whose approximately 40% of it is discarded, generating important environmental issues due to its large quantity and the organic content. Considering that whey contains about 55% of the whole milk nutrients, its recovery from dairy liquid wastes could be a potential source for the production of different value-added products. In a circular economy perspective, a promising possibility could be the use of whey for the production of innovative biopolymers such as PBAT poly (butylene-co-adipate terephthalate), PHA (polyhydroxyalkanoates), and PLA (polylactic acid), potentially employable for the creation of milk biodegradable bottles. In this regard, the research work aims to explore the consumers' willingness to purchase sustainable packages, as well as their willingness to pay for them considering renewable packages made using plant-based material (e.g., corn, sugarcane, etc.) and organic waste feedstocks from the dairy industry (e.g., whey). To reach the stated objectives, we collected individual-level information (e.g., age, gender, education, income) from a convenient sample of 260 Italian consumers and an extended version of the Theory of Planned Behavior estimated using a structural equation model. Findings show that attitudes and perceived behavioral control are the most important drivers of the consumer's intention to purchase sustainable packages. Finally, descriptive statistics show that respondents slightly prefer to purchase products packaged using plant-based material over those from organic waste feedstocks, and most of the respondents are willing to pay from 1% to 5% more for milk packed by biodegradable packaging regardless of the raw material used.

069

THE EFFECTS OF ARTICHOKE OUTER PETAL LEAVES LIGNOCELLULOSIC EXTRACT ON POTATO STARCH-BASED BIODEGRADABLE FILM PROPERTIES

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Artichoke is an important vegetable of Mediterranean cuisine, however only 15-40% of globe artichoke weight consists of the edible parts. The rest of the plant which is discarded as waste is composed of many valuable constituents like; dietary fiber, cellulose, hemicellulose, bioactive compounds, minerals and proteins which are mainly found in the outer petal leaves. In this study, the alkali extracts of outer petal (bract) of globe artichoke (APE) which was discarded as processing waste was used as a lignocellulosic fiber source at different concentrations in potato starch-based biodegradable food packaging films. The effects of APE incorporation (0-5-10-20% w/w on starch basis) into starch-based films were characterized by water vapor permeability (WVP), mechanical properties, FTIR and optical properties. The WVP of the films were not significantly improved with the addition of APE possibly due to increased swelling capacity of lignocellulosic fibers after alkaline extraction compared to untreated leaves. FTIR spectra of the films exhibited a possible interaction of starch with APE, since the peak intensity of the films changed with respect to the addition of APE into starch-based films. The tensile strength of the 10% APE film was the highest; however 20% APE addition negatively affected the film strength. In contrast, the highest elongation at break value observed for 20% AP films ($p < 0.05$). Although there was a clear tendency between the incremental greenness and yellowness with decrease in the lightness values upon the increased level of APE addition, the opacity of the films were found in the same group ($p > 0.05$).

Keywords: artichoke petal, starch, waste utilization

070

NOVEL BREATHABLE PACKAGE SYSTEM TO IMPROVE THE FRESH FIG (FICUS CARICA 'DOTTATO') SHELF LIFE

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The fig (Ficus carica 'Dottato') is a high perishable climacteric fruit. The souring, the skin bruising, the splitting and the fungal growth are the main causes of decay during the post-harvest period dramatically affecting the product shelf-life. The present paper shows the results during the long-term storage of fig using an innovative polypropylene (PP)-based, recyclable packaging system, endowed with a PP patented device (Blow Device®) conferring breathable properties to the package. The normal and modified atmosphere (5% O2, 15% CO2) was tested. The innovative packaging system (BD) was evaluated in comparison with a PP sealed tray (ST), a micro-perforated film-based tray (MF) and a conventional unwrapped tray currently used for fig commercialization (CTRL). The following parameters were monitored during the storage trials at 2 °C up to 28 days: headspace gas composition, inner pressure inside trays, product mass loss, rate of decay, flesh and skin colour, total soluble content, titratable acidity (TA), firmness, elasticity, total phenols (TPC) content. The

packaging system and storage duration affected most of the parameters investigated ($p<0.05$), except TPC and flesh tone (H*). The parameters variation was significantly smaller using the experimental trays (BD, ST, MF). Rot decay incidence was similar using ST and BD after 14 days (0-5%). ST significantly mitigate rot decay rate and physical-mechanical parameters compared to BW and MF. However, ST trays led to product anoxia, with relevant CO2 content (30-40%) and the highest TA values. MF and CTRL had the same rot decay incidence, after 7 days (5-20%) due to the low CO2 content. The BD allowed reaching a steady-state equilibrium of the atmosphere in the headspace in the range 7-15% O2 and 5-15% CO2. After 14 storage days, the figs packed in this condition showed a negligible mass loss (0.2%) and satisfactory quality parameters.

071

DEINKING EFFICIENCY OF INDUSTRIAL WASTE AND INVASIVE PLANT PAPERS FOR PAPER BAGS

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Recycled and reused waste papers are significant low-cost fibre resources (raw materials) for the pulp and paper industry. The current demand for pulp and paper products, especially for packaging applications, demands new alternative sources due to increased demand and more circular approaches, which reuses the residues of some production or other alternative sources. For the proper end of life treatment and recycling procedure, the printed inks must efficiently be removed from the packaging after being disposed into the recycling stream. The deinking is usually done with chemicals and flotation procedures, while enzymes are also an alternative way to separate the ink particles from the packaging paper. In this paper, we have tested the deinking efficiency of two alternative papers: one made from waste jute bags, which are usually burned after the coffee is roasted, and one made from an invasive plant, Japanese knotweed, an invasive plant endangering local biodiversity. Both papers were printed with water-based flexo inks used for flexible paper packaging and two deinking procedures (classic and enzymatic) applied to the printed samples. The deinking test was conducted following ISO 21331: 2020 and ISO ISO 21933: 2020. The methodology involved: preparation of samples, impregnation, pulping, enzymatic treatment, flotation, papermaking, and finally, evaluation of optical and mechanical properties. The samples were determined by the thickness, grammage, and optical properties (ISO whiteness, CIE Whiteness, and UV component). During our study, we have shown that the efficiency of enzyme treatment is comparable to chemical treatment efficiency, and these papers regarding the deinking efficiency can be a viable printed paper packaging substrate for food products.

072

RECYCLING OF POLYPROPYLENE BY SUPERCRITICAL CO2 FOR EXTRACTION OF CONTAMINANTS FROM USED BEVERAGE CUPS

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Plastics provide unparalleled functional properties for a minimal price yet today suffer from a bad reputation. Their wide application can be seen all around the world and their production is said to double in the next decade. European Union policies towards a circular economy, address plastic packaging which is one of the major concerns and sets ambitious recycling targets. The highest percentage of plastic usage in the packaging industry is polyolefins (POs) such as polypropylene and polyethylene (65%). These POs cannot be recycled for food contact using conventional PET recycling approaches. Thermal degradation prevents the use of high temperature and as consequence decontamination of PO may be insufficient when using lower temperatures. The recyclability of polypropylene (PP) single-use beverage cups by using supercritical fluid extraction using carbon dioxide (scCO2) to decontaminate flakes was studied. Decontamination efficiencies (DE) of selected markers were used in challenge tests. The decontamination of PP was compared with that of polyesters PET and PLA. The effect of processing time (10, 30 and 60 min); and temperature (60, 70 and 80 °C), at constant pressure, in the decontamination of PP was studied. The reproducibility of the scCO2 extraction was addressed in perspective to the analytical variability in the concentration determination. The challenge tests set up follow the EFSA approach and are quantified using GC-FID. PP showed the highest average DE of all the surrogates in all time conditions; PET had lowest average DE. It was observed a relative increase in the decontamination efficiencies with the increase in time of the process, particularly for PET and to some extent PLA. For PP, such an impact was not significantly observed. The temperature did not seem to have a significant effect for PP, under the conditions tested. Additionally, the DE of volatile components chosen as surrogates for this study was observed to be higher than that of semi-volatile components. The scCO2 treatment did not affect the overall migration or the sensorial properties of the plastic treated.

073

NEXT GENERATION SCREENING METHODOLOGIES FOR THE ADVANCED AND COMPREHENSIVE MONITORING OF INTENTIONALLY AND NON-INTENTIONALLY ADDED SUBSTANCES IN FOOD CONTACT MATERIALS

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Packaging made of plastic preserves food by protecting it for example from light, humidity, mechanical influences and microbial contamination. However, the packaging can also be a source of some serious chemical food contaminants. Migration phenomena should be evaluated and controlled, since they can bring about unacceptable changes in the composition of the food, not only deteriorating its organoleptic properties, but also and most importantly possessing toxicity threats for the consumers. The complex mixture of substances with known or unknown identity/origin comprising a food contact material (FCM) underline the difficulty associated with the identification of chemicals migrating from the packaging into the food. This challenge is the focus of the current research work, targeting the identification and semi-/quantification of both intentionally and non-intentionally added substances (IAS & NIAS) migrating from various FCMs into their content. Aiming the comprehensive IAS & NIAS screening, GC-MS/MS and GC-APCI-QTOFMS methods were developed, for the target screening of volatile migrants. Furthermore, corresponding contaminants of low volatility and high polarity were identified by LC-MS/MS and LC-ESI-QTOFMS methods. Particularly the high-resolution mass spectrometric (HRMS) methods applied are utilized for further suspect and non-target screening and retrospective analysis of obtained FCMs. For these screening procedures the entire spectrum of food simulants is being evaluated with different migration protocols being employed, depending on the intended use and origin of the analysed samples. Risk assessment of the identified migrating compounds is also performed using the corresponding legislation, on-line tools and in-house built software. The application of these workflows into a large set of products and the subsequent complete screening of migrating chemical contaminants will promote the production of inert and consequently organoleptic neutral and safe FCMs. Thus, this work will assess public health risks, by facing current and future challenges.

074

SENSE-FRUIT: A FRUIT SIMULATOR FOR ADVANCED MONITORING OF POSTHARVEST SUPPLY CHAINS

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To ensure the quality and shelf life of fresh produce, it is crucial to control the fruit's microclimate (H2O, O2, CO2, and C2H4) along the whole supply chain. Therefore hygrothermal sensing is essential to identify non-optimal conditions, such as temperature abuse in the cold chain. Monitored sensor data assists the optimization of packaging, storage, and transport conditions to maximize the product's shelf life. However, realistic monitoring that captures, for example, fruit pulp temperature instead of surface temperature, is rarely applied. Thus, analyzing only air temperature can lead to non-ideal process adjustments due to the fruit's inertia and delayed reaction to temperature changes. For this purpose, we recently developed biophysical fruit simulators that mimic the thermal response of different fresh fruit and vegetables in their environment. These react hygrothermally as a fruit, and a built-in sensor enables monitoring of the fruit core temperature. Furthermore, we aim to integrate additional sensors to trace other environmental parameters, including surface humidity. As a stand-alone unit with no external cables or hardware, the fruit simulator does not impact the cooling behavior of the packed fruits or the airflow field around them. Moreover, it is possible to place it at multiple locations inside the cargo or together with the product within the designated packaging. In conclusion, this simulator will provide much more comprehensive data than currently available from air temperature sensors, and these data can later be translated into process optimizations. Thus, this technology will improve in-transit sensing of postharvest supply chains and thereby help to mitigate food loss and waste.

075

REDUCING FOOD WASTE BY QUALITY CONTROLLED LOGISTICS USING INTELLIGENT PACKAGING

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Food waste is a global problem resulting in major environmental impact. Intelligent packaging can be used to reduce food waste when used in supply chain management based on Quality Controlled Logistics (QCL). It is demonstrated how monitoring food quality in

combination with mathematical modelling enables the use of dynamic expiration dates (DED) on food packages. Simulations show that QCL by using the information on the quality of products that is provided by intelligent packaging can reduce food waste by more than 50% compared to FIFO or other issuing policies.

076

FOOD WASTE AND ECO-DESIGN: SYNERGY BETWEEN FOOD AND PACKAGING LCA

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Food packaging solutions available in the market are plenty with different material compositions and shelf life potentialities. Nowadays, in a scenario where 1.3 billion tons of food products are wasted every year, and these wastes may occur at any step throughout the food supply chain (from farm to fork), it is desirable to identify the best packaging solution highlighting a better shelf life perspective. Food packaging sector is evolving, entering in the market the optimized packaging concept which can help food waste reduction with less environmental impact. The work aims to present two case studies which consider food waste reduction, packaging design and circular economy approach through the Life Cycle Assessment method. For each case study, an eco-design approach was performed considering all the resources such as electric and thermal energy, water, materials, and transport necessary to obtain food packaging and food products environmental impacts. Different functional features of the packaging were accounted for (e.g. potential food waste production, shelf life extension, and beef browning prevention) to normalize the environmental impact resulting from the analysis. Moreover, multivariate approaches (Principal Component Analysis) were performed to correlate environmental impacts and the functional characteristics of the packaging. The results highlight how the less environmental impact packaging solution does not always represent the greener solution considering also functional characteristics of the packaging implying higher potential food wasted. In conclusion there is the necessity to design packaging simultaneously capable of maintaining food quality and safety, to reduce food losses, and to promote circular economy models identifying greener packaging solutions.

