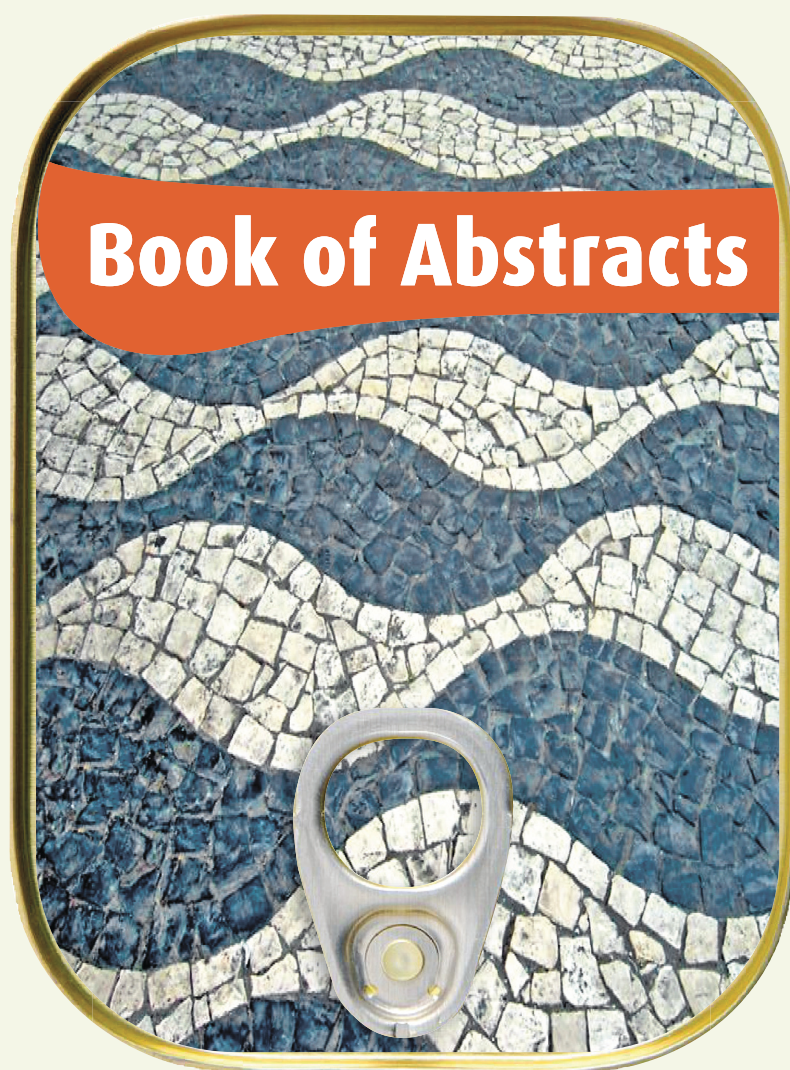


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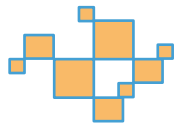
International Conference on Safety
and Innovation in Food Packaging 2016



National Institute of Health Dr Ricardo Jorge
Lisbon, Portugal

16th June 2016





InSI-Pack

International Conference on Safety
and Innovation in Food Packaging 2016

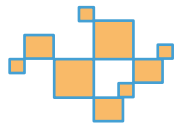
Book of Abstracts

National Institute of Health Dr Ricardo Jorge
Lisbon, Portugal

16th June 2016

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Conference Program

8:30 - 9:00	REGISTRATION	
9:00 - 9:30	Opening Session	Executive Board of INSA, I.P.
9:30 - 9:45	Insights on safety and innovation in Food Packaging	Ana Sanches Silva (INSA, Portugal)
9:45 - 11:10	Session 1: Emergent issues on Food Packaging safety	Chairs: Fernando Ramos & Giovanna Buonocore
	Migration modeling as screening tool for specific migration	Perfecto Paseiro Losada (USC, Spain)
	Use of inert gas-enriched atmospheres and post-packaging irradiation in shelf-life extension of watercress	José Pinela (CIMO, Portugal)
	Hygienic properties of fruits and vegetables packaging - comparison between wood and plastic	Ana Luísa Fernando (UNL, Portugal)
	Viral disinfection of strawberries and raspberries by gamma radiation	Andreia Pimenta (IST, Portugal)
11:10 - 11:40	Coffee break	
11:40 - 12:30	Session 2: Food packaging laws and regulations	Chairs: Ana Vera Machado & Susana Bernardino
	Current US Migration protocols for coatings. Strategies for potential migrant determination	Rafael Paseiro-Cerrato (FDA, USA)
	New developments in exposure assessment of FCM in EU	Maria do Céu Selbourne (UCP, Portugal)
	Review of new analytical techniques for food contact materials	Joel Pereira (UCP, Portugal)
12:30 - 14:00	Lunch	
14:00 - 15:00	Session 3: Nano, Active and Intelligent packaging	Chairs: Ana Luísa Fernando & Rafael Paseiro-Cerrato
	Nanostructured polymers as innovative materials for active food packaging	Giovanna Buonocore (CNR, Italy)
	Advanced films from architected hybrid nanoparticles	José Paulo Farinha (IST, Portugal)
	Antioxidant active packaging based on chitosan incorporated with different essential oils	Victor de Souza (UNL, Portugal)
	Controlling permeability via morphological control: A safe approach for food packaging	Artur Mateus (IPL, Portugal)
15:00 - 15:30	Coffee break	
15:30 - 16:30	Session 4: Bio food packaging	Chairs: Perfecto Paseiro & Fátima Vaz
	Biomaterials with potential use for active packaging	Nathália Ramos de Melo (UFF/UFRRJ, Brazil)
	Biopolymer coatings for food packaging applications	Khaoula Khwaldia (INRAP, Tunisia)
	PLA nanocomposites: development, properties and environment	Ana Vera Machado (UM, Portugal)
16:30 - 17:00	Best poster award. Closing ceremony	Maria Antónia Calhau (INSA, Portugal)

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Plenary conferences

Inaugural conference

INSIGHTS ON SAFETY AND INNOVATION IN FOOD PACKAGING

Ana Sanches-Silva*

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Significant developments have been observed in food packaging since the beginning of the current millennium. This reflects the need of more efficient processes, improvement of safety and quality through the whole supply chain, the need of reducing product losses and the environmental impact.

Safety aspects of food packaging have assumed increasing interest by regulatory bodies as well as by general public. As a result, legislation on food contact materials is being updated and new guidelines are being adopted. Bisphenol A (BPA), phthalates, non-intentionally added substances (NIAS), and associated issues have been target of many studies and opinions due to their potential adverse health effects and risk assessment.

A new generation of food packaging systems, including active and intelligent packaging, is emerging, based on technological breakthroughs and new technologies that offer the perspective of increasing shelf-life, reduce food losses, and allow detecting or monitoring changes in the food product, package or its environment.

It is foreseeable that some food packaging will need to be modified in the near future, and it is encouraging to know that the innovations are within a school of thought that valorizes environmental health. Consumers are becoming more aware of the need for sustainability, therefore furthers advances in the bio based food packaging sector from suppliers and manufacturers are assuming greater importance. Some examples of recent innovations in packaging material technology and applications will be assessed.

Keywords: Active Packaging, Food Packaging, Innovation, Intelligent Packaging, Safety.

Acknowledgements

This work was supported by the research project "Labelling and tracking of nanoclay from food packaging nanocomposites: a food safety issue – NanoPack4Food" (2014DAN1019) under the Cooperative Programme of the Agreement on Scientific Cooperation between National Research Council of Italy (CNR) and Foundation for Science and Technology of Portugal (FCT).

Short Biography

Ana Sanches-Silva is an invited researcher at the National Institute of Health Dr. Ricardo Jorge (INSA). She obtained the degree in Pharmacy by the University of Coimbra, Portugal, and received her European Ph.D. in Pharmacy from the University of Santiago de

Compostela, Spain, with honours. In addition, she was awarded with the prize for best doctorate student. After two years post-doc at this university through competitive programmes, she joined the department of Food and Nutrition of the INSA through the post-doc grant funded by FCT and later through the prestigious national program of human resources 'Science 2007'.

Ana Sanches-Silva has a remarkable track record (over 80 scientific contributions in peer-reviewed journals or book chapters, Scopus H index of 17). Her research interests are focused on the evaluation of safety and composition of food and food packaging. Moreover, her special interest is the development of active packaging, study of food-packaging interactions, especially the migration from packaging to food, and development of analytical methodologies for the analysis of food contaminants and components.

Plenary conference

MIGRATION MODELLING AS SCREENING TOOL FOR SPECIFIC MIGRATION

Perfecto Paseiro Losada*

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Migration modelling is one of screening approaches established by Regulation 10/2011 for testing compliance of specific migration of substances from plastic food contact materials not yet in contact with food. Theoretical migration estimations must overestimate real migration.

Current migration models are based on Fick's laws diffusion and the numerical and analytical solutions shown by Crank (1975). Generally recognized diffusion models and Practical guidelines on the application of migration modelling for the estimation of specific migration are set out in two technical reports of the Joint Research Center - E.J. Hoekstra et al. (2015) and C. Simoneau (2010). Overestimation of key parameters, diffusion coefficients in polymers and partition coefficients of the migrant between polymer and food or simulant are indicated.

A simple and inexpensive method using a Spreadsheet to estimate the migration using Crank equations is shown.

A simple methodology to determine key parameters of diffusion under real conditions polymer/food is shown and found results for different foods combination of PE-migrant-Food and food simulant are compared and discussed versus theoretical migration estimations.

References

- Crank (1975). The mathematics of diffusion, 2nd edition, Oxford University Press.
- E.J. Hoekstra, R. Brandsch, C. Dequatre, P. Mercea, M.R. Milana, A. Störmer, X. Trier, O. Vitrac A. Schäfer and C. Simoneau; Practical guidelines on the application of migration modelling for the estimation of specific migration; EUR 27529 EN; doi:10.2788/04517.
- C. Simenau (2010) Applicability of generally recognised diffusion models for the estimation of specific migration in support of EU Directive 2002/72/EC; EUR 24514 EN; doi:10.2788/85958.

Short Biography

Perfecto Paseiro Losada is full time Professor of the Department of Analytical Chemistry, Nutrition and Bromatology at Faculty of Pharmacy of the University of Santiago de Compostela.