077

ZEIN IN ANTIMICROBIAL FOOD PACKAGING

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Biodegradable and sustainable packaging with improved properties has received increased interest in food industry. Biopolymer materials based on renewable biomass can be used as an alternative to conventional plastic packaging. A corn protein, zein, has a hydrophobic nature and has excellent film-forming properties. It can be used for making edible films, what more even for producing nanofibrous layers. This study aimed to develop the zein based coatings, films, and nanofibers with antimicrobial substances to prepare active food packaging. Mechanical, antimicrobial, and antibiofilm properties of the films were analysed. Composite films with various zein to chitosan ratios were also investigated. Zein/chitosan systems proved to serve as suitable carriers for various essential oils (thyme, oregano, clove) and other antimicrobial compounds (thymol, carvacrol, curcumin). It was further observed that the active substances were rapidly released into the environment within 24 hours and the films no longer show antimicrobial activity. Zein nanofibers were also successfully prepared with active compounds; nevertheless, they had lower antimicrobial activity than films. Those mentioned above, natural active substances in food packaging could slow the surface growth of bacteria, yeasts and fungi, prolong the shelf life of food and thus serve as an alternative to chemical antimicrobials. In addition, edible and biodegradable films can substitute for natural layers to prevent moisture loss while selectively enabling the exchange of important gases.

078

ALBANIAN LEGISLATION AND CHALLENGES RELATED TO FOOD PACKAGING WASTE MANAGEMENT

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Packaging plays an important role not only on keeping product safe and fresh, but encourages people buying it. All food that we use comes to us packed on different size, shape and materials. The National Environmental Agency has reported that the total amount of solid waste generated from 48 out of 61 Albanian Municipalities during the year 2019 was 837,122 tones. From this amount

34,405 tones or 4.1 % was plastic, 29,572 tones or 3.5 % was paper and cardboard, 16.060 tones or 1.3% glass, and 13,153 tones or 1.5 % metals (including aluminum and tin). The recovery and management of food packaging materials in Albania are regulated based on laws and regulations and the food packaging can be considered as the main contributor with more than 50 percent of the waste by volume. The main objective of the current study is to analyze actual legislation related to food packaging waste management, comparing with EU directives and regulations in order to improve actual Albanian legislations and waste management from the food industry. Some laws, regulations and strategies are approved by the Albanian government in order to manage direct or indirect packaging and food packaging materials. Thus, the packaging and food packaging material is mainly regulated by the Law No.9863 "Food Law", date 28.1.2008; the Law No. 10431,"On the environmental protection", date 9.06.2011 and the Law No. 10463, "On the integrated waste management". Further, are approved the Decisions of the Council of Ministers "On materials and plastic materials intended to come in contact with food" and"Packaging and waste packaging". These laws and decisions are partly harmonized with EU directives and regulations, thus the improvement of actual legislation. Another observed issue on the management of food packaging was the separation in source of the waste. Furthermore, this study highlights a lack of collaboration between the central government and several municipalities. Therefore, besides improvement of Albanian legislation, it is required to raise awareness and collaboration between central and local governments on food packaging management.

Keywords: Food legislation, food packaging materials, waste management, plastic waste, raising awareness.

079

BIO-BASED PLATELET-SHAPED BIOCHARS AS REINFORCEMENTS IN BIOPOLYMERS FOR FOOD PACKAGING APPLICATIONS

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In this work, we have successfully extracted platelet-shaped biochars (PCNC) with widths/lengths up to 100 μm and thicknesses down to 100-150 nm from pyrolyzed nematic structures of cellulose nanocrystals. The PCNC showed 87% carbon content and mostly amorphous nature. The performance of PCNC as a reinforcing agent for food packaging applications was evaluated by comparing to the reinforcing capabilities of graphene oxide (GO) in a 6,14 biopolyamide (PA) and a cellulose nanofibers (CNF) matrix. For both cases, PCNC was found to be a better reinforcement than GO. PA/PCNC composites showed improved thermomechanical properties compared to PA/GO (PA/PCNC 5% showed a storage modulus at 100°C of 545 MPa while PA/GO 5% 392 MPa). Additionally, PA/PCNC composites showed reduced water diffusivity than PA/GO composites (PA/PCNC 1% showed a water diffusivity of 1.3 * 10-7 cm2/s, PA/Go 1% 1.8 * 10-7 cm2/s). Besides, filaments made with PA/PCNC also showed a better surface finish than PA/GO. In CNF composites, the incorporation of 5% of PCNC reduced the moisture-induced swelling by 31% (from 0% RH to 90% RH at 35 °C), increased the CNF´s young modulus and stress at the break by 34% and 22%, respectively. Besides, unlike GO, the incorporation of PCNC increased the electrical conductivity of CNF up to 10-3 S/m. To summarize, PCNC was a better reinforcement than GO, for both PA and CNF, in several aspects.

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NATURAL PECTIN-BASED EDIBLE COMPOSITE COATINGS WITH ANTIFUNGAL PROPERTIES TO CONTROL POSTHARVEST DECAY AND REDUCE LOSSES OF 'VALENCIA' ORANGES

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The potential of essential oils (EOs) and natural plant extracts to inhibit Penicillium digitatum (PD), Penicillium italicum (PI), and Geotrichum citri-aurantii (GC), the most economically important pathogens causing postharvest diseases of citrus fruits, was evaluated in in vitro studies. Selected antifungal agents and concentrations were incorporated into a pectin-based edible coating. In vitro mycelial growth inhibition was evaluated in PDA Petri dishes by exposure to the volatile compounds of EOs in the vapor phase or by direct contact of the natural extracts using the agar dilution method after 7-14 days of incubation at 25°C. Commercial EOs and volatile compounds evaluated were cinnamon (CN), lemongrass (LG), Satureja montana (SM) and myrrh (MI) EOs, eugenol (EU) and geraniol (GE). Dry extracts included green tea (GT), propolis (PRO) and vanillin (VA). Among these agents, CN, SM, EU and GE (at a dose of 20 µl) inhibited the radial growth of all the pathogens by 90-100%; whereas, VA, PRO and MI extracts were effective at concentrations of 0.125-0.5% (w/w). The effective agents were tested as ingredients of pectin-beeswax

edible coatings at different concentrations (0.2-2%w/w) to control green mold and sour rot on 'Valencia' oranges artificially inoculated with PD and GC, respectively. Disease incidence (%) and severity (lesion diameter, mm) were measured during 14-20 days of incubation at 20°C. Coatings containing 0.2% GE, 0.8% EU or 1.5% MI EOs reduced green mold incidence after 8 days by more than 40%, while the highest reduction in disease severity was observed with 0.8% CN. In the case of sour rot, the most effective coatings were those amended with EU (0.2-0.4%w/w), with 100% reduction of both disease incidence and severity. These results suggest the potential of these antifungal coatings to reduce citrus losses. Further studies should focus on the evaluation of the quality of coated citrus fruit during cold storage.

081

DEVELOPMENT OF BACTERIAL NANOCELLULOSE POLY (3-HYDROXYBUTYRATE-CO HYDROXYVALERATE) COMPOSITE FOR FOOD PACKAGING

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Food packaging is increasingly demanding for advanced and eco-friendly sustainable materials that comply with food packaging requirements. Currently used materials are synthetic and non-degradable, raising environmental issues derived from the accumulation of plastics in landfills/waterways. Therefore, in this work, we intended to develop a sustainable and biodegradable food packaging based on bacterial nanocellulose (BNC) and polyhydroxyalkanoates. BNC is a biopolymer produced by Komagaebacter xylinus as a 3D nanofibrillar network, with interesting properties such as high porosity, biocompatibility and biodegradability. Applications such as biomedical, pulp & paper, composites, foods and many others, can benefit from these properties. Concerning food packaging, BNC has been demonstrated to offer interesting mechanical properties and the ability to support substances that play an active role in, for instance antimicrobial. However, the water vapour permeability is too high for packaging applications. While attempting to control the water vapour permeability, composites of BNC with poly-3-hydroxybutyrate-co-3-hydroxyvalerate (with a hydroxy valerate content of 18%) (PHBV) were produced. PHBV is a known polymer produced by bacteria with high degree of hydrophobicity and biodegradability. BNC membranes produced by static culture were plasticized either with glycerol (BNCgly) or polyethylene glycol (MW600) (BNCPEG), by impregnation for 24 h in 1% m/v solutions, followed by air-drying. The BNC was then coated with PHBV (20%m/v) dissolved in formic acid (60 ºC; 2 h), and oven-dried. The morphology, water vapour permeability, degree of hydrophobicity and mechanical properties were then assessed. Overall, PHBV coating on plasticized BNC reduced significantly the water vapour permeability (down to 0.032 g.um/ (m2.day.Pa) under 50% relative humidity), and enhanced the degree of hydrophobicity (Contact angle within 80-90º), compromising the high stiffness (from 3.1GPa to 1.3GPa) of BNC. However, the obtained properties were acceptable for packaging applications. Concerning the plasticizer used, better adhesion of PHBV was observed with glycerol, resulting in enhanced coating performance and barrier properties.

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LIGNIN/PLA BASED SUSTAINABLE COMPOSITES FOR FOOD PACKAGING APPLICATIONS

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Globally, 42% of total polymer consumption goes for packaging applications. Among the polymers used in food packaging, polylactic acid (PLA) is widely used in plastic films, bottles and biodegradable medical devices. However, PLA exhibits some limitations such as slow crystallization, poor thermal stability and high cost which makes it unsuitable for food storage applications. We suggest that these limitations can be overcome through incorporation of biopolymers like lignin. Lignin can be obtained as a byproduct from agricultural and forest biorefineries and contains several different functional groups (hydroxyl, carbonyl, and carboxyl groups). However, lignin has some compatibility issues with PLA due to the polar functional groups present. Modification of these polar groups within lignin can significantly minimize compatibility issues with the PLA matrix and enhance the properties. The present work proposes oxypropylation and benzylation reactions of lignin hydroxyl groups to boost the hydrophobicity and followed by the production of modified lignin/PLA composites. This work will also focus on producing modified lignin nanoparticle (LNP)-based PLA composites due to its strong potential for several applications. However, the hydrophilic nature of the LNP still results in compatibility issues, and therefore need for new approaches to produce surface-modified

lignin particles better suited to PLA composites. The morphology of produced composite films will be examined through scanning electron spectroscopy and transmission electron microscopy. Similarly, the composites physico-chemical properties including (mechanical- tensile, Young's modulus and glass transition temperature and type of interaction and bonding Additionally, to improve the antimicrobial property of the packaging film, copper (Cu) nanoparticles will be incorporated into the composite and the anti-bacterial performance will be evaluated. The proposed work will provide significant advances to boost the utilization of PLA polymer at low costs for various food packaging applications.
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TAILOR-MADE PACKAGING STRATEGIES TO EXTEND THE SHELF LIFE OF FRESH PORK BELLY

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The food not consumed before use-by date accounts for about two-thirds of household food waste. Thus, shelf life extension becomes a key approach to prevent food waste. Intensive pork selection to meet demand for leaner meat products has resulted in leaner bellies with softer texture and poor oxidative stability that might result in reduced shelf life. Packaging of belly in a modified atmosphere (MAP) with high levels of oxygen, the common practice in Spanish retail, might result in reduced shelf life. The objective of the present work was to evaluate the impact of breed and the packaging system on pork belly stability. Deboned pork bellies with low (Pietrain crossbred lean, Pl), medium (Pietrain crossbred fatty, Pf), and high (Duroc) fat levels were selected. Bellies were sliced, packed in MAP1 (70:30; O2:CO2), MAP2 (30:40:30; O2:CO2:N2) and vacuum skin, and stored at 3.4 ±0.8°C (12+12 h lightness/darkness) for 20 days. Sensory odour and colour (acceptance sensory threshold set at ≤3), oxidation (TBARS), and colour (computer vision system analysis) were measured. Breed and packaging type proved to have a significant effect on quality parameters throughout refrigerated storage. Belly samples from Duroc pigs showed higher colour and fat stability than those from Pietrain crossbred. As expected, skin packaging slowed down quality deterioration showing higher product stability than high oxygen MAP (MAP1 & 2) throughout storage. Sensory analysis confirmed those results, non-acceptable rancidity and lean colour scores were detected after 10 days of refrigerated storage for Pietrain samples (Pl & Ph), and after 15 days of storage for Duroc samples. The results highlight the importance of designing fresh meat packaging strategies adapted to the specific characteristics and protection needs of each product type taking into consideration key factors that have an impact on quality such as breed.

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SUSTAINABILITY MESSAGE OUTLOOK IMPACTS CONSUMER RESPONSE TOWARD SUSTAINABLE PACKAGING

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Sustainable food packaging can be grouped into those solutions that provide an improved packaging solution to consumers (e.g., being made from recycled material) and those that require consumers to act (e.g., is made from recyclable material). What differentiates these two types of solutions is that in the first group (we call this "backward message outlook") consumers may buy a product that is already "sustainable", whereas in the second group ("forward message outlook") these solutions can deliver their sustainable role if consumers engage in this process. With this distinction in mind, we conducted a series of online experiments (Study 1a, 1b, 2), a study in a demo-supermarket (Study 3), and a field study (Study 4). In all experiments, we exposed participants to messages that increased the saliency of either of the two types of solutions. Our main finding is that exposure to a forward message outlook improves consumer willingness to pay (Study 1a, 1b), which is mediated by perceived sustainability of packaging type (Study 2). We further show that the same message increases willingness to buy as well as the willingness to pay for food products with sustainable packaging (Study 3), as well as the market share of products offering sustainable packaging solutions (Study 4).

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RESEARCH TRENDS IN FOOD PACKAGING: A BIBLIOMETRIC COMPARATIVE ANALYSIS UTILIZING TEXT MINING

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We conducted a bibliometric assessment of food packaging literature using Web of Science database on scientific documents published between 2000-2021 years. Bibliometric data related to food packaging were

saved as BibTex and imported to R studio for further analysis. The data were screened automatically based on DOI number and duplicated documents were removed. Author keywords and keyword plus were assessed with a word cloud to demonstrate hierarchical representation of the words according to appearing frequency. Unsupervised classification method called topic modeling was performed on author keywords, keyword plus, titles and abstracts of the scientific documents. Latent Dirichlet Allocation (LDA) method was used to construct the topic model treating each document as a combination of topics and each topic as a blend of words allowing grouping of articles based on content (related words). Bibliographic data patterns were visualized and notable research trends in food packaging field were detected. The focus of this study is to assess research trends in the food packaging for the last twenty years performing descriptive and retrospective bibliometric research. Besides, we aim to introduce text mining by utilizing various packages in R software, and inspire future application of this technique on systematic review.

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URINARY LEVELS OF ENDOCRINE-DISRUPTING CHEMICALS, INCLUDING TRICLOSAN AND 4-NONYLPHENOL IN SCHOOL-AGED CHILDREN OF SOUTHERN ITALY POPULATION WITH A PLASTIC-FREE LIFESTYLE

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Triclosan and 4-nonylphenol are endocrine disruptors (ED) frequently widely used in daily products. Triclosan is a broad-spectrum antimicrobial and antifungal agent added to a wide variety of personal care products such as soaps, toothpaste, mouthwashes, acne medications, deodorants, disinfection solutions, shampoos, and others. 4-nonylphenol is an alkylphenol primarily involved in the production of alkylphenol ethoxylates (APEs), which are surfactants mainly used for their wetting, dispersing, and emulsifying properties. This study aimed to evaluate the urinary Triclosan and 4-nonylphenol concentration in an Italian pediatric cohort, testing the levels of this ED over a period of 6 months, evaluating the effects of a diet regimen with a reduction of Plastic Food Packaging (PFP). 30 Italian children were enrolled and divided into two groups: "School Canteen" and "No School Canteen." The first group consumed one meal at school using a plastic-free service for 5 days/weeks, while the other group did not modify their normal meal-time habits. The Triclosan and 4-nonylphenol levels were tested in urine samples at three-time points: T0, is the time before the application of the plastic-free regimen diet; T3, 3 months later; and T6, 6 months later, by ELISA test. A reduction of urine Triclosan and 4-nonylphenol levels was detected in the "School Canteen" group. In particular, the reduction was significant analyzing both the intra (among the three testing times) group and inter (between "School Canteen" and "No School Canteen") group variability. Our results show the effects of a diet regimen with a reduction of PFP, demonstrating a connection between urinary Triclosan and 4-nonylphenol levels and food packaging.

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BYPRO3D – CAN AGRI-FOOD AND FOREST BYPRODUCTS BE REUSED IN THE ECOLOGICAL PRODUCTION OF 3D FOOD PACKAGING?

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From agri-food and forest industries, biobased byproducts still containing valuable biomolecules are generated. On the other hand, additive manufacturing (AM) offers cost-effective 3D printing technologies to create innovative/sustainable food packages. Fused deposition modelling (FDM) is a popular AM technique, whose feedstocks (filaments) have low or no biodegradability. To minimize all these issues, in this work, non-value agri-food and forest byproducts, namely potato washing slurries (PWS), coffee silverskin (CS), and woodforce (WF) were used as a source of biomolecules suitable for developing biobased filaments. The influence of CS and WF on optical, wettability, and mechanical properties of thermoplastic starch (TPS)-based films was studied. Moreover, the extrudability and printability of TPS/CS- and TPS/WF-based formulations were explored. Due to their pristine coloration, CS and WF gave rise to brownish TPS-based films with increased rigidity and surface water tolerance, thus reinforcing the hydrogen bonding between their lignocellulosic material and amylose/amylopectin chains, while minimizing their availability to interact with water molecules. Both TPS/CS- and TPS/WF-based formulations allowed to extrude filaments with 1.75 mm thickness, which allowed a well-succeeded 3D printing of customized food containers. Overall, TPS/CS- and TPS/WF-based filaments revealed that PWS, CS, and WF are a great source of biobased materials suitable to develop ecological 3D food packages, giving place to a green strategy that encourages the circular economy.
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ANTIOXIDANT BIOBASED BLISTERS DERIVED FROM AGRIFOOD BYPRODUCTS

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Agrifood industry produces biobased wastes that are often discarded while containing valuable biomolecules. Eggshells derived from the egg processing industry and dust from air suction in locust bean gum (LBGd) processing industry are good examples of it. On the other hand, the ecological footprint of non-biodegradable packages demands the development of more sustainable materials. In this work, the feasibility of using eggshells-derived calcium carbonate to reinforce the thermoforming ability and water tolerance of LBGd-derived films was studied. LBGd, a protein-rich byproduct (56% of protein) that also contains polysaccharides (28%), lipids (6%), phenolic compounds (12%), and ashes (2%), allowed developing stretchable materials (90% elongation at break) with moderated water tolerance. Due to the presence of phenolic compounds, LBGd-based films showed a good antioxidant activity, with 60% inhibition of ABTS radicals after 24 h. When applied for blisters production, LBGd-derived materials were able to be thermoformed; however, the obtained shapes were partially lost after a short period of time (2 h). By incorporating eggshells-derived calcium carbonate, LBGd-derived films showed an increased plasticity, keeping their thermoformed shape for longer periods (3 h) than the pristine formulations, as well as evidenced higher hydrophobicity. Overall, eggshells-derived calcium carbonate revealed to be suitable to tune the plasticity and water resistance of LBGd-derived blisters, opening an opportunity for the valorization of two agrifood industry byproducts.

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STARCH-RICH POTATO WASHING SLURRIES AND SPENT FRYING OIL AS RAW MATERIALS FOR THE HYDROPHOBIC AND ELASTIC BIOBASED MATERIALS DEVELOPMENT

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Potato chips industry gives rise to various byproducts, such as starch-rich washing slurries and spent frying oil, that are often landfilled, despite their valuable biomolecules content. Therefore, repurpose potato chips industry by products is of major concern. Potato starch, in the presence of plasticizers and by the action of heat and shear stress, acquires thermoplastic properties, allowing developing transparent bioplastics [1]. Although these abilities are desirable for food packaging applications, starch water sensitivity and brittleness limit the application range of starch-based materials, hampering their widespread usage in modern industry as a substitute of the non-biodegradable plastics. To overcome these shortcomings, fatty acids have been esterified into starch-based formulations [2]. Based on transesterification reaction principle, in this work, the viability of hydrophobizing and plasticizing starch-based films using spent frying oil in the presence of an alkaline catalyst (KOH) was studied. The incorporation of 15% and 20% oil and KOH into starch-based formulations conferred an increase in the surface hydrophobicity (water contact angle of both sides ca. 90º), thickness (from ca. 72 to 91 and 83 um, respectively), stretchability (in ca. 20x), and elasticity (in ca. 5x) of the corresponding films. These results sustain the hypothesis that starch was modified by the spent frying oil-derived fatty acids, possibly through transesterification reaction. Overall, gelatinize starch in the presence of potato spent frying oil and with an alkaline catalyst revealed to be a promising in situ approach to develop water tolerant and flexible starch based films, extending their application range to the food packaging sector while promoting the potato chip industry byproducts valorization.

References:

1. G. Oliveira, I. Gonçalves, A. Barra, C. Nunes, P. Ferreira, M.A. Coimbra, Food Res. Int., 138 109733 (2020).

2. P. Liu, Sh. Sun, H. Hou, H. Dong, Food Hydrocolloid., 61 351 (2016).
Acknowledgements: Thanks are due to the University of Aveiro and FCT/MCTES for the financial support of LAQV-REQUIMTE (UIDB/50006/2020), CICECO-Aveiro Institute of Materials (UIDB/50011/2020 & UIDP/50011/2020), and CESAM (UIDB/50017/2020 + UIDP/50017/2020) research units and CQ-VR at UTAD Vila Real (UIDP/00616/2020) through PT national funds and, where applicable, co-financed by the FEDER, within the PT2020 Partnership Agreement, Compete 2020, and to the Portuguese NMR Network. The authors also thank to POTATOPLASTIC project (POCI-01-0247-FEDER-017938), financed by FEDER through POCI, to "Isolago – Indústria de Plásticos, S. A.", the project leader, and to "A Saloinha, Lda." for providing potato byproducts. FCT is also thanked for the post-doc grant SFRH/BPD/ 117213/2016 (SP) and for the Individual Call to Scientific Employment Stimulus (IG, CEECIND/00430/2017). This work was also supported by Norte Portugal Regional Operational Programme (NORTE 2020), under the PT 2020 Partnership Agreement, through the European Regional Development Fund (ERDF) and FSE.

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POTATO CHIPS BROWNISH RESIDUES AS ADDITIVES FOR DEVELOPING ANTIOXIDANT AND UV-PROTECTIVE STARCH-BASED FILMS

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Food industry byproducts, together with the perishable foodstuff loss, promote environmental and societal concerns. Under a circular economy concept, these byproducts can be valued as a source of biomolecules, such as polysaccharides, proteins, lipids, phenolics, and high-molecular weight brown color compounds (melanoidins), with interest to develop active biobased materials. Potato chips industry gives rise to byproducts, such as starch-rich washing slurries and brownish frying residues that have simply been landfilled, increasing its ecological footprint. In this work, the brownish-derived extract (BrE) and starch, both recovered from potato chips processing, were in situ gelatinized to form potato starch-based films. The influence of BrE amount (5%, 10%, and 15% w/w of dry starch weight) on optical, mechanical, physicochemical (solubility, wettability), and active (antioxidant and UV-protective) properties of starch-based films was studied. The incorporation of BrE conferred a yellowish coloration to the starch-based films, while maintaining their transparency, and improved ca. 2x the traction resistance and elasticity of the films. Their wettability increased ca. 15º and 20º the water contact angles at the upper and down films surface, as well as their antioxidant activity (ca. 94% of ABTS•+ inhibition in 4 h). Besides, the films properties were directly related to the BrE dosage: when compared to the pristine films, as high the BrE amount, lower the solubility in water (from 12% in the pristine to almost 0% in films containing 15% of BrE) and higher the UV radiation absorption capacity, mainly at UV-C and UV-A at 340 and 250 nm, respectively, of the BrE/starch-based films. Therefore, brownish chips-derived extract reveals to contain molecules of interest to tune the performance of potato starch-based films, offering a new in-situ strategy to valorize potato chips industry byproducts.