Since 1990 his main research field is in the field of Food Contact Materials, developing analytical methods for migrants in foods, food simulants and residual starting substances in packaging materials (plastic materials, coatings, printing inks, active packaging and nanoparticles) as well as for determining key parameters of the diffusion.

Supervisor of 23 Doctoral Thesis, direction of 15 national and regional projects, more than 170 scientific papers; participation in 6 international projects (5 EU projects "Development of methods of analysis for monomers, ACTIPAK, RECYCLABILITY, FOODMIGROSURE and FACET and 1 EU-Mexico project)

Highlights of the academic experience and management

Secretary of the Faculty of Pharmacy, University of Santiago de Compostela from 12/03/2004 to present.

- Member of the Evaluation Committee of Science Degree (MONITOR, VERIFICA and ACREDITA programs) of the National Agency for Quality Assessment and Accreditation of Spain (ANECA) [Agencia Nacional de Evaluación de la Calidad y la Acreditación], from 12/09/2012 to present.
- Member of the Scientific Committee of the Spanish Food Safety and Nutrition Agency (AESAN), [Agencia Española de Seguridad Alimentaria y Nutricion], from 27/11/2008 to 23/01/2013.
- Spanish Representative in EFSA_FIP Network on Food Contact Materials (FCM), from 09/2014 to present.

Plenary conference

CURRENT US MIGRATION PROTOCOLS FOR COATINGS. STRATEGIES FOR POTENTIAL MIGRANT DETERMINATION.

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The majority of food contact materials (FCM) contain synthetic polymers, such as polyesters, polyacrylates and polyvinyl products. In the United States, the Food and Drug Administration must approve both the starting material and the final polymer to be used in a FCM before it can be placed on the market. Currently, the Food Contact Notification (FCN) system assesses the safety and technical effect of any new FCM. A main component of the FCN is information on the extent of migration of components from the food contact material into a food product. Coatings are crosslinked polymers that have been extensively employed by industry in food cans. Can lacquers act as a barrier to protect food from metal migration and protect the metal from being damaged by components of the food. Although polymeric can coatings are very stable, it is important to determine if any components of the FCM migrate into the food product. Because of this, migration protocols to evaluate mass transfer from FCM into foodstuff are necessary to assess consumer's exposure to migrants. FDA provides guidance for industry on migration testing protocols for can coatings in Appendix II.5. Generally, for high temperature, heat sterilized and retorted can products; the protocol requires a retort step at 121 °C for two hours which is followed by a migration test at 40 °C for 10 days.

Starting materials (monomers and additives) for manufacture of FCM are well characterized and approved through the FCN process for specific uses but other chemicals may form via side reactions during the manufacture of the polymer. These chemicals may remain in the polymer structure and migrate into the food. These substances, known as Non Intentionally Added Substances (NIAS) are a potential concern from a food safety perspective. As a consequence, it is essential to develop analytical methods for the determination and the identification of the starting substances as well as the reaction products that migrate into food or food simulants. In this study, analytical techniques such as gas and liquid chromatography coupled to different types of detectors such as DAD, CAD, FLD, MS and HRMS are used to study migration from several types of can coatings and food simulants. Techniques that do not require sample treatment such as DART-MS were explored and were found to be very useful for directly determining substances within the sample in minutes.

The knowledge and understanding of the limitations of current migration test protocols as well as the use of appropriate analytical techniques for the identification and determination of chemicals that can migrate from the FCM into food is indispensable to comply with food safety authorities and consequently to guarantee consumers safety. The results from this work could be used to develop an updated migration testing protocol which could provide more accurate data for safety assessments.

Keywords: Food contact materials; can coatings; analytical methods, migration.

Short Biography

Rafael Paseiro-Cerrato obtained his European PhD at the department of Analytical Chemistry, Nutrition and Food Science, Faculty of Pharmacy, University of Santiago de Compostela. He obtained the highest mark of Cum laude. In addition, he was awarded with the extraordinary prize for best doctorate student. In 2012 he started to work as ORISE fellow in the US Food and Drug Administration (FDA) at the Center for Food Safety and Applied Nutrition (CFSAN) in the Division of Analytical Chemistry. He has a deep experience in the field of food and food contact materials. He has participated in national and international projects. In addition, Rafael Paseiro-Cerrato has several publications related with food and food packaging in international journals with a high impact factor.

Plenary conference

NANOSTRUCTURED POLYMERS AS INNOVATIVE MATERIALS FOR ACTIVE FOOD PACKAGING

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Inorganic materials have been long recognized as very promising materials with a wide range of possible applications. Among these, many investigation efforts focused on the exploitation of the porous network provided by such materials as a reservoir for the accommodation of drug molecules. In fact, the well-known opportunity to chemically functionalize the surface of siliceous mesostructures with different organic moieties constitutes a route for controlling the drug release by diffusion under specific conditions. Drug release from mesoporous materials is generally controlled by diffusion. Nevertheless, when the interactions between desorbing molecules and silica pore walls are significantly strong and/or show some kind of specificity, the release also depends by the stability of the complex between the functional groups of the drug and those of the substrate. This phenomenon allows then to fine tune the release of specific molecules from a given mesostructure by simply changing the functional groups that are attached to its pore walls during the synthesis process. In addition to the production of smart drug delivery systems, such approach can be also used in the field of food packaging due to the increasing interest in the concept of "active packaging" materials as compounds which, interacting with the packaged foodstuff, are able to control quality as well as to increase shelf-life.

The aim of the present work is the study and the comparison of the release from active polymeric films of various active compounds embedded or supported into/onto three inorganic carriers: SBA (Santa Barbara Amorphous), Montmorillonite and Halloysite. Migration tests were performed at 25 °C, using 96% v/v ethanol and water as food simulant, on polymer films obtained by embedding active inorganic carriers into LDPE, chitosan and PCL matrices. Obtained results show the influence of functionalization of the inorganic carriers on the diffusion of active compounds and thus on their release kinetics into the liquid media.

Keywords: Inorganic carrier, Chemical functionalization, Active compound release

Short Biography

Dr. Giovanna G. Buonocore graduated in Chemical Engineering in 1998 at the University of Naples Federico II (Italy) and received her Ph.D. in Materials Science and Engineering in 2003 from the same University. She has joined in 2003 the IMCB group (Institute for Composites and Biomedical Materials of the Italian Research Council CNR) where she held the position of permanent researcher since 2008.

Her current research activity is focused on the development, characterization and modelling of multifunctional nanostructured polymeric materials used in various application fields such as packaging, transport and cultural heritage.

She is authors and co-authors of 56 scientific contributions (full papers, communication, review) in international peer-reviewed journals, 1 book chapter and 3 patents (1 with international application - WO). Her works received more than 1000 citations and her activity is ranked with an H index of 18 (Scopus Database source).

Dr. Buonocore has been supervisor of several master and Ph.D. thesis, of temporary researchers involved in research projects as well as of foreign visiting researches from international institutions at CNR-IPCB.

Since 2004 she has been officially involved in several national and international projects on the development of advanced multifunctional polymeric materials both as scientific responsible and participant to research activities.

Plenary conference

BIOMATERIALS WITH POTENTIAL USE FOR ACTIVE PACKAGING

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Biological base materials have been researched not only for being a renewable source material but also with the purpose of minimizing undesirable factors caused to the environment for usual materials, as well as being an alternative to consumption of by-products of industries.

The fact that comes from renewable source, however, not necessarily it results to the biopolymer to be biodegradable or compostable, since this characteristic relates to the chemical structure of materials and the chemical connection type.

Biopolymers can be obtained from renewable sources such as ethanol from sugar cane, the Castor oil, co-products of food industries such as fruit peels and whey proteins from cheese industries, as well as derived from various natural sources as polysaccharides, proteins and lipids.

When these materials are intended to package food, mainly as contact packaging, whether films or edible coatings, proteins have been shown to be attractive for also can add nutritional value to the packaged product. Therefore, proteins as corn zein, wheat gluten, soy, peanuts, cotton seed, sunflower, rice bran, egg white, gelatin, collagen, and whey proteins have been studied as potential sources.

For films and coatings can be incorporated substances such as antimicrobials, antioxidants, coloring, flavorings, enzymes that are designed to maintain the quality of the food, change undesirable characteristics as well as allowing their preservation. In this way, the materials are activated, allowing the formation of active packaging, i.e. packaging which interact with food intentionally.

The global capacity of production of bio plastics reached 400,000 tons in 2009 and a magnitude of US\$ 4 billion in 2012. The prediction is to keep growing, reaching 3.5 million tons in 2020 and representing a rate of annual growth of 21.8%.

There is an increasing study around of biomaterials in search not only of the biodegradability as well as higher quality of products with the smallest possible additive content, being the closest to the “in natura”. With the permissibility of the incorporation of additives aimed at natural additives to these new materials, bio-materials, it is possible to glimpse the satisfaction of one more of the current consumers’ longings.

Keywords: co-products, films, edible coating, biodegradability, renewable source.

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CNPq - National Council for Scientific and Technological Development

CAPES - Coordination for the Improvement of Higher Education Personnel

FAPERJ - Foundation to Support State Research in Rio de Janeiro

Short biography

Nathália Ramos de Melo, PhD in Food Science and Technology at Viçosa Federal University in 2007 with part of the studies in the School of Chemical Engineering at Zaragoza University - Spain. Master of Food Science and Technology and graduated in Food Engineering at Viçosa Federal University - Brazil. Adjunct professor IV (exclusive dedication), researcher since 2008, head of Agribusiness Engineering department, coordinates the Agroindustrial Packaging & Technology laboratory (LAETec) at Federal Fluminense University. Research team member of Packaging laboratory at Viçosa Federal University (LABEM-UFV). Nowadays compounds the permanent teaching staff of the graduate program in Science Technology Food at Rio de Janeiro Federal Rural University- Brazil. Guides PhD, graduates and undergraduates students. Experience in Science and Technology Food area with an emphasis on packaging for food (development of materials, active packaging, packaging for the disabled), Microbiology, Migrating compounds and Food Safety.