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BIOPOLYMER-BASED ELECTRICALLY CONDUCTIVE BIOCOMPOSITE FILMS FOR FOOD PACKAGING APPLICATIONS

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The pulsed electric field (PEF) is a promising non-thermal food processing technique. [1] Currently the food is processed into a treatment chamber before packaging, which represents a risk of recontamination. The use of an electrically conductive food packaging to sterilize food in-pack may overcome this drawback. In this regard,

electrically conductive biocomposites are promising materials for this application due to their non-toxic nature. [2-3] Herein, electrically conductive alginate/zein biocomposite films were produced. Graphitic fillers supported on sepiolite clay were prepared using liquid caramel as carbon precursor.[4] The electrical conductivity was improved by MWCNT doping. The fillers were characterized by XRD, Raman, SEM, elemental analysis, N2 isotherms, electrical conductivity, thermal stability (TGA/DSC) and 13C NMR. The biocomposite films were prepared by solvent casting using the fillers with the highest electrical conductivity. The films achieved an electrical conductivity of 0.005 S m-1 in-planes and 0.0008 S m-1 in perpendicular direction. These biocomposites are promising materials for packaging to sterilize food by PEF.

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References:

[1] B. Roodenburg, et al. J. Food Process Eng. 36 (2013) 77–86.
[2] A. Barra, et al. Compos Sci Technol 173 (2019) 53–60.
[3] A. Barra, et al. Nanomaterials, 10 (2020), 2077.
[4] C. Ruiz-García, et al. Phys. Chem. Chem. Phys., 15 (2013) 18635–18641.

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THE POTENTIAL OF BIONANOCOMPOSITES AS SUSTAINABLE FOOD PACKAGING

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Biodegradable biopolymers are sustainable alternatives to conventional plastics for food packaging applications. To compete with synthetic polymers biopolymers, they need to meet the requirements of cost-effective materials, to ensure the mechanical and gas barrier characteristics of food packaging. Additionally, it is demanded to step towards active packaging, which means that packaging material needs to interact with the food product to enhance its shelf life, contributing to reduce food waste. In this context, bionanocomposites integrating different fillers such as clays, metal oxide particles and graphene derivatives, are bringing great challenges to the field of active food packaging. Furthermore, polysaccharides have been exploited to develop edible and biodegradable films due to their functional and sustainable characteristics. The combination of the fillers to design new formulations based on polysaccharides allow to produce biomaterials with enhanced mechanical and barrier properties, conferring functional properties as antioxidant capacity, antimicrobial activity and/or electrical conductivity [1,2]. Electrical conductivity is a required property for the processing of food at low temperature using electric fields. These bionanocomposites have a great potential as innovative and active food packaging.

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References:

[1] A. Barra, et al. Compos Sci Technol 173 (2019) 53–60.
[2] A. Barra, et al. Nanomaterials, 10 (2020), 2077.

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DEVELOPMENT OF NOVEL MATERIALS FOR ACTIVE FOOD PACKAGING BASED ON STARCH AND BIOCHAR-ZINC OXIDE COMPOSITES

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The main function of conventional food packaging is to be a passive barrier to protect and preserve the product from external contaminations and physical damage, so that the quality and safety can be maintained during the whole supply chain. The addition of designed active components into sustainable food packaging material and its interaction with the foodstuffs targets the active food packaging concept, while increasing the foods shelf-life [1]. Zinc oxide nanoparticles have been considered feasible to be incorporated into active food packaging systems due to their antimicrobial properties against bacteria as well as their high ultraviolet light absorption capacity, avoiding food deterioration by oxidation [2]. Furthermore, the addition of electrically conductive carbon-based materials (e.g. biochar) allows the

sterilization of packaged food by nonthermal technologies using a pulsed electric field [3]. In this work, active biochar-ZnO (C-ZnO) composites, obtained by the pyrolysis of sucrose (Suc-ZnO) and D-glucosamine (GlcN-ZnO) in the presence of as-synthesize ZnO particles, were homogeneously incorporated into a biodegradable starch-based formulations by melt-mixing. The granulated formulations were then hot-pressed to obtain flexible starch-based films. In addition to the enhancement of the mechanical reinforcement and of the water tolerance achieved with the maximum concentration of C-ZnO (50 wt% of dry starch weight), starch-based films with both C-ZnO also showed exceptional functional and active properties, namely antioxidant and antimicrobial activity and electrically conductivity. Furthermore, GlcN-ZnO filler was revealed to impact more on the features of the film than the Suc-ZnO, probability due to the presence of nitrogen element in the carbon structure. The results obtained showed that the combination of the unique properties of C-ZnO fillers and the starch matrix represents a potential strategy to design new materials for active food packaging.

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References:

[1] A. M. Khaneghah, S. M. B. Hashemi, S. Limbo, Food and Bioproducts Processing, 111 (2018) 1-19
[2] A. Akbar, A. K. Anal, Food Control, 38 (2014) 88-95
[3] X. Wang, H. Bai, Z. Yao, A. Liu, G. Shi, Journal of Materials Chemistry, 20 (2010) 9032-9090

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EFFECT OF THE EXTRUSION PROCESS CONDITIONS ON THE GENERATION OF "NON-INTENTIONALLY ADDED SUBSTANCES" IN POLYETHYLENE FILMS

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An emerging issue in the food packaging field concerns the so called Non-Intentionally Added Substances" (NIAS), which are compounds that, although not intentionally added, may be present in food contact materials and migrate into the food, being therefore a potential risk for human health. The presence of NIAS in plastic food packaging materials has been recognized for the first time in EU Regulation 10/2011. However, their risk assessment is a very challenging task and there are no protocols made by the authorities on how it can be performed. In this context, the analysis of the causes and conditions of NIAS generation is of fundamental importance to improve the quality and toxicological safety standards of food packaging, considering also a possible more stringent evolution of the European legislation on this topic. Therefore, in this work, the degradation of a common antioxidant used in polyolefins, tris(2,4-di-tert-butylphenyl)phosphite, and the consequent generation of two NIAS, tris(2,4-di-tert-butylphenyl)phosphate (I168-ox) and 2,4-di-tert butylphenol (2,4DTB), was investigated during the production of polyethylene (PE) blown films. Films were produced on a laboratory scale under extreme conditions starting from PE pellets already stabilized by antioxidants. Gas chromatography coupled with mass spectrometry was carried out on the pellet and on the produced films, in order to identify and quantify the NIAS and the antioxidant. The risk assessment on the quantified NIAS was performed using the Matrix Tool. Results revealed that the extrusion conditions, in terms of temperature, screw speed and residence time, significantly affected the generation of the NIAS and, therefore, they should be optimized in order to minimize their formation. However, NIAS estimated exposure values were below their respective thresholds, therefore there were no safety risks for the consumers.

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NAVIGATING SUSTAINABLE PACKAGING SOLUTIONS FOR FOOD WASTE MINIMIZATION IN DOWNSTREAM ACTIVITIES

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What forces facilitate or hinder the adoption of packaging solutions among professionals in commercial foodservice? What are the effects of sustainable packaging on food waste minimization? Around 100 million tons of food is wasted annually in the EU, or 173kg per capita per year, which means that approximately 32 per cent of all food purchased per year is not eaten. Food waste management has links to other global challenges including climate change, health, poverty, as well as

sustainable production and consumption. It is estimated that almost 60% of the total climate impact of food waste is caused at the end of the food chain by households and commercial food services. Food waste prevention is a complex, multilevel phenomenon and an integral part of the food value chain covering the whole cycle–from production and consumption to waste management and the market for packaging and secondary raw materials. Ensuring food quality and safety and waste prevention is one of the integral functions of packaging. This paper explores the under researched topic of food waste prevention and minimization in commercial foodservices using a multi-method research design combining quantitative survey data analysis, qualitative interview data, and case studies. The paper will deliver an objective assessment of sustainable packaging options, looking for areas of improvement and best practices.

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INFLUENCE OF AN INNOVATIVE, BIODEGRADABLE MULTILAYER ACTIVE PACKAGING ON "PESTO" SAUCE CHARACTERISTICS DURING STORAGE

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Active packaging is one of the emerging technologies developed as an alternative to traditional one, to maintain and increase shelf life of foods. In this study an innovative, biodegradable multilayer active packaging, with excellent oxygen barrier properties, has been realized to extend the shelf life of "Genovese pesto" sauce. The use of biodegradable material for food packaging in fact, has been very limited because these polymers have generally poor barriers against external agents and weak mechanical properties. In this study, cold plasma treatment was employed to obtain the adhesion of two layers of polylactic acid (PLA) films, in place of synthetic adhesives, and also to immobilize ascorbic acid used as an oxygen scavenger active agent. Preliminary studies were performed on activated pouches filled with sunflower oil, used as a model system, to evaluate the performances of the new PLA packaging. Packed oil samples were stored in thermal abuse conditions at 35 °C, to accelerate oil oxidation phenomenon and analysed for peroxide value and colour during 64 days of storage. Subsequently, different samples of refrigerated "pesto", have been packed in the new biodegradable active system, stored at 25 and 45°C and analyzed for peroxide value, water activity, textural parameters and microbiological loads at 0, 8, 14, 20, 27, 34 e 41 days. Both samples (sunflower oil stored at 35°C and pesto stored at 25°C) presented lower peroxide values and maintained more stable quality characteristics, in terms of colorimetric, microbiological and textural parameters when compared with the respective control samples, during storage. Obtained results highlighted the potentiality of the new active biodegradable material, to extend food products shelf-life and maintain high quality levels during storage.

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DESIGN AND DEVELOPMENT OF INNOVATIVE HIGH PERFORMANCE PVOH/PLA BIO-COATINGS FOR FOOD PACKAGING

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The food packaging sector has recently been identified as a key sector to address the challenge of circular economy: multifunctional, biodegradable food packages are currently highly sought after to replace traditional multilayer packaging that is non-recyclable and non-degradable. Biodegradable polymers, however, suffer from inherent shortcomings, like low barrier and mechanical properties that severely limit the best before date. In this scenario, the correct design plays a crucial role, in order to obtain structures that are truly effective and which constitute a real added value for food waste reduction, rather than an additional economic and environmental cost. These considerations inspired the aim of this work, in which innovative, biodegradable films with high functional performance have been produced through double-coating technique. The multilayer layout was carefully designed: a biodegradable blown film made of PLA and PBAT was selected as substrate to confer the suitable ductility and tear resistance; a first coating layer of modified polyvinyl alcohol (m-PVOH), was spread to ensure high O2-barrier properties; a second coating layer based on amorphous PLA, incorporating different percentages (from 5 to 20% wt) of a wax deriving from revaluation of sugar cane wastes, was further spread to protect the moisture sensitive PVOH inner layer. The systems were characterized by several techniques (FT-IR, SEM, O2, tensile tests, UV-Vis, contact angle, delamination tests) in order to obtain information on chemical-physical properties and functional performance of the films. Results highlighted a decrease of the O2 permeability up to 99% with respect to the neat substrate, significantly extending the application range of these bio-films in the food packaging field. Good interlayer adhesion and control of the layers thickness was achieved during the films production. Moreover, the PLA coating layer provided additional sealability function to the structure, and the wax incorporation led to an increase in surface

hydrophobicity without affecting the overall functionalities of the films.

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ORGANOCATALYTIC ACETYLATION OF PEA STARCH

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Starch is one of the most abundant macromolecules on earth. However, the suitability of this biopolymer as packaging material is hampered by its hydrophilic nature and tendency to retrogradate. Thus, starch biofilms are characterized by poor moisture resistivity and mechanical properties. The replacement of the hydroxyl groups of the anhydroglucose units by an esterification reaction has been approached to improve starch performance as packaging material. This chemical modification is normally performed using acids (or acid anhydrides) as donors of the non-polar acyl groups and sodium hydroxide or metal-based compounds as catalysts. The use of green organocatalysts for carbohydrate derivatization reactions is gaining prominence. However, the efficiency of the reaction in starch sources other than maize starch remains unexplored, neither has their compatibilization with normal starch during film-making been studied. The aim of this work is to provide mechanistic understanding of the parameters controlling the acetylation of pea starch by an organocatalyzed esterification process. The chemical and structural characteristics of the resulting modified starch, including the degree of substitution, together with their morphology, thermal and pasting properties were studied. Native and modified starchy biofilms were developed and their mechanical properties compared. Results showed that certain naturally-occurring compounds are efficient organocatalysts in the production of acetylated pea starch. Nevertheless, Nuclear Magnetic Resonance (1H NMR) evidenced that the organocatalyst can be esterified to the glucose and actively compete with the acetic anhydride donor. The molecular structure of the granules was maintained in low acetylated starch (DS<1), whereas granules were totally disrupted at longer reaction times (>3 hours). Acetylated pea starch was characterized by a lower phase transition temperature with a lower enthalpy as well as a dramatic reduction in the pasting properties in comparison to native starch. Organocatalytic acetylation of pea starch improved the moisture resistivity and mechanical properties of starch films.

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BIODEGRADABLE NANOCOMPOSITE MULTIFUNCTIONAL PACKAGING FILM FOR FRUITS

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Biopolymers have been used in food packaging in recent years due to high pollution rates and decreased biodegradation of synthetic polymers. Chitosan (CH) and Sodium alginate (SA) are both biodegradable biopolymers with excellent film forming capability. TiO2 nanoparticles have high mechanical strength, degradation ability and antimicrobial properties, which are beneficial in food packaging. The aim of the current work is to develop the biodegradable multifunctional nanocomposite film for fruit (i.e., Pear) packaging applications. Bionanocomposite film was prepared by solvent casting method using CH-SA and various concentrations of TiO2. The multifunctional properties such as UV barrier, thermal, water retention, mechanical, chemical, and antimicrobial were determined. The results showed that the TiO2 incorporated nanocomposite film has a higher tensile strength than the control films without TiO2. The highest UV barrier properties were observed in the developed nanocomposite films with increased TiO2 concentration. There was a reduction in film transparency and observed the opaque colour of the film, as the concentration of TiO2 increases. These nanocomposite films with TiO2 also showed higher thermal stability and water hydrophobicity properties. In addition, the antimicrobial studies demonstrated the enhanced antimicrobial properties of the nanocomposite films with TiO2 against bacteria Salmonella and Listeria monocytogenes with respect to the control film. The results concluded that the nanocomposite films incorporated with TiO2 has a potential to enhance the antibacterial and UV barrier, mechanical properties of the packaging film. Finally, the developed packaging materials can be employed as an active packaging to extend the shelf life and improve the quality of packaged fruits, as well as it can reduce the harmful impact on the environment.

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DEVELOPMENT OF ESSENTIAL OIL INCORPORATED POLYMER PLA/PBAT ACTIVE FILM FOR FOOD PACKAGING APPLICATIONS

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The use of active packaging has increased immensely during the last few years due to consumer demand, increased pollution and the increased need for food safety and quality. The insertion of additives such as essential oils in active packaging allows it to preserve food by scavenging, adsorbing, absorbing, emitting, releasing, and eliminating gases, thus reducing food waste. The Poly (Lactide) (PLA)/Poly (Butylene Adipate co Terephthalate) (PBAT) films were made with different concentrations of two essential oils, eucalyptus oil and cinnamon oil (1%, 5%, and 10% w/w). Various properties, such as surface morphology, colour, optical, mechanical, water retention, and the chemical composition of each film, were evaluated. Further, the antibacterial activity and efficacy of the films were determined against Escherichia coli and Staphylococcus aureus. The result shows that varying amounts of eucalyptus oil and cinnamon oil in PLA/PBAT blend films had a significant impact on film attributes such as optical, antimicrobial activity, mechanical properties, surface hydrophobicity and biofilm inhibition. The UV-blocking property of PLA/PBAT-cinnamon oil films (10% w/w) increased by 80%, whereas for PLA/PBAT-eucalyptus oil films (10% w/w) it increased by 40%. Cinnamon oil increased PLA/PBAT film transparency by 1.10 folds, while eucalyptus oil decreased it by 0.93 folds. As the concentration of oils rose, the tensile strength of eucalyptus oil film declined by 17%, while cinnamon oil film decreased by 42%. When compared to eucalyptus oil films, cinnamon oil films had better antibacterial action against E. coli and S. aureus. Biofilm inhibition was 84.37% in the film, containing 10% (w/w) eucalyptus oil, and 89.82% in the film including 10% (w/w) cinnamon oil. The PLA/PBAT-cinnamon oil films have effective antibacterial and UV-blocking capabilities compared to PLA/PBAT-eucalyptus oil film and can be utilized in food packaging to improve the quality and extend the shelf-life of foods.

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SCIENCE AND MEDIA FRAMING THE FUTURE OF PLASTICS IN A TRANSITION TO THE CIRCULAR ECONOMY

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Plastic packages are crucial for the food industry as they ensure food safety and reduce food waste by extending the product's shelf life. However, too often the current plastic industry follows a linear economy; non-renewable sources are used for production and used packages end up in landfill. Although the main issues related to the linear plastic economy may seem obvious, the way to transform this economy into a circular one is not. All sorts of stakeholders envision new roles of plastics, and for new sorts of plastics in the circular biobased economy. These types of 'futurity framing' are influential as they may open up alternative paradigms of thinking about plastics in a circular biobased economy and hinder or contribute to a transition toward a circular biobased economy. We found three futurity frames based on a media analysis of six Dutch national newspapers and an analysis of relevant international academic papers: plastics in a linear economy, plastics in a circular economy, or a plastic economy in transition. Different types of plastics were foreseen in these three futurity frames according to different types of actors. Within media and academic sources plastics were considered part of a linear economy based on its non-biodegradability, non-composability, or non-recyclability. To transition to a circular economy, actors focused on an improvement of material properties in combination with a change in consumer behavior and waste management system. Interestingly, all actors envision a similar role for plastics in a future circular economy: it will still be important. However, we found two conflicting future imaginaries; whereas academic actors mainly focused on the alternative forms of plastics that can equal technical characteristics of conventional ones, actors in newspapers mainly focused on the value of closing the loop for traditional plastics.

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DEACTIVATION KINETICS OF INOCULATED SARS-COV-2 ON A PATENTED CARDBOARD ACTIVATED WITH NATURAL ANTIMICROBIALS

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According to current knowledge, the respiratory infections caused by SARS-CoV-2 can be easily transmitted between people through droplets of different sizes, representing a main global issue. Scientific evidence indicates that contaminated packaging materials can play a role in SARS-CoV-2 diffusion. Therefore, it is essential to understand how the virus behaves on these surfaces in order to clarify its role during the cross-contamination phases. Recently, the development of innovative and sustainable active packaging, capable of extending food shelf-life and maintaining the quality characteristics of the packed products, has strongly increased. An example of this is represented by the international patent WO2017089292A1 titled "ATTIVO - Packaging for fruit and vegetable products treated with an antimicrobial

solution", capable of reducing food losses and already applied at industrial level for fresh products. In this framework, this research evaluated the persistence of deliberately inoculated SARS-CoV-2 on corrugated cardboard activated with the patented antimicrobial "ATTIVO" mixture. The results were compared with those obtained using a benchmark, represented by traditional corrugated cardboard for Fruit & Vegetable boxes. The antiviral effect of "ATTIVO" single constituents was also assessed to understand their individual antiviral activities and to detect any additive or synergistic actions among the components. The innovative packaging significantly reduced the levels of inoculated SARS-CoV-2, increasing the virus inactivation kinetics at 23°C and 90% RH. Among the components, citral and hexanal showed the greatest antimicrobial activity against SARS-CoV-2. The presence of ethanol significantly increased the antiviral effect of the patented mixture. The data obtained suggest that ATTIVO is a useful strategy to reduce the virus persistence on food packaging materials, even when very high levels of virus are inoculated. The data obtained regarding single components and carriers of ATTIVO can be used to further potentiate the antiviral effectiveness of the product.

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POLYSACCHARIDE-BASED ACTIVE COATINGS FOR FRESH AND MINIMALLY PROCESSED FRUITS

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Minimally processed fresh fruits have increased the consumer's demand for natural products without synthetic preservatives and colorants. These new consumption behaviors have prompted research on the combination of active compounds from natural sources and edible films, which the food industries have traditionally used. This combination brings great potential for improving the quality of fresh-cut fruits by incorporating natural and multifunctional additives directly into food formulations. These antioxidants, antibacterial and antifungal additives, are responsible for the food protection for their release through the polymer matrix to bring them into direct contact with food to protect it from possible organoleptic degradation. Keeping in mind the widespread applications of active compounds, this work focuses on the preparation of various edible coatings based on chitosan as edible polymer and two different natural extracts to evaluate their effectiveness on the quality and preservation of strawberries cut apples. Some parameters of food quality, such as weight loss, antioxidant capacity, ascorbic acid content, or total mesophiles' growth at different times, were evaluated. The addition of active compounds resulted in an improvement in all those parameters when using both types of coatings, most notably for those coated with chitosan and tea extract, concerning the control of strawberries without any coating. The results demonstrated that active polysaccharide-based coatings with natural active additives could be considered as active food packaging.

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BIOACTIVE COMPLEXES OF CHITOSAN AND GREEN COFFEE BEAN OR ARTICHOKE EXTRACTS FOR FOOD PACKAGING APPLICATIONS

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Phenolic acids possess good antimicrobial and antioxidant properties. However, these compounds are unstable, sensitive to temperature, alkaline media, oxidation and light, and therefore quickly lose their beneficial properties. The biological activity of phenolic acids could be preserved by the immobilization in polymeric carriers containing cationic groups, for example, in the particles of cationic polysaccharides and further can be exploited as packaging materials in preservation of various foods. Chlorogenic acid, an ester of caffeic and quinic acids, as the main phenolic compound in green coffee bean (GCBE) and artichoke extract (AE) and can exist in the form of 3-O-caffeoylquinic, 5-O-caffeoylquinic and 4-O-caffeoylquinic acids. In the present study, the formation of water insoluble complexes between chitosan (ChS) and phenolic compounds such as caffeoylquinic acid (CQ) derivatives has been investigated and their antioxidant and antifungal properties have been assessed. The CQ, GCBE and AE adsorption on ChS was investigated by employing the equilibrium adsorption method, and the Langmuir adsorption model was used to describe the adsorption isotherms. It has been estimated by the UPLC-UV method that the content of adsorbed CQ was only 1.64 % and 6.12 % of the total amount of adsorbed AE and GCBE, respectively. The obtained results indicated that not only CQ derivatives but also other phenolic compounds of natural extracts have been immobilized on ChS. Furthermore, it was demonstrated by growth inhibition bioassay that GCBE/ChS and AE/ChS complexes possess some antifungal activity against B. cinerea and F. graminearum strains. The antioxidant activity of AE/ChS and GCBE/ChS was evaluated by the

ABTS•+ method, and expressed as time dependent ABTS•+ radical scavenging activity. It was determined that immobilization of phenolic compounds of extracts prevented the rapid loss of antioxidant properties, i. e. AE/ChS and GCBE/ChS powders exhibited the prolonged radical scavenging activity.

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DEVELOPMENT OF CELLULOSE-BASED PACKAGING FILMS FROM THE RESIDUES AFTER ALGINATE EXTRACTION

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Cellulose-based fractions with different levels of purification were extracted from the residues generated after alginate extraction from three brown seaweeds, namely Alaria esculenta, Saccharina latissima and Ascophyllum nodosum. These residues were mainly composed of carbohydrates and proteins, Alaria and Saccharina being richer in cellulose, while fucoidan concentration increased in Ascophyllum. The lower cellulose content in the latter and, consequently, the low extraction yields, made it unsuitable for the extraction of cellulosic fractions; however, it presents potential for the extraction of bioactive fucoidan-rich fractions. In contrast, self-supporting films were obtained from the cellulosic fractions from Saccharina and Alaria residues, which were subsequently characterized to evaluate their potential as food packaging materials. While the higher cellulose purity films presented more desirable characteristics in terms of mechanical properties and visual appearance, the presence of non-cellulosic components in the films from less purified fractions reduced their water sensitivity and promoted greater barrier. Thus, the results point out to the potential of simple alkaline treatments for the extraction of fractions able to produce films with the best compromise between functional properties and economical and environmental efficiency.