Oral Communications

USE OF INERT GAS-ENRICHED ATMOSPHERES AND POST-PACKAGING IRRADIATION IN SHELF-LIFE EXTENSION OF WATERCRESS

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Watercress (*Nasturtium officinale* R. Br.) is a semi-aquatic plant of the Brassicaceae family highly appreciated in the Mediterranean cuisine. It features sharp, peppery and slightly tangy taste and contains health-promoting phytochemicals. Its consumption as a fresh-cut product has increased in recent years, as well as the global market of minimally processed vegetables. This demand is driven by the growing interest in the role of food in promoting the human health and well-being and to meet consumer needs for fresh-like and more convenient foods. Due to the reduced shelf-life of this plant, the suitability of inert gas-enriched atmospheres and ionizing irradiation for preserving visual, nutritional and functional quality attributes during cold storage was studied. Watercress samples were gathered in the Northeast region of Portugal, rinsed in tap water and a portion was immediately analyzed (non-stored control). The remaining fresh material was packaged in polyethylene bags under N₂- and Ar-enriched atmospheres, conventional atmosphere (air) and vacuum (no atmosphere). Samples under conventional atmosphere were irradiated at 1, 2 and 5 kGy of gamma-rays (predicted doses) in a ⁶⁰Co experimental chamber. A non-irradiated control followed all the experiment. Then, all packaged samples were stored at 4 °C for 7 days. The studied quality parameters included the colour that was measured with a Konica Minolta colorimeter, and total soluble solids and pH determined in squeezed juice. The proximate composition (moisture, proteins, fat, ash, carbohydrates and energy) was evaluated using the AOAC procedures. Organic acids, free sugars, fatty acids and tocopherols were analyzed by chromatographic techniques. Samples were also evaluated for its DPPH• scavenging activity, reducing power, and lipid peroxidation inhibition capacity through the inhibition of the β-carotene bleaching and thiobarbituric acid reactive substances (TBARS) formation. Differences among treatments were analyzed using the one-way analysis of variance (ANOVA) and a linear discriminant analysis (LDA) was used to evaluate the effects on the overall postharvest quality. After evaluating the effect on the individual quality parameters, the LDA revealed that the Ar-enriched atmosphere and the irradiation at 2 kGy were suitable processing choices for preserving the integrity of the non-stored control samples during cold storage. Thus, these non-thermal treatments were highlighted for shelf-life extension of fresh-cut watercress.

Keywords: fresh-cut watercress, modified atmosphere packaging, gamma irradiation, cold storage, postharvest quality.

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HYGIENIC PROPERTIES OF FRUITS AND VEGETABLES PACKAGING - COMPARISON BETWEEN WOOD AND PLASTIC

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Wood has been a traditional material for fruits and vegetables packaging. However, lately, the trend has been its substitution for plastic boxes. The arguments for it are related with the fact that plastic packages are more lasting, are able to occupy less space when empty, and due to the fact that plastic is considered a more hygienic material and easier to clean than wood.

So, the aim of this work was to compare wood and plastic boxes in terms of hygiene. In Assay 1, the microbial contamination of wood and plastic boxes used for fresh fruits and vegetables transportation was characterized and quantified. The samples were collected in MARL (Supplying Market for the Region of Lisbon) where both types of packaging are commonly used. In Assay 2, the susceptibility of each one of the materials (wood and plastic) to the contamination of the surrounding environment was evaluated. Different environmental conditions, similar to those during transport, storage and commercialization of fruits and vegetables, were tested along a period of three months. In Assay 3, materials were contaminated with molds and yeasts and incubated at different conditions of temperature and moisture. Parallel, materials were also contaminated with *Bacillus cereus*. Those microorganisms are usually detected in horticultural products, and cross contamination of packaging is an eventual hazard.

Results obtained in the first assay, lead to the conclusion that there were no significant differences between wood and plastic packaging, in terms of microbial contamination. However, fruit's packaging presented lower molds, yeasts and coliforms than vegetable's packaging. Observations and results also allowed concluding that high microbial counts obtained in some packaging were due not to the type of material, wood or plastic, but due to the lack of cleaning and sanitizing treatments prior to use.

According to results obtained in Assay 2, both materials, wood and plastic, presented similar behavior. At different experimental conditions, it was concluded that wood is not more susceptible to the surrounding contamination than plastic. In Assay 3, the growth and development of molds and yeasts was enhanced in wood, but not in plastic. On the other hand, plastic materials, at 20°C, enhanced higher growth and development of *B. cereus* than wood materials.

Keywords: Food safety, microbial contamination, biological hazards, wood packaging, plastic packaging.

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VIRAL DISINFECTION OF STRAWBERRIES AND RASPBERRIES BY GAMMA RADIATION

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Viruses are a major cause of human water and foodborne diseases. Especially important are a variety of nonenveloped human and animal enteric pathogenic viruses. These type of viruses primarily infect the intestinal tract through ingestion of contaminated water or food. Enteric viruses, like norovirus (NoV) and adenovirus (AdV), can enter the environment through the discharge of waste materials from infected individuals and contaminate drinking and recreational waters or fresh food products, and be transmitted back to susceptible individuals to continue the cycle of infection. The stability of these viruses and their presence in waters and food can cause serious implications on public health. In this scenario, gamma irradiation could be an efficient technology to achieve elimination of viral pathogens.

The goal of this study was to investigate the inactivation of murine norovirus type 1 (MNV-1), as a NoV surrogate, and human adenovirus type 5 (AdV-5) in fresh berry fruits by gamma irradiation. Fresh strawberries and raspberries were inoculated with MNV-1 or AdV-5 and with a viral pool of MNV-1 and AdV-5 to achieve a viral titer of 10^7 PFU/g, and irradiated in a Co-60 equipment (Precisa 22, Gravinier, Lda, UK) at several gamma radiation doses (1 up to 7 kGy; dose rate of 1.6 kGy/h). The viruses were recovered from spiked samples and then purified and concentrated by low speed centrifugation. The inactivation of viral particles infectivity was tested by plaque assay using Raw 264.7 for MNV-1 and A549 cells for AdV-5. The D10 values (dose required to reduce the virus by 90%) were estimated for each virus and fruit.

A reduction on MNV and AdV titers of 2 log₁₀ PFU/ml was achieved after irradiation at a dose of 4 kGy for both fruits. MNV and AdV seems to have the same radioresistance when irradiated in a viral pool or in individual viral suspension. Even at a dose of 7 kGy it was detected the presence of viral particles in an infective state. The observed D10 values for AdV ranged between 2.33 kGy (viral pool in strawberries) and 2.59 kGy (strawberries); and for MNV between 2.21 kGy (viral pool in strawberries) and 2.81 kGy (strawberries), with no significant differences between each sample and each virus. The obtained results indicated that the studied enteric viruses seem to be more resistant to gamma radiation than cited bacterial pathogens.

Summing up, the non-thermal irradiation process presented virucidal potential, although the selection of the gamma radiation dose for the disinfection treatment of berry fruits, must achieve a balance to guarantee the food safety and preserve food quality. Moreover, as previously studied, this technology could be an effective virus mitigation tool to treat sewage polluted waters, which are the major vehicle of contamination for minimally processed food products.

Keywords: Adenovirus; Norovirus; foodborne viruses; strawberries; raspberries; gamma radiation

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NEW DEVELOPMENTS IN EXPOSURE ASSESSMENT OF FCM IN EU

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Packaging materials and systems are in continuous development in several front lines: nanomaterials, active and intelligent, new additives for plastics and modified traditional ones. Compliance of these food contact materials (FCM) must be verified but the needed protocols and criteria are not always available. Difficulties occur also at the evaluation of impurities, and reactions and degradation products associated to the materials. Additionally, at the EU level, most non-plastic materials do not have specific harmonized legislation. Risk assessment is increasingly required in all the above areas.

Exposure is essential for risk quantification. Exposure estimates are compared to the health-based guidance values for the chemical in question. Dietary exposure combines food consumption data with data on the concentration of the chemicals in food. In the FCM this latter is resultant from the migration and other transfer processes.

Exposure model followed in Europe in the FCM assessment relies on the assumption of a general consumption of 1 kg packaged food/day, while all that food is packaged in a materials containing the chemical of interest. For the migration testing, standardized conditions are used which are based on a packaging surface to volume ratio of 6 dm²/kg food. In light of new developments and the experience gained since those principles were set, it was considered as necessary to review the scientific background underpinning exposure (EFSA, 2015). It is recognised that changes in packaging usage patterns, such as: increased use, trend towards smaller packs, more processed foods, long storage times and products heated in the packaging, as occurred. It has been questioned how conservative is the presently used model, particularly regarding the protection of specific groups of population groups such as infants and children. It may be argued that some substances have very limited use in FCM but on the other hand some substances are used in different materials and not only in plastics.

The presentation will focus on the new developments regarding exposure assessment approaches, in particular consumption data and the impact on the safety assessment. The new EFSA proposed model and developments at research environments are discussed.

REVIEW ON NEW ANALYTICAL TECHNIQUES FOR FOOD CONTACT MATERIALS

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Safety of materials and packages in contact with foods is based on two main pillars: (i) composition of the materials and articles and (ii) interaction between the product and the food, in particular migration of substances of potential concern. Composition is controlled by the raw material supplier and/or converter and determines the potential for migration, while migration itself depends in great extent on the use conditions, being therefore, controlled by the food packer.

The residual substances and those that migrate must be identified and quantified, with focus on the finish product, material or package. It should be taken into consideration the manufacturing process applied and the impact of the use conditions, as impurities and reaction and degradation products can be formed, such as e.g. oligomers. Depending on the objective, different information about the material/package is available and consequently different levels of analytical means is required to perform the evaluation.

Developments on the materials and recognition that direct determinations in food are much more realistic than simulation has increased the difficulties in characterizing, detecting and measuring migrating substances, as for example nano-based materials, with the analytical tools more commonly available in laboratories. Consequently, new techniques are increasingly used for the safety assessment of food contact materials, including chromatographic and optical techniques.

A review on the most recent techniques used for separation, detection, identification and quantification of migrants, such as accurate mass spectrometry, ion-mobility mass spectrometry, atmospheric pressure gas chromatography, two dimensional gas-chromatography and asymmetrical flow field-flow fractionation with multi-angle light-scattering detection, will be presented. Main characteristics and applications will be discussed. One key aspect for reliable and reproducible results is the sample treatment before analysis which is often a time-consuming step. Analytical techniques that need less sample handling will also be focused and a few examples will be given.

Keywords: Analytical techniques, food contact materials, migration

ADVANCED FILMS FROM ARCHITECTURED HYBRID NANOPARTICLES

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Aqueous emulsions of polymer nanoparticles are used as binders in films and coatings. When a polymer emulsion is applied over a surface, water evaporates and the polymer nanoparticles deform as they pack close together. By annealing at a temperature above the polymer minimum film formation temperature (MFFT), chains inter-diffuse between adjacent nanoparticles to yield a strong film. This is a good alternative to the use of films and coatings based on organic solvents, which have been ruled out due to environmental problems.

Here we show two different approaches to produce high performance hybrid latex dispersions. In one approach, we used controlled crosslinking of the polymer chains to improve the film chemical resistance and mechanical strength, tuning the system so that the crosslinking reactions are slower than polymer inter-diffusion across the boundaries between adjacent particles. In the second, we used nanoparticles with a silica core and a polymer shell, so that the film strengthening inorganic fillers become homogeneously distributed in the matrix.

References

- [1] Ribeiro, T.; Baleizão, C.; Farinha, J. P. S., "Functional Films from Silica/Polymer Nanoparticles", *Materials*, 2014, 7, 3881.
- [2] Piçarra, S.; Afonso, C.A.M.; Kutreva, V.B.; Fedorov, A.; Martinho, J.M.G.; Farinha, J.P.S., "The Influence of Nanoparticle Architecture on Latex Film Formation and Healing Properties", *Journal of Colloid and Interfacial Science* 2012, 368, 21.
- [3] Piçarra, S.; Fidalgo, A.; Fedorov, A.; Martinho, J.M.G.; Farinha, J.P.S., "Smart Hybrid Polymer Nanoparticles for High Performance Water-borne Coatings", *Langmuir* (accepted), 2014
- [4] Piçarra, S.; Martinho, J.M.G.; Farinha, J.P.S., "Reactive Aqueous Emulsions for Composite Coatings" PCT/PT2013/000070, 2013.
- [5] Ribeiro, T.; Baleizão, C.; Farinha, J. P. S., "Synthesis and Characterization of Perylenediimide Labeled Core-Shell Hybrid Silica-Polymer Nanoparticles", *J. Phys. Chem. C*, 2009, 113, 18082.
- [6] Ribeiro, T.; Fedorov, A.; Baleizão, C.; Farinha, J.P.S., "Polymer Diffusion in Films of Perylenediimide-Labeled Core-Shell Hybrid Silica-Polymer Nanoparticles", *Journal of Colloid and Interface Science* 2013, 401, 14.
- [7] Martinho, J. M. G.; Farinha, J. P. S., "Fluorescence Decay Methods for the Characterization of Latex Film Formation", *JCT CoatingsTech* 2013, 10, 46.

Keywords: Silica, Polymer, Nanoparticles, Films, Coatings

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ANTIOXIDANT ACTIVE PACKAGING BASED ON CHITOSAN INCORPORATED WITH DIFFERENT ESSENTIAL OIL

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Avoid oxidation process is one of the biggest challenge in the food industry. These reactions are considered as deteriorative in major cases, resulting in undesirable changes such as modifications on texture, loss of nutritional values, and development of off-flavors, off-odors, colored and even toxic substances. Therefore, antioxidant compounds are used as preservatives to maintain the food quality until consumption. Recently demand for more natural and healthy products has pushed the industry to search for alternatives to the traditional methods of food preservation. In this matter, active packaging has emerged as a feasible tool. Essential oils are natural compounds extracted from plants, with antimicrobial and antioxidant properties due to their rich content in polyphenols. Thus, the aim of this work was to develop an active packaging based on chitosan, a natural biopolymer, incorporated with five different commercial essential oils (ginger, rosemary, sage, tea tree and thyme). The film form solution was made dissolving the polymer (2% w/v) in 1 % (v/v) glacial acetic acid with agitation for 24 hours at room temperature (18 ± 2 ° C). After complete dissolution, 30% w/w of glycerol (on polymer base) and 1% v/v (on film form solution base) of each essential oil tested was incorporated. The system was agitated for more 10 minutes to complete homogenization. Tween 80 (0.02 % w/v on film form solution base) was used as emulsifier. Degasification was performed in a sonicator for 5 minutes to eliminate air bubbles. Films were casted and naturally dried for 48 hours. To evaluate the antioxidant power, migration assay was carried out using ethanol 95 % v/v as fat simulant: 2.4 cm² of each film was emerged in 4 mL of simulant (6 dm² per L). Air nitrogen was flushed into the vials to eliminate oxygen and the system was incubated at 37 ± 2 ° C for 10 days. Total phenolic content and antioxidant activity were periodically (24 h, 48 h, 96h, 146h, 196 h and 240 h) monitored by Folin-Ciocalteu reagent and DPPH assay, respectively. Experiment was done in triplicate. Films of chitosan without incorporation of essential oil were also tested as control. Migration is a diffusion process where the compounds incorporated into the polymeric matrix migrates to simulant. This gradual mass transfer is desired since guarantee activity during the storage of the food being packaged. Total phenolic content in the simulant media along the 10 days varied according to the essential oil used. Films with thyme oil released the highest amount of phenolic compounds, followed by tea tree, ginger, sage, rosemary and control samples. The radical DPPH assay results were in accordance with the phenolic content in the simulant media. Results also show that pure chitosan films have demonstrated antioxidant potential. In conclusion, the essential oils tested demonstrated potential to be used by the food packaging industry as an alternative tool to preserve oxidation processes. Nevertheless, further researches are demanded to evaluate the behaviour of these novel materials in contact of different food matrices.

Keywords: Biopolymers, migration, antioxidant active packaging, total phenolic content, DPPH assay.

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CONTROLLING PERMEABILITY VIA MORPHOLOGICAL CONTROL: A SAFE APPROACH FOR FOOD PACKAGING

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Some 60 years ago it was food packaging that made the development of self-service stores and subsequently supermarkets a practical proposition. The packing provides physical and barrier protection for the food content and offers security to the consumer. This initial success story has continued with many technological developments which have enhanced the effectiveness of food packaging in preserving and protecting the food and reducing waste. At the same time food packaging has been under increasing close scrutiny with regard to recycling, contamination of food from chemical migration and the use of materials from sustainable sources and via sustainable processing. We propose that these multiple requirements of high performance packaging coupled to the need for recycling and enhanced sustainability can only be met by the use of polymer films with controlled morphology. By this we mean the controlled distribution and orientation of structural elements such as crystalline lamellae, glassy domains or heavily cross-linked regions which will significantly impact on the permeability of gases through the film. It is the case that the controlled morphology of polymer films is essential for the production of transparent packaging which dominates much of the market in terms of food stuffs. The requirement to control the polymer morphology in specific ways to limit the permeability in turn generates further challenges for processing of polymer films for this application. The proposed approach is based on the mixing of very small quantities of nano-fillers that acts as nucleation agents for lamellae growing in a specific programmed direction. Samples were prepared and characterized by SEM, SAXS and WAXS in situ experiments. We present examples where the required morphology can be achieved and discuss the limitations which are intrinsic to such processes.

BIOPOLYMER COATINGS FOR FOOD PACKAGING APPLICATIONS

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Increased environmental concerns over the use of certain synthetic packaging and coatings in combination with consumer demands for both higher quality and longer shelf life have led to increased demand for non-petroleum-based polymers from renewable resources. Naturally renewable biopolymers can be used as edible and biodegradable films and coatings for food packaging. This study covers the extraction and production of the most studied biopolymers which may have a great importance in the future of the packaging industry as well as their properties and applications as edible coatings on food products and biodegradable coatings on paper packaging materials. Special emphasis is placed on biopolymer modifications to improve their functional properties, which are crucial in terms of food packaging. The recent developments in the field of biopolymer packaging materials are discussed.

Keywords: Bipolymer, Edible coatings, Active packaging, Food, Paper

PLA NANOCOMPOSITES: DEVELOPMENT, PROPERTIES AND ENVIRONMENT

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The use of plastics has resulted in their uncontrolled disposal in landfills, with consequent production of a wide range of harmful chemicals. For these reasons, recyclability and biodegradability have become key criteria for sustainable plastic production and use.

Biopolymers appear as potential alternative for conventional plastic materials. However, mechanical and barrier properties are poor, exhibited lower processability temperature and thermal stability, which limit its industrial application, in particular in food packaging field. In last years, bio-nanocomposites, have proven to be a promising option to improve the properties of biopolymers, since they combine the intrinsic properties of natural polymers, as biocompatibility and biodegradability, and the typical properties of nanoparticles, such as mechanical and barrier properties and high thermal stability. Concerning food quality and shelf life, great improvements can be achieved combined with reducing of plastic waste, which stimulates the exploration of new bio-nanocomposites for packaging. It is of common knowledge that plastic materials are not inert and when in direct contact with the product, migration of substances, like residual monomer, into the product can occur. This issue becomes even more important when nanoparticles are added.

This work aims to investigate the suitability of poly(lactic acid) (PLA)/clay nanocomposites for food packaging parts, which would be produced by thermoforming. The nanocomposites were prepared by melt mixing in a twin-screw extruder.

Rheology and GPC demonstrated that PLA structure was not significantly affected by processing. XRD results indicated that intercalation of the clay platelets occurred. The addition of organoclay improved physical and mechanical properties of PLA to accomplish the packaging requirements.

GPC results after biodegradation revealed a more pronounced polymer chain scission in compost medium.

Thermoforming tests demonstrate that the developed materials can be thermoformed using the conventional equipment. Food contact test showed that the prepared parts are suitable to be used in food packaging.

Keywords: Poly(lactic) acid; Nanocomposites; Thermoforming; Food packaging.

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Food Safety & Quality

FRUITS AND VEGETABLES PACKAGING - IS PLASTIC BETTER THAN WOOD IN TERMS OF HYGIENE?

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The use of plastic in food packaging is increasing worldwide. Regarding fruits and vegetables packaging, the trend is similar, and the traditional wood boxes, used to store, transport and trade those goods in bulk, are being substituted by plastic boxes. Reasons for it are linked with the lower weight, the lesser space occupied when empty, the longer lifetime and the assumption that synthetic polymers are easier to clean and sanitize than wood.