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WHEN NANOCHEMISTRY MEETS FOOD PACKAGING: DEVELOPMENT OF ACTIVE MATERIALS BASED ON POLYOXYMETALATES AND NANOCELLULOSES

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Traditional packaging materials are inert polymers made of cardboard, glass and, ultimately, plastic that act only as a barrier to protect food products from environmental disturbances. Nowadays, these traditional, inert packages are giving rise to active food packages that not only serve this protection purpose but also interact with the package atmosphere or the food product directly to increase both its shelf-life and safety. Bearing this in mind, in this work we describe the development of new active packages with antioxidant and/or antifungal activities based on the incorporation of novel polyoxometalates into the packaging material and the use of cellulose nanofibrils (CNF) to incorporate the antimicrobial compound ethyl lauroyl arginate (LAE). For this purpose, the polyoxometalate (NH4)15{Na[(Mo2O4)6(μ2-SO3)3(μ6-SO3)]2}·5H2O were synthesized and characterized by FTIR, TGA and polydispersity measurements. Polyoxometalate (NH4)15{Na[(Mo2O4)6(μ2-SO3)3(μ6-SO3)]2}·5H2O has shown a very strong antioxidant activity, with an antioxidant activity index (AAI) superior to 2.0 (3.16) and an IC50 of 16.1 μg/mL according to the DPPH method used. Additionally, when incorporated into PLA bags, this polyoxometalate also proven to have radical scavenging activity, by being able to inhibit salicylate hydroxylation by OH radicals (60% mean inhibition), as measured by HPLC coupled to fluorescence detection. Additionally, the antimicrobial packaging material obtained from bio-resourced CNF with LAE demonstrated a potent in vitro activity against L. monocytogenes at concentrations as low as 1% LAE. Furthermore, these films were also evaluated for the control of L. monocytogenes in semi-soft cheese made from raw milk.

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HIGH SOLIDS, SOLVENT FREE MODIFICATION OF ENGINEERED POLY-SACCHARIDES

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The natural-identical engineered polysaccharide, α-(1, 3) glucan, produced by the enzymatic polymerization of sucrose, was chemically modified by acylation with succinic anhydride. This modification reaction was initially performed at the micro-scale in a TGA reactor to assess a range of reaction conditions and to study the mechanism of the reaction. Subsequently, the best performing conditions were reproduced at the larger laboratory scale. The reaction products were characterized via coupled TGA/DSC analysis, FT-IR spectroscopy, solution viscosity and pH determination. The acylation path resulted in partially modifying the polysaccharide, by altering its behavior in terms of thermal properties and solubility. The acylation in a solvent free approach was found promising for the development of novel, potentially melt-processable and fully bio-based and biodegradable ester compounds.

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EFFECT OF EDIBLE LIPID-BASED COATINGS ON THE SHELF LIFE AND QUALITY OF HORTICULTURAL PRODUCTS AND THEIR CONSUMER ACCEPTANCE

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Currently, EU regulations permit the application of edible coatings only for horticultural products with inedible peels. On the other hand, many other countries already classified several edible coatings as generally consumer safe. For this reason, research on the efficiency of various biopolymer-based edible coatings is carried out 1) to avoid packaging waste and 2) to increase shelf life and quality of fresh produce. As do plastic film packaging, edible coatings reduce the release of both water vapour and CO2 from and the uptake of O2 by the products, thus minimising the loss of freshness and of value-adding ingredients. The different edible biopolymers tested, i.e., lipids and/or polysaccharides, only partially protected highly perishable fresh products. In addition, essential, comprehensive and meaningful information on the optimal application of edible coatings on these products is still lacking currently.
Therefore, this work investigates (1) the effects of coatings on physiology, quality and shelf life of selected products. It also evaluates (2) the consumers' acceptance of and their opinion on the application of edible coatings on fresh fruit and vegetables with edible peels.

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THE EFFECT OF TRANSPORTATION VIBRATION TO THE MICROBIOLOGICAL STATUS OF BOTTLED MINERAL WATER

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The microbiological status of beverages including mineral water is important to avoid any harmful effect during metabolism. In the last decades the increasing consumption of mineral water could be observed all over the world with shipping very long distances which leads to prolonged periods of transportation and causes deterioration. Therefore, the present study investigated the effect of vibration on water quality. The bottled water samples were inoculated with a microorganism isolated from the water samples earlier and conditioned on 5 °C until use. Then the drinks were exposed to random vibration with a truck transport test profile (1 - 200 Hz) at various vibration intensity (low, medium and high). After agitation their microbiological status (total colony count at 22 °C and 37 °C and pathogens) were determined. The fresh bottled water contained mixed culture, as long as the controls infected did monoculture. The results showed that at the low intensity vibration did not affect the microbial growth when it was freshly bottled, at inoculated samples the growth rate increased 2.5 times. At medium vibration intensity the mixed culture inhibited the growth, and with the monoculture the vibration only decreased the growth rate. At high vibration intensity only a slight difference of growth rate was observed between the fresh bottled drinks and inoculated drinks. The maximal total colony count was log cfu/cm3controll = 5.62 and log cfu/cm3vibration = 4.83 at vibration cited sample. The Summary, the impact of vibrations on the mineral water after transportation vibration negatively affects its microbiological status.

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ANALYSIS OF SUSTAINABLE PACKAGING ATTRIBUTES IN THE CONFECTIONARY SECTOR

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Every year more and more packaging waste is generated in Europe, with consequent negative direct impact on the environment. On the other hand, packaging also plays an important role in safely and conveniently distributing

products throughout the supply chain. While research on sustainable packaging as an option to significantly reduce this environmental impact is growing, it failed to examine real packaging choices available to consumers in the market. The purpose of this paper is to evaluate packaging solutions in the market by examining their sustainability-related attributes and the cues they provide to consumers for judging the sustainability of each packaging. It provides a comprehensive market analysis (field study) of packages in one product category. The confectionery and bakery goods segment is an excellent example of the important impact packaging can have on consumer decisions at the point of sale. Especially for wafers, that come in different types, shapes, sizes also fulfill a gift function. In this paper, we first reviewed the consumer research on packaging and sustainability on which we build an empirical-based conceptualization of sustainability attributes and cues of packaging solution. Based on an attribute-cue-matrix we show which attributes and cues that producers use in their communication with customers. Our results can help to better understand the gaps between the attributes consumers find important and the cues they use on one side and the attributes and cues the providers use on the other side.

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THE APPLICABILITY OF PHBV THERMOFORMED TRAYS TO PACK FRESH FOOD PRODUCTS UNDER MODIFIED ATMOSPHERE PACKAGING

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So far, no thermoformed trays made of PHBV are known on the market. By using the commercial grade PHI003 (Natureplast, France) and the addition of Boron nitride as nucleating agent, it was possible to produce extrusion flat film to use as a basis for thermoforming. The trays were thermoformed by COOPBOX (Italy) and could be used for modified atmosphere packaging after sealing with a biodegradable top film. For sustainable packaging innovations, it is of key importance to always consider the environmental impact of the food and the packaging together. Therefore, the PHBV trays should guarantee at least the same shelf-life of the modified atmosphere packed (MAP) products vs. their current reference pack. Hence, the same barrier properties must be achieved. The permeability for water and oxygen was determined for the PHBV extrusion flat sheets and showed to be comparable to conventional plastics, used for MAP. These results indicate that the use of PHBV as a monolayer packaging material for thermoformed trays is feasible for several types of food products with a short to medium shelf life. This latter was confirmed by performing shelf life tests with MAP falafel (shelf life of 28 days) and high oxygen packed fresh beef (shelf life of 8 days). During the shelf-life test, gas measurements, microbial analyses and pH were evaluated. For fresh beef color stability was also assessed. The results showed that comparable shelf lives were obtained in the new PHBV packaging concept compared with PET trays (falafel) and PP trays (fresh beef). This study confirmed that a fully biodegradable packaging can be used for MAP food products in the future.

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MICROPLASTIC RELEASE BY PACKAGING, A NEW RISK FOR CONSUMERS

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Microplastics are widely spread and used as essential components of disposable food packaging due to the fact that they allow for good preservation of food products. It has been observed that, through the leaching process, microplastics pass to humans through food and drink, and this exposure has been evaluated to highlight possible risks to human health. The purpose of this systematic review is to provide an overview of current knowledge on the subject of the correlation between the release of microplastics present in packaging and the relative ingestion by humans associated with possible health risk. The method applied for this analysis is a literature revision, the articles were selected using some key words: packaging, microplastics, ingestion of plastic, human health. Microplastics are found ubiquitous in the food web, an average mass value of microplastics has been tested < 1 mm, and it has been estimated that humans ingest 0.1-5 g of microplastics weekly on average. Numerous studies carried out on animals have shown that micro and nano plastics cause damage to the oxidative and inflammatory balance of the intestine, as well as an interruption of the epithelial permeability of the intestine and also cause dysbiosis and toxicity of the immune cells. Amounts of microplastics ranging from 4.0 to 18.7 MPs / kg were found in meat packaged in food trays made of extruded polystyrene. The analyses also focused on the use of packaged beverages since humans are daily exposed to these oral contaminants. An appreciable amount of microplastics released from food packaging is ingested by humans and various studies have reported that this absorption causes intestinal disorders and

immune disorders that should be further investigated to estimate the risk that the ingestion of microplastics has on human health, now and in the future.

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ASSESSING THE ENVIRONMENTAL SUSTAINABILITY OF PACKAGING ON SEAFOOD SUPPLY CHAINS: A CRITICAL REVIEW

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Packaging fulfills many essential functions for food preservation and it becomes even more important when it is related to seafood products, which are highly perishable products due to their intrinsic properties, i.e. high-water content, neutral pH and high content of unsaturated lipids and nitrogenous compounds. Thus, such products require immediate processing to retain safety and quality, in order to protect consumers. Despite their benefits, packaging production, use and disposal are associated with a multitude of environmental impacts. Therefore, the present study gives an overview about the packaging contribution to the environmental performance of seafood products through a life cycle perspective. The literature search resulted in the selection of 32 life cycle assessment (LCA) case studies related to seafood, including packaging, which were evaluated by both qualitative and quantitative analysis. The qualitative analysis assessed how direct (e.g. packaging material) and indirect impacts (e.g. influence on seafood loss and waste) have been considered, while the quantitative analysis evaluated packaging contribution on seafood products' life cycle towards climate change impact. Qualitative analysis showed that seafood LCAs focus mainly on direct environmental effects from packaging materials, to which some articles recommend to reduce packaging volume/weight or substitute materials in order to decrease the impacts. Direct impacts related to packaging end-of-life have also been evaluated, and the recommendation is to increase recycling rates. Quantitative analysis demonstrated that the type of packaging material has a great influence on climate change impact. Packaging from canned products presented the highest contribution due to higher impact of materials related to aluminum, tinplate and glass, compared to other types of products that use packaging made of plastic and paper. More LCA studies are needed to further understand the environmental sustainability of seafood products including its packaging throughout supply chains.

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USE OF GALLIC ACID BASED OXYGEN SCAVENGER TO PREVENT THE DISCOLORATION OF PROCESSED MEAT PRODUCTS UNDER INDUSTRIAL CONDITIONS

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For meat and meat products, color is one of the most important aspects affecting purchase decision and assessment of quality and palatability. When both light and oxygen are present, the color of several processed meat products changes resulting in a loss of redness. In this study a gallic acid-based oxygen scavenger was used to prevent the discoloration of processed meat products under industrial conditions. Meat products (delivered by the industrial meat processor) were packaged under modified atmosphere with 1% of O2 (simulating the worst case residual oxygen under industrial packaging conditions) using high barrier trays (similar barrier properties as industrial packaging) with or without gallic acid based oxygen scavenger. Afterwards, they were stored under similar conditions (temperature and exposure to light) applied to the industry. Samples stored in the dark did not show any discoloration, whereas products stored under illumination showed a pronounced loss in redness resulting in Δa between -3.08 and -3.65 already after 4 hours. In packages with scavengers, the oxygen scavenger showed maximum oxygen scavenging rates in the range of 47.17 – 61.40 mLO2/gGA/d and was able to reduce the headspace oxygen concentration below 0.1 vol.% within 18 – 28 hours. This resulted in retaining the color of the products and there was no significant reduction in redness of the products during the storage of 21 days.

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EFFECT OF HUMIDITY ON ETHYLENE REMOVAL KINETICS OF VARIOUS SCAVENGERS IN ACTIVE PACKAGING

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Gaseous plant hormone ethylene is responsible for altering fruit and vegetables quality often resulting in tissue softening, rapid ripening, senescence, and eventual decay. Being endogenously biosynthesised by fruit and vegetables, ethylene accumulates inside packages containing fresh produce, thereby, reducing the produce shelf-life. Hence active ethylene removal is often desired inside fresh produce packages. Active ethylene scavenging involves use of adsorbers, absorbers or oxidizers such as potassium permanganate, activated carbon, clays and zeolites often integrated into the package in the form of sachets or strips. Although many studies have been carried out to develop novel ethylene scavengers, a very few studies have explored their kinetics especially under different humidity. The main objective of this study was to study the ethylene removal kinetics of various ethylene scavengers at different humidity. Airtight glass jars were used to expose selected scavengers, such as, potassium permanganate supported on zeolite, modified zeolite; clay based material Z5 and Basolite to ethylene (10 ppm). Relative humidity of <5%, 50% and 100% was maintained within the jars with the help of salt solutions and temperature was kept constant (13°C). Ethylene concentration was measured inside the glass jars using ethylene detector, ETD-300. The data obtained was fit to a pseudo first order kinetic model. The results were compared with those obtained by using a commercial ethylene scavenger. The results showed that high humidity decreased the ethylene scavenging ability of most scavengers. Most scavengers were found to be more efficient at 10% RH than 50% and 100% RH. In case of Z5 and Basolite desorption of ethylene was also observed. As most of the fruits and vegetables are transported and stored at high humidity this study could be relevant in identifying most promising ethylene scavengers.