Therefore, a comparison between wood and plastic in terms of hygiene was performed. A characterization and quantification of the microbial contamination was done in wood and plastic boxes used to store, transport and trade fresh fruits and vegetables. Samples were collected at MARL (Supplying Market for the Region of Lisbon) by swabbing the two different materials surface and different microbial indicators were quantified, namely total viable microorganisms, yeasts and molds, total coliforms, enterococci, *Escherichia coli*, *Clostridium perfringens*, *Pseudomonas* spp. and *Bacillus cereus*. These microorganisms are usually frequently identified in horticultural products and its presence can also result from operators and use conditions. Results showed that most of the contamination was due to yeasts and molds, followed by *B. cereus* and coliform bacteria (in order of magnitude). Lower contamination was due to enterococci, *Clostridium perfringens* and *Pseudomonas* spp., and *E. coli* was detected in only one sample (from a total of 32). Yet, no significant differences were observed, for each class of microbial analysis, between wood and plastic packaging. The microbial contamination of wood and plastic materials stored for three months in different experimental conditions (C1: 4-7°C, 80-82% relative humidity, simulating the cold environment; C2: 20°C, 55-60% relative humidity, simulating closed environments with at room temperature; C3: 15-30°C, 50-80% relative humidity, simulating a variety of storage conditions and transport, as well as the effect of moving the materials between different conditions) was also analyzed and compared. No significant differences were detected between materials thus indicating that wood and plastic are similar regarding their susceptibility to the environmental contamination. Both materials were also artificially contaminated with molds and yeasts and *B. cereus*. It was observed higher growth and development of molds and yeasts in wood than in plastic, suggesting that the porous and carbonaceous nature of wood enhanced this microbial proliferation. By opposition, higher growth and development of *B. cereus* was observed in the plastic boxes, suggesting also that irregularities in the polymer matrix accommodates these bacteria and allows its multiplication.

Keywords: Food safety, microbial contamination, biological hazards, wood packaging, plastic packaging.

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INNOVATIVE TECHNOLOGIES FOR SHELF LIFE EXTENSION OF MINIMALLY PROCESSED VEGETABLE

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Minimally processed vegetables are defined as vegetables for human consumption, fresh, packed and ready for consumption. Among them, iceberg lettuce is one of the most popular ready-to-eat vegetables in retail groceries. The shelf life of commercial iceberg lettuce is 7 days at 6°C in modified atmosphere package. The commercially used atmosphere composition is 0-2% of oxygen and 10% of carbon dioxide. In this packaging condition, enzymatic browning kinetic is very low but fermentation process starts and the risk of contamination by *Listeria monocytogenes* is high (O'Beirne et al., 2015). Thus, a packaging design is needed to assure the right gas composition (3-5% O₂ and 10% CO₂) in the headspace during the full storage time and new washing methods have to be implemented to inhibit the enzymatic browning. The objective of this work was to study the effect of salicylic acid (SAC) washing treatment, film packaging material and modified atmosphere packaging on product shelf life. Iceberg lettuce has been cut and washed in water or in SAC solution. The concentration of SAC was established on the basis of the K-value of inhibition of the acid compared to the enzymatic reaction of the PPO. Then, the lettuce was packed in air or in MAP by using two different films, polypropylene (PP) and a microforated BiOPP (MF). All samples were stored for 15 days at 6°C. At different time intervals (0, 3, 6, 9, 13 and 15 days), the following quality indices have been monitored: weight loss (WL), water condensed, color (L*, a*, b*, DE) of the green and white leaves, total phenol and quinones. Head space gas analysis has been performed to monitor the packaging design procedure. A D-optimal factorial design was used and data has been analyzed by ANOVA. The consumer acceptability has been determined by survival analysis. The censoring for each consumer had been determined as reported by Hough (2010). A Weibull distribution has been used to describe the survival function and model parameters have been estimated by using Weibull analysis software. Results showed that the film packaging material, the SAC washing treatment and the storage time had a significant effect on WL, whereas no significant differences have been observed due to packaging technology. The samples packed in MAP by using the MF film showed the lowest WL (0.5%) after 15 days of storage. The film, the packaging technology and the time had a significant effect on condensed water. The MF map sample has the smallest water condensed values (0 - 0,125g at 15 days). Samples packed in MAP with MF and treated with SAC showed the lowest changes of colorimetric parameters. Results of acceptability test have been elaborated to determine the cut-off point of the quality indices. Results highlighted that the shelf life can be extended to 15 days at 6°C by packaging the samples by using MF film and MAP technology.

Keywords: Iceberg lettuce; Salicylic acid; Modified atmosphere package; Microforated film; Shelf life.

NITROGEN VS ARGON: WHAT IS THE MOST EFFECTIVE ATMOSPHERE FOR SHELF-LIFE EXTENSION OF BUCKLER SORREL LEAVES?

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Buckler sorrel (*Rumex induratus* Boiss. & Reut.) is an underutilized leafy vegetable with peculiar sensory properties and potential as a gourmet food. In the food industry, different packaging methods have been used for shelf-life extension, but it is important to know how the quality of minimally processed vegetable is affected by these treatments. Recently, nitrogen and argon have been used for food packaging. Nitrogen is low soluble in water and other food constituents and does not support the growth of aerobic microbes. In turn, argon is biochemically active and appears to interfere with enzymatic oxygen receptor sites. In this study, modified atmospheres enriched with nitrogen and argon were evaluated for shelf-life extension of buckler sorrel leaves.

Wild samples were gathered in Bragança, Portugal, considering local consumers' sites and criteria. Healthy and undamaged leaves were selected, rinsed in tap water, and a portion was immediately analyzed (non-stored control). The remaining fresh material was packaged in polyethylene bags under nitrogen- and argon-enriched atmospheres and a conventional control atmosphere (air). All packaged samples were stored at 4 °C for 12 days and then analyzed. The headspace gas composition was monitored during storage. Different quality attributes were evaluated, including visual (colour), nutritional (macronutrients, individual sugars and fatty acids) and bioactive (hydrophilic and lipophilic molecules and antioxidant properties) parameters. Different statistical tools were used; the one-way analysis of variance (ANOVA) was applied to analyse the differences among treatments and a linear discriminant analysis (LDA) was used to evaluate the effects on the overall postharvest quality.

The argon-enriched atmosphere better prevented the samples from yellowing. The proximate composition did not change significantly during storage. Samples in control atmosphere revealed higher protein and ash contents and lower levels of lipids. The non-stored control samples presented the higher amounts of fructose, glucose and trehalose. The storage time increased the palmitic acid levels and decreased the content in α -linolenic and linoleic acids. The γ - and δ -tocopherols were higher after the 12 days of cold storage. Probably, the synthesis of these lipophilic compounds was a plant strategy to fight against the abiotic stress induced by storage. Higher levels of total phenolics and flavonoids and increased reducing power and β -carotene bleaching inhibition capacity were also found in the stored control samples. Once again, this result may be attributed to the intrinsic plant-protection mechanisms. Overall, the argon atmosphere was more suitable for quality preservation and shelf-life extension of buckler sorrel.

Keywords: Rumex induratus, modified atmosphere packaging, vacuum packaging, cold storage, postharvest quality.

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FLUORESCEIN 5-MALEIMIDE: LABEL OF FOOD CONTACT NANOCOMPOSITES

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Engineered nanomaterials (ENMs) are increasingly being used due to their physical and chemical properties that allow improving a wide range of consumer products. Although they present a vast number of benefits, they also present risks to human health and the environment. Therefore, there is the need of evaluating the risks of nanotechnologies in foods. To fulfill this require new techniques are being developed. Fluorescent labeling is a simple approach for particle tracking that presents low detection limits. A fluorescent organic dye can be directly incorporated into layered silicates like montmorillonite (MMT) by ionic exchange but this can be dislodged from the substrate during the extrusion process. However the covalent bond of the fluorescent tag to the nanoclay can be a good alternative because it provides stability between the fluorescent tag and the clay.

The main objective of this study was to develop an analytical method by Ultra High Performance Liquid Chromatographic (UHPLC) to determine fluorescein 5-maleimide, a fluorescent compound, as potential label of MMT.

Conditions like chromatographic column, column temperature, mobile phase composition, mobile phase gradient as well as detector conditions were tested. Fluorescence detector and diode array detector (DAD) were compared.

In general good linearity was found, excellent determination coefficients were achieved in all cases. Regarding the response of both detectors, as expected, better response was also obtained with fluorescence detector, allowing obtaining lower limits of quantification. The quantification limits of fluorescein 5-maleimide with the fluorescence detector were, at least, 10 times lower than with the DAD detector. Different behaviour was found in the two solvents tested. Ethanolic solutions allowed obtaining lower detection limits (LOD) than methanolic solutions (LOD ethanol = 0.03 µg/mL; LOD methanol = 0.06 µg/mL, using fluorescence detector).

Keywords: Fluorescent labeling, Fluorescein 5-maleimide, Montmorillonite, Nanoclay.

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INFRARED MICROSCOPY ON CHARACTERIZATION OF PACKAGING MATERIALS

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Infrared spectroscopy is the primary analytical technique for the identification and molecular characterisation of polymers. A standard FT-IR instrument can measure samples down to about 50 micrometres in dimension. This is sufficient for bulk measurements on polymers. However, the microstructures of polymers, including different layers in laminates, are generally of the single to tens of micrometres scale. Infrared microscopes are capable of measuring samples on this scale to determine the identity and spatial distribution of components within the material.

Data will be presented from a variety of multicomponent packaging materials including novel polymeric materials. Data analysis methods for extracting the maximum amount of information from the samples will be discussed.

Automated Infrared microscopy and multivariate data analysis are shown to be a fast and effective combination for complete characterization of packaging materials.

DETERMINATION OF RHODAMINE AND TETRAMETHYLRHODAMINE-5-MALEIMIDE BY ULTRA HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

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Nanoscale materials present unquestionable advantages, however there is a need to understand how the nanoscale influences the toxicological properties of materials, as well as the possibility of exposure. Nowadays, we are still facing the lack of tools and methodologies available to easily track the movement and position of engineered nanomaterials (ENMs) from nanocomposites. Elemental analysis via atomic absorption spectrometry or inductively coupled plasma mass spectroscopy are the most commonly used techniques for tracking and detecting nanoclays. However, these methods lack the ability to track single or clustered nanoclay particles and their positions, which is an important feature.