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USE OF COMPOSTABLE PLASTIC BIOMATERIALS FOR MODIFIED ATMOSPHERE PACKAGING OF MINIMALLY PROCESSED ONIONS FROM APULIA REGION

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The “Cipolla Bianca di Margherita” is a Protected Geographic Origin (PGO) white onion typical of South of Italy and well known for its great flavour, sweetness and very low pungency. It is harvested very early (since May) and is characterized by a high water content and intense metabolic activity, which makes its shelf life very short. A ready-to-use peeled product was obtained removing external dry layers. Two new compostable plastic biomaterials (hereinafter referred to as ECOVIO and ECO/PLA) with different Oxygen Transmission Rate (1210 and 640 cm3 m-2 d-1 bar-1) were tested for passive MAP establishment and compared with polypropylene (PP) as a control (1100 ml m-2 d-1 bar-1). Onions were peeled and packed within bags of 35 x 9.5 cm, subsequently samples were stored at 5 ± 0.5 °C up to two weeks, and at day 0 and after 3, 7 and 14 days, gases evolution, weight loss, the sensorial evaluation of odor, off odor score and external damages, aroma volatiles, firmness and surface color were evaluated. As a result of the different permeabilities of the tested materials, differences in CO2 accumulation were observed after 14 days of storage with 9, 2.5 and 3.7 KPa for PP, ECOVIO and ECO/PLA, respectively. Consequently, a higher off odor score was observed for PP samples. No significant differences were observed for color and firmness, while for samples packaged in the 2 biomaterials a significantly higher weight loss was observed, approximately 3 %, compared to 0.3 % of the PP-packed onions. Biodegradable materials result to be suitable to store minimally processed onions for two weeks with no impact on their quality and appearance, avoiding off odor development during low temperature storage, nonetheless hydrophobic properties of these materials is still a limit for the weight loss suffered by fresh produce.

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RISK ASSESSMENT IN USE OF RECYCLED POLYETHYLENE FROM POST-CONSUMER WASTE AS FOOD CONTACT MATERIAL

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Flexible low-density polyethylene (LDPE) is widely used as food packaging material. Extensive research has been performed on migration from commercially available food packaging plastic materials. However, to date, only few

studies on migration from recycled polyethylene have been conducted. This research aims to provide important data on overall and specific migration of recycled polyethylene (PE) from post-consumer waste (PCW). Three layered films were produced with PE virgin outer layers and a mid-layer from recycled PE material. Overall and specific migration were determined on various 3-layered structures made from virgin low-density PE (LDPE) and virgin linear low-density PE (LLDPE), respectively, with two different recycled PE from post-consumer waste (R1 and R2) (six different constructions: LDPE, LLDPE, LDPE/R1, LDPE/R2, LLDPE/R1 and LLDPE/R2). Migration was conducted with 10%, 50% and 95% of ethanol at 40°C for 10 days. With 10% ethanol as simulant no migration was detected in any of samples, while for 50% ethanol overall migration (OM) values were below 0.5mg/m2, thus well below the overall migration limit (OML) of 10 mg/dm2. For samples with 95% ethanol as simulant overall migration values were from 0.96 for LLDPE/R1 to 3.33 for LDPE/R2, but still below overall migration limit OML. Specific migration (SM) was performed using sophisticated analytical techniques (liquid and gas chromatography). From SM results intentionally and non-intentionally added substances were detected, identified and quantified for samples with 95% ethanol as simulant. Intentionally added substances (IAS) detected in the samples were additives added in production of PE (additives P168, AO1010, AO1076) as well as non-intentionally added substances (NIAS) (Diethylhexyl phthalate DEHP, Diethylhexyl terephthalate DEHT, P168-ox, Arvin 4 and Arvin 8 as well as oligomers). Specific migration values were under specific migration limit (SML) values defined in the legislation. Present study gives a valuable insight into possible migration of chemical compounds for recycled PE and its safety in use as food contact material.

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IMPACT OF POLYLACTIC ACID PACKAGES ON MICROBIOLOGICAL SPOILAGE OF FRESH PRODUCE: A CASE STUDY WITH CHERRY TOMATOES

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Polylactic acid (PLA) is a biodegradable polymer used for food and pharmaceutical products, although the barrier properties are not ideal for both. As a result, different modifications of row PLA have been proposed that besides increasing the packaging cost may also have a negative impact on environment and recycling processes. Nevertheless, unmodified PLA can benefit for packaging of vegetables moderate in respiratory and transpiration activities, as the low barrier to water vapor while leading to a tolerably increase in mass loss may reduce the risk of decay. In this study the storage performance of cherry tomatoes sealed with three different packages (PLA1 and PLA2 achieved with a PLA film and BOPP achieved with a biaxially oriented polypropylene film) was compared. PLA1 was designed to get an in-package RH≤ 92 %; PLA2 to get an in-package O2 ≥ 15 kPa, CO2 ≤5 kPa and RH ≤ 92%; BOPP packages had 4 macro-holes each 6-mm in diameter. Before storage (7 days at 5 °C and 85 % RH plus 7 days at 20 °C and 60-65 % RH, or 7 days at 20 °C and 60-65) half fruit were inoculated with a 104 mL-1 conidial suspension of Botrytis cinerea. In PLA1 and PLA2 CO2 ranged between 3 (5 °C) and 20 kPa (20 °C), O2 between 3 (20 °C) and 14 kPa (5 °C) and RH between 85 (20 °C) and 92 % (5 °C), in BOPP gases composition was similar to air while RH ranged between 95 and 100 %. Although differences in gases composition among packages were significant, juice pH, TSS and TA acidity were not different. Mass loss was higher in PLA1 and PLA2 packages, but overall appearance did not differ among packages. In contrast, higher loss due to fungi infections occurred in BOPP packages.

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STUDY ON THE CHEMICAL TRANSFER OF SILVER NANOPARTICLES (AG-NPS) AND ZINC OXIDE (ZNO-NPS) FROM PACKAGING OF SEAFOOD PRODUCTS AND CHARACTERIZATION OF NPS WITH SINGLE PARTICLE ICP-MS

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This study provides a first insight on the chemical characterization and quantification of silver nanoparticles (Ag NPs) and zinc oxide (ZnO NPs) in processed canned seafood products, stored in tin box. These NPs are recognized as emerging pollutants and are commonly used as antimicrobial in packaging. It is known how seafood is a precious nutritional source of unsaturated fatty acids, protein, and different micronutrients. Nevertheless, it may cause possible health problems due to the chemical transfer of toxic compounds coming from food packaging. To verify the percent presence of Ag and Zn in packaging composition, fragments of them were analyzed by scanning electron microscopy coupled with microanalysis using a Stereoscan 360 instrument combined with an X energy dispersion detector (SEM-EDX) using the Inca software. For each brand and for each species of canned product, four representative points were scanned for a qualitative analysis, taking into

account the internal intact layer, two breaking points, and the external intact layer. The SEM analysis on packaging did not show the presence of Ag in any of the scanned points. Microanalysis mainly highlighted, in addition to the presence of oxygen (O), the presence of iron (Fe), tin (Sn) and zinc (Zn). On the inner surface of the packaging, that is the one in contact with food, the predominant presence of carbon (C) makes the use of organic coatings, such as epoxy resins, likely. A global migration test was also applied to verify the transfer of ZnO NPs, according to the Ministerial Decree of 21 March 1973 and subsequent modification, and the single-particle ICP-MS analysis did not revealed NPs concentration above the calculated limit of detection (1.5 X 103 Particle number concentration/mL). Nevertheless, traces amount of Ag NPs and ZnO NPs have been quantified in all the seafood products, supposed that concentrations found originate from bioaccumulation of NPs in the marine environment or a chemical transformation of accumulated elemental compounds once entered in organism body districts.

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NANO AND MICRO FIBROUS EDIBLE MATERIALS FOR FOOD PACKAGING APPLICATIONS

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Edible ingredients have been used to obtain nano- and microfiber webs. The main constituents of the fibers are polyvinyl alcohol with propolis. Propolis collected by bees has antiviral and antibacterial properties and is widely used in food, medicine and beauty care. During the preparation of spinning solution, the propolis water and extracts were dissolved then the resulting solution was combined with polyvinyl alcohol (PVA) solution creating various types of spinning solutions with different propolis concentrations. The electrical conductivity, viscosity and pH of the solutions were determined. Corresponding nanofibers webs obtained by using Nanospider type electrical electrospinning device with cylinder type electrode. In the result, nanofibers web samples from prepared electrospinning solutions, samples were tested with scanning electron microscopy (SEM) to analyse nanofibers diameters and morphology. Solutions that ensure the formation of high-quality fibers were chosen to obtain nanowebs. By choosing low concentrations of PVA in solutions and an appropriate mixing method, the fibers obtained contain more than a third of the total weight of propolis. The intended use of the obtained membranes could be a barrier to gases and microorganisms, which can be eaten with food or rinsed with water before eating.

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WHAT'S THE ROLE OF ACTIVE PACKAGING IN THE FUTURE OF FOOD SUSTAINABILITY? A SYSTEMATIC REVIEW

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Nowadays, the strong increase in products consumption, the purchase of products on online platforms as well as the requirements for greater safety and food protection are a concern for food and packaging industries. Active packaging brings huge advances in the extension of products shelf-life contributing to the reduction of food degradation and losses. This work gathers and evaluates all existing strategies and technologies of active packaging that can be applied in food products, with a global view of new possibilities for food preservation. Oxygen scavengers, carbon dioxide emitters/ absorbers, ethylene scavengers, antimicrobial and antioxidant active packaging, and also other active systems and technologies including the products commercially available were summarized and the respective mechanisms of action provided. Although the advantages of these technologies are undeniable, a long path must be done until its generalized use: increase the awareness of governmental decision-makers, of producers, logistics, retailers and consumers; foster the implementation of infrastructures to ease the use, the efficiency and the efficacy of these technologies; continue their development to reduce the cost per packaging.

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DESIGN CONCEPT OF AN ENZYMATIC TIME-TEMPERATURE INTEGRATOR DEVICE FOR CHROMATIC QUALITY PREDICTION OF CHERRIES

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The peculiar characteristics of cherries, such as color, firmness, palate, among others, including its antioxidant properties that benefit human health, increase its demand. However, its high perishability leads to a reduced shelf life and consequently generates undesirable changes in the cherry flow chain. To ensure food quality and safety and prevent food waste, a smart device prototype is proposed. The concepts related to the formulation and design of the enzymatic-type chromatic time-temperature integrator

(TTI) device to monitor the real-time quality of cherries is described. The kinetic parameters for thermal inactivation of cultivar Santina cherries were determined based on the degradation of phenolic compounds that are substrates of the polyphenol oxidase enzyme, whose hydroxylation reaction of a monophenol to o-diphenol leads to the oxidation in o-quinone. The proposed device concept aims to help retailers and consumers to decide upon selling and buying, respectively, according to the remaining shelf life.

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FOSTERING AWARENESS ON ENVIRONMENTALLY SUSTAINABLE TECHNOLOGICAL SOLUTIONS FOR THE POST-HARVEST FOOD SUPPLY CHAIN

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This study presents a current status and future trends of innovative and environmentally sustainable technological solutions for the post-harvest food supply chain and the food industry, in terms of ecological packaging, active and/or intelligent packaging. All these concerns are currently highlighted due to the strong increase in the purchase/sale of products on online platforms, as well as the requirements for stricter food security and safety. Thus, this study aims to provide guidelines to increase the global awareness and to qualify agro-industrial micro, small and medium size enterprises for the adoption of innovative food solutions though industry digitalization (Industry 4.0), associated logistics and circular economy, with a concern for cybersecurity and products information, communication and shelf-life extension. The adoption of these guidelines will certainly foster along the complete food chain (from producer to consumer, with all interme-diary parties) the awareness on environmentally sustainable technological solutions for the post-harvest food supply chain, and thus, promoting the future food sustainability in required by the population increase, the climate change, the exodus of rural population to urban areas, and food loss and waste.