Recently fluorescent labeling has been proposed as a simple method to track particle at nanoscale. In this method fluorescent compound (tag) bonds covalently to the nanoclay allowing to track them.

The main objective of this study was to develop an analytical method by Ultra High Performance Liquid Chromatographic (UHPLC) to determine simultaneously rhodamine and tetramethylrhodamine-5-maleimide, two potential labels of MMT.

Due to the lack of information regarding the analytical behaviour of the selected fluorescent tags, there was the need of carrying out numerous tests to develop an UHPLC method that allowed determining the selected fluorescent tags. Different conditions of the methods were tested including chromatographic column, column temperature, mobile phase composition, mobile phase gradient and detectors conditions were tested.

UHPLC was used because it allows reducing the time of analysis and to obtain well defined peaks and low quantification limits. Fluorescence detector and diode array detector (DAD) were compared as well as different solvents. The results of the calibration curves of rhodamine and tetramethylrhodamine-5-maleimide, prepared in ethanol and methanol, presented excellent determination coefficients in all cases, indicating suitability for quantification. Better response was obtained with fluorescence detector, allowing working at lower concentrations.

Keywords: Fluorescent labeling, Nanoclay, Rhodamine, Tetramethylrhodamine-5-maleimide.

Acknowledgements

This work was supported by the research project "Labelling and tracking of nanoclay from food packaging nanocomposites: a food safety issue - NanoPack4Food" (2014DAN1019) under the Cooperative Programme of the Agreement on Scientific Cooperation between National Research Council of Italy (CNR) and Foundation for Science and Technology of Portugal (FCT).

FOOD PACKAGING: PROVIDING RELIABLE INFORMATION TO CONSUMERS WITH GLUTEN INTOLERANCE

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Food safety continues to mobilize all aspects of the food chain, from producers to consumers. Thus, labelling has proved to be an important tool during the buying decision: the label is the first link between the product and consumers. Food packaging provides consumers with relevant information about the product, allowing them to make conscious, healthy and safe choices, especially to those suffering from food allergies or intolerances.

Celiac disease is a chronic small intestinal immune-mediated enteropathy precipitated by exposure to dietary gluten in genetically susceptible individuals, hampering macro and micro nutrients absorption. It has not been possible until now to establish an acceptable daily intake of gluten that can be tolerated by people with celiac disease, which treatment currently consists of a gluten-free diet throughout life.

As the number of persons with gluten intolerance increases, the food industry demonstrates a greater concern to produce food that can be safely consumed by this group of people.

In accordance with the European Regulation No. 1169/2011, which came into force on 13 December 2014, it is required to indicate on the label substances or products causing allergies or food intolerances. At the European level, foodstuffs intended for particular nutritional uses have their own Regulation No. 41/2009, applicable since January 2012, concerning the composition and labelling of foodstuffs suitable for people intolerant to gluten.

In this context and to confirm gluten-free information on packaged food products, our laboratory works with the food industry and carries out analysis for the assessment of gluten content. Therefore, 50 samples were tested for gluten (2010-2016) by an Enzyme-linked Immunoassay (ELISA) R5 (RIDASCREEN® Gliadin).

All the samples analysed contained levels of gluten below the 20 mg/Kg limit proposed by the Codex Alimentarius Commission for gluten-free foods. These results were in agreement with the gluten-free information presented on the food packaging.

These analysis underline the importance of the laboratory in ensuring that gluten-free information on the labels of food packaging is reliable, so people with celiac disease can make informed and safe choices about the products available on the market.

References

- Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to Consumers.
- Commission Regulation (EC) No 41/2009 of January 2009 concerning the composition and labelling of foodstuffs suitable for people intolerant to gluten.
- RIDASCREEN® Gliadin - Enzyme immunoassay for the quantitative analysis of gliadins and corresponding prolamins.
- Pité, MR. Validation of an alternative method for gluten analysis in foodstuffs ELISA-R5: compared with current official method of analysis. Master's thesis in Quality Control and Food Toxicology. Faculty of Pharmacy, University of Lisbon, in 2007.

Keywords: Food packaging, Food safety, Gluten-free diet, Gluten-free information, Packaged food products.

DRY-CURED HAM PACKAGED UNDER VACCUM: NUTRITIONAL EVALUATION

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Dry-cured ham is a charcuterie product very appreciated in European countries such as Portugal, Spain and Italy. This product is generally found in the market as a whole-piece format or sliced in vacuum-packed trays.

The aim of this study was to determine the moisture, fat, protein content and individual fatty acids of sliced dry-cured hams packaged under vacuum commercialized in Portugal.

Six brands of dry-cured ham were randomly selected and acquired in supermarkets. Moisture content was determined by a drying method in a hot air oven

method. Soxhlet method was used for the determination of fat and Kjeldahl method was used for the determination of protein. Fatty acids methyl esters were determined by gas chromatography with a flame ionization detector (GC-FID).

According to the results obtained, moisture content ranged from 45.7 ± 0.02 and 51.7 ± 0.02 g/100 g, while fat content between 9.40 ± 2.22 and 19.7 ± 0.00 g/100 g. Protein content varied between 23.8 ± 4.86 and 42.8 ± 4.06 g/100 g.

Brand F contained the lowest levels of saturated fatty acids (SFA) (3.26 ± 0.01 g/100 g), monounsaturated fatty acids (MUFA) (4.65 ± 0.01 g/100 g) and polyunsaturated fatty acids (PUFA) (1.07 ± 0.00 g/100 g), while brand B (7.04 ± 0.07 g/100 g), brand E (11.1 ± 0.12 g/100 g) and brand A (4.61 ± 0.04 g/100 g) presented the highest SFA, MUFA and PUFA values, respectively.

Based on the results obtained, the nutritional value of dry-cured hams available in the Portuguese market presents variable composition. These differences may be due to the feeding of pigs, the variety of animals and processing conditions. Moderate consumption of these products is recommended due to their high fat content, especially in saturated fatty acids.

Keywords: Dry-cured ham; Fat; Nutritional content; Protein; Vacuum packaging.

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MINERALS CONTENT OF DELICACY MEAT PRODUCTS PACKAGED UNDER VACCUM: DRY-CURED HAM

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The unique sensorial and nutritional qualities of dry-cured Iberian pork products are responsible for the expansion of the market of these delicacies, highly appreciated in Portugal, Spain and Italy.

The objectives of this study were to evaluate the composition of six dry-cured meat brands available in the national market regarding their ash, phosphorus, sodium and calcium content.

For the determination of ash, samples were carbonized, followed by incineration in a muffle furnace at 600 °C. Phosphorus and calcium measurements were carried out on the ash previously obtained. Phosphorus was determined by spectrophotometry at 720 nm and calcium by complexometric titration with EDTA, adjusted to pH 13. Charpentier-Volhard method was used for evaluation of sodium chloride.

Ash content ranged between 4.86 ± 0.00 g/100 g (brand B) and 7.89 ± 0.00 g/100 g (brand A). Phosphorus content varied between 164 ± 0.03 mg/100 g (brand D) and 248 ± 0.01 mg/100 g (brand E). Sodium content ranged between 422 ± 0.88 and 1350 ± 0.67 mg/100 g, for the dry-cured hams of brands C and D, respectively. Calcium content ranged between 70.8 ± 4.27 and 79.5 ± 0.26 mg/100 g, for dry-cured hams of brands B and C, respectively.

In general, considerable differences were achieved among the six samples analysed for all the parameters evaluated. However, greater differences were found for sodium content, where a threefold difference was found between the lowest and the highest value. Due to the high salt content of dry-cured Iberian pork products, associated with cardiovascular diseases, the consumption of these products shall be moderate.

Keywords: Ash; Calcium; Dry-cured ham; Minerals; Phosphorus, Sodium.

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This work was supported by the project PTDC/AGRTEC/3366/2012 with the acronym Rose4Pack (Biodegradable active packaging with rosemary extract (*Rosmarinus officinalis* L.) to improve food shelf-life) funded by the Foundation for Science and Technology (FCT) and COMPETE Program (FCOMP-01-0124-FEDER-028015). Patrícia Vicente is grateful for the research grant under the project Rose4Pack.

STUDY OF FORMALDEHYDE MIGRATION FROM MDF (MEDIUM DENSITY FIBREBOARD) USED AS FOOD CONTACT MATERIAL BY HPLC METHOD AND ACETYLACETONE METHOD

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Formaldehyde (HCHO) is a small molecule that has one carbon and one heterogeneous oxygen atom. This monomer is used as a component of various materials, including wood based panels products such as urea-formaldehyde resins. Some food packaging contains formaldehyde-based resins that could migrate. On the other hand FA can be found in a wide range of foods. Formaldehyde is authorized by the European Commission according to Regulation (EU) No 10/2011 to be used in food contact materials with a specific migration limit (SML) of 15 mg/kg.

In this work, formaldehyde migration tests for MDF were performed; for that purpose different simulants including water, Tenax, and other possible substitutes as solid agar, humidified agar and agar 1.5% were investigated.

The experimental setup was as follows: the fibreboard piece and the simulant without direct contact were introduced in an airtight container. Then, the system was maintained at 20°C for 10 days and the relative humidity was controlled by a sodium chloride solution.

In order to carry out the analysis one of the most frequently used method for formaldehyde determination was used. Formaldehyde reacts with acetylacetone in the presence of ammonium acetate to form 3,5-diacetyl-1,4-dihydrolutidine. The absorbance of this complex is measured at 410 nm.

The analysis of formaldehyde was also achieved by a high-performance liquid chromatographic (HPLC) method after a reaction with 2,4-dinitrophenylhydrazine (DNPH). The derivatization product is quantified at 360 nm. The analysis was carried out using a Kromasil ODS (C18) column and a gradient elution method using Milli-Q water and acetonitrile as mobile phase.

Formaldehyde migration was detected in all of matrices analyzed, and the obtained results were quite different. It was also observed that the results obtained by the acetylacetone method were higher than those obtained by the HPLC method.

Keywords: Formaldehyde, HPLC, Acetylacetone, Fibreboard.

BISPHENOL A ANALYSIS IN FOOD AND PACKAGING

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Food contact materials should be monitored to ensure product quality and safety, with the ultimate objective of ensuring that no damage will occur in consumer health. This point has become very important in recent years.

Bisphenol A (2,2-Bis(4-hydroxyphenyl)propane), known as BPA, is present in many of the products that we use in day to day. Bisphenol A is authorized by the European Commission according to Regulation (EU) No 10/2011 to be used as a monomer in the manufacture of food contact materials with a specific migration limit (SML) of 0.6 mg/kg.

This chemical can be transferred to food from some types of containers such as polycarbonate containers and metal cans with epoxy resin coatings. In 2011 a restriction was imposed on the use of BPA in relation to the manufacture of polycarbonate baby bottles.

The health concern related to BPA is due to its chemical structure allows it to fit in the estrogen receptor behaving as an endocrine disruptor. BPA has been associated with many health problems such as infertility, prostate and mammary gland cancers, cardiovascular effects, obesity and diabetes.

In this work, it has been conducted analysis in foods packaged in metal cans to check if there was migration of BPA from the packaging to the food. Furthermore the metal cans were also analyzed. Four types of drinks were analyzed, including beer and energy drink. An analytical method based on high performance liquid chromatography with fluorescence detection (HPLC-FLD) was optimized for the identification and quantification of BPA. The analysis was carried out using a reversed Kromasil ODS (C18) column and a gradient elution method using Milli-Q water and acetonitrile as mobile phase. The analyte was extracted from the packaging using acetonitrile as extracting solvent, and the beer samples were analyzed directly. The confirmation of the results was performed using liquid chromatography coupled to mass spectrometry (LC-MS/MS). In this case, the analysis was performed using a reversed Kromasil ODS (C18) column and a gradient elution method using Milli-Q water and methanol as mobile phase. The limit of detection (LOD) of the proposed method was ≤ 0.025 mg/L in the food simulants studied; which is appropriate for monitoring product safety as it is below the specific migration limit (SML) established in accordance with Regulation 10/2011. The results showed that, even with drastic experimental conditions, the migration tests were negative, that is, BPA was not detected in any samples above the detection limit. Therefore, they comply with the regulations of the European Union.

Keywords: Bisphenol A, Beer, Migration, HPLC, LC-MS/MS.

CHEMANTEC (Técnicas Analíticas Galicia S.L): at the forefront of the analysis of materials in contact with food

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Food industry is considered one of the most important market in Europe. Concretely, food packaging is a sector continuously evolving. Some publications anticipate that the sector will increase by 3% worldwide, being paper, cardboard and plastic packaging industries the areas with most benefited sectors, to the detriment of metal and glass packaging. This growth is also leading to a great interest in R+D for food packaging, with the development of many innovations aimed at ensuring food safety and quality.

This technology development has served for considering food packaging not only as a simple protection method but also as a tool for improving food quality and increasing its shelf life.

Chemantec is a spin-off of the University of Santiago the Compostela, specialized in the development of analytical techniques and consulting to ensure packaging safety and food quality. Therefore, personalized services offered by Chemantec, allow to overcoming of specific food industry problems, from the packaging process until the final product that reaches the consumer.

The main activities are focused on food safety, specially:

- Ensuring chemical safety of food contact materials, by determining food-packaging interactions, and more specifically, the migration of chemicals into food.
- Evaluation of new active packaging, including biodegradable materials that increase shelf life of foods, as well as their safety and quality.

Furthermore, Chemantec also offers its expertise to pharmaceutical and cosmetic industry.

Keywords: Food contact materials, Overall Migration, Specific Migration, Food safety, analytical methodology ad-hoc.

APPLICATION OF MATHEMATICAL MODELS TO MYCOTOXINS CHILDREN RISK ASSESSMENT: A CASE STUDY OF PORTUGUESE CHILDREN EXPOSURE TO CO-OCCURRING MYCOTOXINS IN PROCESSED CEREAL-BASED FOODS

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People, animals and the environment can be exposed to multiple chemicals at once from a variety of sources, but current risk assessment is usually carried out based on one chemical substance at a time. In human health risk assessment, ingestion of food is considered a major route of exposure to many contaminants, namely mycotoxins, a wide group of fungal secondary metabolites that are known to potentially cause toxicity and carcinogenic outcomes. Mycotoxins are commonly found in a variety of foods including those intended for consumption by infants and young children and have been found in processed cereal-based foods available in the Portuguese market.

The use of mathematical models, including probabilistic approaches using Monte Carlo simulations, constitutes a prominent issue in human health risk assessment in general and in mycotoxins exposure assessment in particular.

The present study aims to characterize, for the first time, the risk associated with the exposure of Portuguese children to single and multiple mycotoxins present in processed cereal-based foods (CBF).

Portuguese children (0-3 years old) food consumption data (n=103) were collected using a 3 days food diary. Contamination data concerned the quantification of 12 mycotoxins (aflatoxins, ochratoxin A, fumonisins and trichothecenes) were evaluated in 20 CBF samples marketed in 2014 and 2015 in Lisbon; samples were analyzed by HPLC-FLD, LC-MS/MS and GC-MS.

Daily exposure of children to mycotoxins was performed using deterministic and probabilistic approaches. Different strategies were used to treat the left censored data.

For aflatoxins, as carcinogenic compounds, the margin of exposure (MoE) was calculated as a ratio of BMDL (benchmark dose lower confidence limit) to the aflatoxin exposure. The magnitude of the MoE gives an indication of the risk level. For the remaining mycotoxins, the output of exposure was compared to the dose reference values (TDI) in order to calculate the hazard quotients (ratio between exposure and a reference dose, HQ). For the cumulative risk assessment of multiple

mycotoxins, the concentration addition (CA) concept was used. The combined margin of exposure (MoET) and the hazard index (HI) were calculated for aflatoxins and the remaining mycotoxins, respectively.

71% of CBF analyzed samples were contaminated with mycotoxins (with values below the legal limits) and approximately 56% of the studied children consumed CBF at least once in these 3 days. Preliminary results showed that children exposure to single mycotoxins present in CBF were below the TDI. Aflatoxins MoE and MoET revealed a reduced potential risk by exposure through consumption of CBF (with values around 10000 or more). HQ and HI values for the remaining mycotoxins were below 1.

Children are a particularly vulnerable population group to food contaminants and the present results point out an urgent need to establish legal limits and control strategies regarding the presence of multiple mycotoxins in children foods in order to protect their health. The development of packaging materials with antifungal properties is a possible solution to control the growth of moulds and consequently to reduce mycotoxin production, contributing to guarantee the quality and safety of foods intended for children consumption.

Keywords: risk assessment, children health, combined exposure, multiple mycotoxins, mathematical models

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Posters - Session 2
Food Packaging Innovations

SUSTAINABLE MATERIALS BASED ON CELLULOSE AGRO-FOOD WASTES FOR PACKAGING APPLICATIONS

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The annual plastics production reached 288 million tons in 2012, which resulted in regional and global environmental problems ranging from air, water and soil pollution, to climate changes [1-3]. Such drawbacks are progressively becoming more visible competing with the advantages offer by this type of products. The most obvious negative impact is the amount of non-biodegradable waste generation, which could persist for hundreds or even thousands years.

Therefore, renewability and biodegradability have become key criteria for sustainable plastic production and utilisation, namely in applications with short life cycle, as packaging [4]. A number of biodegradable materials and their innovative applications in packaging field have gained much attention over the past several years, since biopolymers have unique properties of considerable interest as the basis to new materials. Cellulose is an example of natural derived polymer that has been exploited for plastic production. Extracted by different methodologies, together with other natural elements present in plants, biopolymers with exceptional thermo-physical properties can be obtained [4].

The present work, aims to prepare new functional biopolymers based on extracted cellulose from agro-food wastes. Green chemistry methodology is applied to extract cellulose from food agro-wastes, which is then modified to produce a biopolymer for packaging. Structural, morphological and thermal characterization of the produced materials were accessed and compared with conventional synthetic polymers. The biodegradability tests were performed to check the microorganisms' capability to assimilate the produced bioplastics. Therefore, this work shows the potential of agro-wastes recovery to produce new cellulose-based bioplastics for food packaging applications.

Keywords: Cellulose, ionic liquids, green chemistry, agro-wastes, biopolymers.

References

1. Hottle, T.A., M.M. Bilec, and A.E. Landis, Sustainability assessments of bio-based polymers. *Polymer Degradation and Stability*, 2013. 98(9): p. 1898-1907.
2. Majeed, K., et al., Potential materials for food packaging from nanoclay/natural fibres filled hybrid composites. *Materials & Design*, 2013. 46(0): p. 391-410.
3. Bayer, I.S., et al., Direct Transformation of Edible Vegetable Waste into Bioplastics. *Macromolecules*, 2014. 47(15): p. 5135-5143.
4. Riggi, E., G. Santagata, and M. Malinconico, Bio-based and biodegradable plastics for use in crop production. *Recent patents on food, nutrition & agriculture*, 2011. 3(1): p. 49.

DEVELOPMENT OF PACKAGING PLASTICS FROM FOOD SECTOR AGRO-WASTES

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Plastic materials produced from petrochemicals are used in a wide range of applications and most of them are extremely durable, requiring many years to degrade and, therefore became a significant source of environmental pollution [1]. To overcome this problem, several studies have been performed, aiming to search for new ecological materials toward innovative and cost-effective fabrication of degradable plastics with similar performance to conventional ones [2,3]. The use of biodegradable/bio-based plastics, became essential, namely in applications where they are used for a short period of time before becoming waste, as food packaging [4]. Thus, the development of new bioplastics based on the combination of biomass residues like agro-wastes, and other natural biopolymers has become a challenge.

Cellulose, the most abundant natural polymer, exhibits good thermal and chemical properties, mechanical resistance and it is also biodegradable and biocompatible. Nevertheless, conventional processing methods cannot be used, leaving industry to resort for cellulose derivatives, consuming extra time and costly chemical purification steps to regenerate it [5].

Thus, the objective of this work is to develop cellulose-based bioplastics, where cellulose is extracted from agro-industrial wastes, by using environmental friendly ionic liquids (ILs) as green alternative. To achieve this goal, the selection of the agro-industrial wastes with higher cellulose content and ILs with high ability to dissolve cellulose was conducted. The extracted residue was characterized by Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy and Scanning Electron Microscopy (SEM) to confirm the presence of cellulose. Moreover, it was observed that the modification of the extracted cellulose with other biopolymers resulted in a polymeric material with similar performance to conventional synthetic polymers, being able to replace the latter in packaging industry.