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TERMS AND SENTIMENTS IN TWITTER MESSAGES RELATED TO SUSTAINABLE FOOD PACKAGING

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This is an exploratory analysis of the Twitter messages related to sustainable food packaging. With the R package rtweet (Kearney, 2019), we have downloaded Twitter messages published from June 30 to July 31, 2021. The search terms include “food + packaging” plus one the next terms: sustainable, sustainability, organic, recycled, recyclable, ecological, ecology, biodegradable, and environment. Restricted to tweets written in English, they consist of 1187 tweets. Descriptive analyses allow us to identify the main hashtags, many of them related to plastic and green terms. We also applied a sentiment analysis. Negative sentiments are associated with words such as waste and toxic. And positive sentiments are associated with words such as soft, easier, friendly, free, fresh and safe, among others. Moreover, when considering specific emotions, we are able to identify the terms associated with disgust, anticipation, anger, trust, surprise, sadness, joy and fear. Most of the tweets are associated with positive emotions such as trust and joy. In addition, we show that the number of likes depends on the sentiment of the tweet. With more likes and retweets for tweets with a neutral sentiment than for tweets with a positive or a negative sentiment.

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INVESTIGATION OF STEREOCOMPLEXED POLY (LACTIDE ACID)/LAYERED DOUBLE HYDROXIDES FOR HIGH-PERFORMANCE MONO-MATERIAL PACKAGING SOLUTIONS

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The consumer goods sector companies are highly interested in having mono-packaging materials with tailored thermal, barrier, and mechanical properties to align with its circular plastic economy ambitions. Poly(lactic acid) - PLA, as the most promising commercially available biobased aliphatic polyester, is a good candidate for the long-term circular economy for plastics due to its intrinsic circularity and tailored thermal and mechanical properties. Recently, stereocomplexed PLA has gained extensive attention for high performance materials with promoted thermal, mechanical, and barrier properties. However, the co-existence of homochiral crystalline and low fraction of stereocomplex crystalline formed during normal melt processing limits its application. Many efforts have been made to address these challenges, and selective stereocomplex crystallization nucleator is one of the most convenient methods. While graphene, clay, and cellulose as fillers have been explored and achieved promising results,

layered double hydroxides (LDH), an approved food contact layered material, has not been studied for its impact on the performance and crystallization of stereocomplex PLA. The aim of this work was to study the crystallization behavior of LDH filled poly(l-lactic acid) (PLLA)/poly(d-lactic acid) (PDLA) blends and to explore the mechanism and potential of LDH for developing high-performance PLA materials by differential scanning calorimetry (DSC). Results indicate that LDH accelerates crystallization kinetics of PLLA/PDLA blends and render high or exclusive stereocomplex crystalline fraction, promising for the development of high-performance mono-material packaging.

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FABRICATION AND SIMULATION OF A COLORIMETRIC PH-SENSITIVE TVBN INDICATOR FOR USE IN FOOD PACKAGING

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The growth of microorganisms causes a gradual increase in total volatile basic nitrogen (TVBN) and consequently a change in the pH during the storage of poultry, meat, and fish. In this study, pH-sensitive dyes were employed for the development of color-changing smart labels that can be used to detect the change in TVBN. The three-layered label was fabricated by entrapping the color-changing pH-sensitive dye solution containing either phenol red (PR) or bromothymol blue (BTB) in a cellulose-based matrix between two plastic layers. To simulate the spoilage of the aforementioned food products, trimethylamine (TMA) was used as a representative of TVBN. The obtained labels were exposed to different TMA concentrations (0-35 %) at 25°C for 48 hours. Two methods were used to measure the colorimetric response of the labels: a portable colorimeter and ImageJ program which were used to calculate the ΔE and ΔRGB patterns using the digital images, respectively. The obtained ΔE and ΔRGB results showed a correlation between the color change of the pH-sensitive indicators and the different TMA concentrations. Furthermore, the results obtained using the ImageJ program (ΔRGB) showed a better correlation with the visuals of the smart labels. According to these results, the highest total color change (ΔRGB) was observed in BTB-based labels in the range of 10-15% TMA where the color changed from yellowish-green at 10% to dark green at 15%. In the light of these results, the obtained pH-sensitive indicators can be used as real-time, non-destructive intelligent labels to observe the quality of meat products over the storage period.

Keywords: Smart packaging, freshness indicator, pH-sensitive dyes, TVBN.

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IMPACT OF DIFFERENT PACKAGING STRATEGIES ON THE SHELF-LIFE OF SEMI-HARD CHEESE

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The use of sustainable materials in cheese packaging is of great interest; however, new strategies need to ensure their quality and safety. The purpose of this study was to evaluate the shelf-life (up to 80 days) of a semi-hard mixture milk cheese with different packaging materials. The conventional packaging was compared with three new packaging strategies that used polylactic acid (PLA) films and polysaccharide-based coatings. The used packaging strategies were a) paper + polyvinyl acetate (PVA) coating with natamycin (conventional packaging), b) paper + polysaccharide-based coating with natamycin, c) PLA + polysaccharide-based coating with natamycin, and d) PLA with natamycin + polysaccharide-based coating. The PLA film was used to replace the paraffin paper and the polysaccharide-based coating was used to replace the PVA. Natamycin is normally used on cheese products to avoid molds and yeasts' growth, and in this study, was used to coat the cheese in strategies a), b) and c), and added to the PLA film in the strategy d). The polysaccharide-based coating was based on a blend of carboxymethylcellulose and whey protein isolate optimized to coat the cheese based on their wettability capacity. The cheeses were packed and their shelf life was studied until at least 80 days by means of their physicochemical characteristics, microbiological behavior, deformation and visual aspect. Results showed that the PLA with natamycin + polysaccharide-based coating strategy leads to the highest microbiological growth and significant changes in the cheeses after 20 days of storage. Only the cheese packed with PLA + polysaccharide-based coating with natamycin and the conventional packaging (paper + PVA coating with natamycin) were able to maintain the microbiological growth below acceptable values (6 Log CFU/g) after 80

days of storage. Acknowledgments: This research was supported through project MobFood – Mobilizing scientific and technological knowledge in response to the challenges of the agri-food market" (POCI-01-0247-FEDER-024524).

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HOW NEUROSCIENCE-BASED RESEARCH METHODOLOGIES CAN DELIVER NEW INSIGHTS TO MARKETERS

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While traditional market research methods are focused on surveys and group discussions, consumers' attitudes, the choices they make, and the behavior they display are all driven by a complex set of factors, and much of what is happening takes place in the subconscious mind. Learning that a stimulus engages in a positive way and that memory formation is taking place does not tell the marketer anything about the quality and impact of these memories or the engagement. With technological advances, the emergence of neuroscience-based methodologies offers a higher degree of reliability. In recent years, a noticeable increase in the use of eye-tracking and EEG frontal asymmetry techniques was observed to measure cognitive processes of consumers among which are attention and perception to gain insights into their decision-making processes, consumer preferences and/or motivations. Using a real-world use case, this study highlights the importance of using neuroscience-based methodologies to evaluate packaging design to identify how well the brand is positioning itself on the subconscious level. While results from our study suggest that subjects displayed avoidance behavior according to the lower frontal alpha asymmetry score, the statistical analysis failed to show significant difference between left and right hemisphere. Regardless of the statistically insignificant EEG findings, relatively longer times to first fixation among the areas on the visual suggest that the visual is not optimally designed and that for obtaining insightful data in the product packaging field, relying on eye-tracking techniques on this occasion was sufficient. However, it also demonstrates that in the case of a crucial element of the marketing mix - product packaging, the eye-tracking technique is sufficient for reliable insights.

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SMART PACKAGING: CHALLENGES AND OPPORTUNITIES IN AGRO-INDUSTRY SUBSECTORS. A SYSTEMATIC REVIEW

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Today, the agro-industrial sector is responsible for the consumption of 20% of all land, 70% of water, 32% of energy produced. At the same time, emissions generated in agriculture and livestock farming are estimated at 19% to 29% of total greenhouse gas emissions. It must be also highlighted that losses in the food supply chain can reach a third of every food produced. In this challenging scenario, smart packaging emerges as one of the possible solutions for reducing loss and emissions. Compared to traditional packaging, which aims to extend the useful life, facilitate transport and marketing, smart packaging allows increased efficiency releasing new functions such as ensuring authenticity, traceability origin and preventing fraud and theft, security assurance, intrinsic and extrinsic parameters monitoring, logistics decision-making, among others. Consequently, it can help to reduce pollution and losses and simultaneously promote the efficiency and efficacy of the food supply chain. Therefore, this study aims to answer the following questions: What are the most suitable smart packaging technologies for use in the agro-industrial subsectors such as meat, dairy, fruits and vegetables, bakery and pastry? What are your opportunities from a perspective of life extension, process optimization, traceability, product quality and safety? What are your challenges? As results of this research, through a systematic review of the main scientific databases, information relevant to the application of indicator technologies, sensors and data carriers in Intelligent Packaging was compiled, with the objective of further extending shelf-life, providing greater logistics control, reducing costs, improving communication between producer, distributor and consumer, reducing losses and emissions, and increasing quality and safety.

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TWITTER IS GARBAGE: WHAT KIND OF PACKAGING WASTE MATERIALS DO PEOPLE TWEET ABOUT? EXPLORATION OF #ZEROWASTE HASHTAG USAGE

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Zero waste is a relatively new concept of waste reduction, which encourages life cycle thinking in the design of new products and services. Today Zero Waste is becoming a lifestyle trend and is creating a buzz across the US, Europe and beyond, additionally social media amplifies this buzz and helps to propagate the movement. The popularisation of the Zero Waste concept through social media can be attributed to Bea Johnson, author of a book titled 'Zero Waste Home: The Ultimate Guide to Simplifying your Life by Reducing your Waste'. Many tips on how to achieve ZW living in Bea Johnson's book refer to packaging and packaging materials and literature shows that global consumers are increasingly concerned about the negative environmental impacts of packaging waste. Given the popularity of Zero Waste lifestyle in social media this study explores the Zero Waste trend as reported by users of the popular social media platform Twitter through the lens of Bea Johnson's Zero Waste living model, taking into consideration the public concern on packaging and packaging materials. For the purposes of this paper, Twitter discourse on Zero Waste is used to draw conclusions on the popular understanding of its impact and effects. This paper uses Thick Big Data study of the collected 124,077 tweets with #zerowaste hashtag. Thick Big Data is a novel, mixed method of research, relying on computational analysis of large datasets combined with highly qualitative content analysis including sentiment. In the study it was found that the majority of popular tweets with #zerowaste hashtag refer to packaging and food packaging. The majority of tweets focused on plastics and the sentiment of this packaging material was negative. Other packaging materials found in #zerowaste hashtag tweets include paper, glass and metal, and the sentiment for those materials is gradually more positive.

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MULTILAYER BARRIER PAPERBOARD BASED ON NANOCELLULOSE AND BIODEGRADABLE THERMOPLASTICS

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Traditional paper-based barrier packaging is a multilayer structure, which typically contains fossil fuel-based non-biodegradable plastics such as low-density polyethylene (LDPE) and aluminum foil for moisture, grease, and oxygen and aroma barriers. It is vital to find alternatives for non-biodegradable plastics with bio-based and biodegradable alternatives. Nanocellulose has an excellent barrier against grease, mineral oils, and oxygen but poor tolerance against water vapor. Polylactic acid (PLA), polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS) are biodegradable thermoplastic polymers that have reasonably high tolerance against water vapor. By processing nanocellulose and biodegradable thermoplastics into thin-multilayer coatings, it is possible to produce a barrier packaging that is 100% biodegradable. A custom-built slot-die was first used to coat micro-fibrillated cellulose (MFC) or carboxymethylated cellulose nanofibrils (CNF) onto a pigment-coated paperboard, which was subsequently coated with either LDPE, ecovio® (blend of PLA and PBAT) or PBS using a pilot-scale extrusion coater. Hyper-platy kaolin and glycerol were added to MFC and CNF respectively to understand their role on adhesion at nanocellulose/thermoplastic interface and on barrier properties. The resulting multilayer paperboard reduced water vapor permeance of nanocellulose coated paperboard by over 72% and the oxygen permeance was similar to that of pure nanocellulose films. Similar improvements were found for grease and mineral oil barriers, and adhesion to extrusion polymers. Moreover, the fact that the coatings were produced using continuous roll-to-roll processes makes them an attractive option for future commercialization.

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FIRST CIRCUL-A-BILITY CONFERENCE

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On-line

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