Keywords: Cellulose, Ionic liquids, Agro industrial wastes, Bioplastics.

References

1. Thompson, R. C., Swan, S. H., Moore, C. J. & vom Saal, F. S. Our plastic age. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 364, 1973–1976 (2009).
2. Isik, M., Sardon, H. & Mecerreyes, D. Ionic Liquids and Cellulose: Dissolution, Chemical Modification and Preparation of New Cellulosic Materials. *Int. J. Mol. Sci.* 15, 11922–11940 (2014).
3. Pinkert, A., Marsh, K. N., Pang, S. & Staiger, M. P. Ionic liquids and their interaction with cellulose. *Chem. Rev.* 109, 6712–6728 (2009).
4. Peelman, N. et al. Application of bioplastics for food packaging. *Trends Food Sci. Technol.* 32, 128–141 (2013).
5. Silvério, H. A., Flauzino Neto, W. P., Dantas, N. O. & Pasquini, D. Extraction and characterization of cellulose nanocrystals from corncob for application as reinforcing agent in nanocomposites. *Ind. Crops Prod.* 44, 427–436 (2013).

STUDY OF BANANA PEEL DRYING KINETIC SEEKING THEIR USE IN PREPARATION MATERIALS BIOPOLYMERS

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For years, plastic polymers, derived from petroleum sources, have been used as the main material for the preparation of packaging. The great demand for its use, however, have aroused concern because of the ecological problem that elapses for its difficult degradation in the environment and the depletion of the source of raw material. In light of this, the bio-based polymers have been highlighted, and can be obtained from vegetable sources, and the coproducts of the food industry potential materials for this application. The banana peel is characterized as a coproduct of the rich processing in starch and fibers having potential for application as raw materials in the preparation of biopolymers. The drying process, due to the reduction of moisture and water activity results in the plant material greater chemical and microbiological stability allowing their storage. To evaluate the behavior during the drying kinetics is important for the adequacy of final product characteristics. Faced with this, the objective of this study was to evaluate the banana peel drying process in order to obtain a raw material to apply in the development of polymeric material biobased. Were used banana peels from silver variety, with the complete maturation. They were submitted to the cleaning process, peeled and separated into size near to 2 cm² and then forwarded to the drying process at 60 ° C for 9 hours (540 minutes) in a tray dryer. To obtain the kinetics during the drying period the samples were collected every 15 minutes during the first 3 hours following every 30 minutes until the end of the process, to make moisture evaluations. The moisture evaluation was performed by submitting about 2 g of sample to 105 ° C until obtaining a constant weight. The banana peel "in natura" presented initial moisture of 89% on a wet basis (1 dimensionless dry basis). Using the dimensionless scale to depict the moisture variation in the sample was important because it allows a better view of the reduction of the water. The banana peel drying kinetics presented with a more expressed moisture variation in two stages: during the first 105 minutes and between 195 and 240 minutes drying. After 440 minutes the process, we observed minimal variation and can therefore be classified as moisture constant. Therefore, the process of drying of 9 hours was sufficient for the banana peel reached constant weight with a final moisture content reached 8.78% on a wet basis or dry basis 0.0119 dimensionless. Therefore, it is possible to provide the coproduct as feedstock for higher storage stability for producing sustainable, biodegradable packaging.

Keywords: Polymer, Bio-based, Agroindustrial coproduct.

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PROPP/UFF, UFRRJ, CAPES, FAPERJ, CNPq

EVALUATION OF COMBINED OR SINGLE USE OF AROMATIC PLANTS EXTRACTS IN WHEY PROTEIN FILMS

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One of the functions of food packaging is to ensure that external factors, like temperature or light, do not affect the quality of the packaged foodstuff. Conventional packaging protects foods from external factors, but they are not able to positively interact with the food product. In order to protect foods from oxidation reactions, food industry employs antioxidants. Most of the times, these substances are synthetic and directly added to foodstuffs. However, these can also be added to food packaging (active packaging) with the aim of being released over time to food surface.

Recent studies have showed that these synthetic antioxidants are associated with adverse effects for Human effects including allergic reactions [1]. Due to these side effects, food industry is trying to substitute these by natural antioxidants.

The objective of this study was to evaluate and compare the antioxidant capacity of extracts from two aromatic plants (rosemary, *Rosemary officinalis* L., and thyme, *Thymus vulgaris* L.) and combinations of both in order to be further used to prepare active whey protein films. DPPH• (2,2-diphenyl-1-picrylhydrazyl) and β -carotene bleaching assays were used to evaluate the antioxidant properties of the selected plants extracts.

DPPH• assay was carried out according to the procedure described by Moure et al. (2001) while β -carotene bleaching assay was described by Miller (1971). Extracts of rosemary and thyme were prepared from plants of different origins as well as combination of these extracts.

Both assays originated coherent results regarding the antioxidant capacity of the extracts or their combinations. Based on the results of both assays and the yield of each extract, the best extract was chosen to be incorporated in the whey protein film. The use of combined extracts of aromatic plants was discussed in order to check if synergetic effects have been observed.

References

- [1] J.I. Cacho, N. Campillo, P. Viñas, M. Hernández-Córdoba. Food Chem. 200 (2016) 249–54. doi:10.1016/j.foodchem.2016.01.026.
- [2] A. Moure, D. Franco, J. Sineiro, H. Domínguez, M.J. Núñez, J.M. Lema. Food Res. Int. 34 (2001) 103–109. doi:10.1016/S0963-9969(00)00136-8.
- [3] H.E. Miller. J. Am. Oil Chem. Soc. 48 (1971) 91. doi:10.1007/BF02635693.

Keywords: Active packaging, Antioxidant, Aromatic plants, Whey protein.

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EVALUATION THE EFFECT OF THE ADDITION OF GLYCEROL PLASTICIZER IN MECHANICAL AND MICROBIOLOGICAL FEATURES OF CELLULOSE ACETATE ACTIVE FILMS INCORPORATED WITH ESSENTIAL OIL CINNAMON

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Antimicrobial active packaging incorporated with natural compounds such as essential oils (EOs) represent an innovation and modern concept in conservation and food safety. However, additives of polymeric materials can cause changes in their properties. The addition of compounds to active films may cause changes in its function, this is beneficial or not. The aim of the present study was to characterize cellulose acetate film (CA) incorporated with EO cinnamon and plasticizer, evaluating the influence of additives on mechanical and microbiological behavior of these materials. Through the "casting" technique were obtained incorporated films with 50% (w/v) of EO cinnamon added glycerol (5, 10, 20 and 30% (w/v)). For a control, a film containing only 50% (w/v) of EO cinnamon. The film was characterized as the mechanical strength (tensile strength, modulus and break elongation) and antimicrobial activity in vitro to *Staphylococcus aureus* and *Escherichia coli*. For tensile strength, films incorporated with EO cinnamon when added different concentrations of glycerol, showed differences ($p < 0.05$) with a reduction of the parameter evaluated, ranging from $54.41 \pm 1.27\text{N}$ (control film) to $41.88 \pm 0.01\text{N}$ (film with 30% glycerol). For the elasticity modulus, the addition of glycerol caused a reduction of mean values of $5.94 \pm 0.01\text{MPa}$ (control film) to $4.89 \pm 0.01\text{MPa}$ (film with 30% glycerol), showing less stiffness in the films with presence of plasticizer. In this way, it's observed that the plasticizer power was higher in the glycerol and EO cinnamon combination. However the elongation at break showed no difference from the control film when added different concentrations of glycerol. Addition of glycerol to the incorporated film with EO cinnamon favored the increase of antimicrobial effect at a concentration of 30% for *S. aureus*, varying the zone of inhibition $0.54 \pm 0.04\text{cm}$ (control film) to $1.13 \pm 0.03\text{cm}$ (film with 30% glycerol). For *E. coli* the concentrations of 5 and 30% glycerol ($0.70 \pm 0.01\text{cm}$ and $0.75 \pm 0.01\text{cm}$, respectively), potentiated the antimicrobial effectiveness of the films when compared to the control film ($0.58 \pm 0.02\text{cm}$). Therefore, the addition of glycerol to the cellulose acetate film with EO cinnamon, besides providing more flexibility and cause structural changes in the packaging network, showed that may enhance its antimicrobial effect. This fact confirms that the chemical structure of the various additives and the polymer matrix is of fundamental importance to define the functional properties of polymeric films. In addition, while protecting and maintaining the integrity of the food, antimicrobial active films featured in this study demonstrate the potential to maintain security of the food against the evaluated microorganisms.

Keywords: active packaging, additives, mechanical properties , antimicrobial properties, food safety.

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UFRRJ, CAPES, FAPERJ, CNPq, PROPPI/AGIR/UFF, EMBRAPA

ANTIMICROBIAL ACTIVITY OF ACTIVE WHEY PROTEIN FILMS

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Aromatic plants are well known for their antioxidant and antimicrobial properties. The content of essential oils and extracts of these plants on compounds responsible for these properties, such as phenolic compounds, depend on different factors, including the variety of the plant, plant part, edaphoclimatic conditions, drying conditions (if applicable) and methods of extraction and analysis [1, 2].

The aim of this work was to evaluate the antimicrobial activity of a whey protein film incorporated with an aromatic plant extract intended for food applications. The antimicrobial activity was evaluated against yeasts (*Saccharomyces cerevisiae*), Gram-positive bacteria (*Staphylococcus aureus*, *Listeria monocytogenes*, *Enterococcus faecalis*, *Bacillus cereus* and *Clostridium perfringens*) and Gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*).

To test the antimicrobial activity of the film, a suspension of each microorganism was inoculated on the surface of agar media plates. Then, flat squares from the whey protein film with (active test films) and without (control films) the aromatic plant extract were placed on the agar surface. The Petri dishes containing the agar media inoculated and a square film were then incubated under temperature and time conditions according to the target microorganism.

Finally, the zone of inhibition of microbial growth on and around the test films was evaluated and compared with the negative control.

The results obtained revealed that the active whey protein films have antibacterial activity against *L. monocytogenes*, *S. aureus* and *C. perfringens*, suggesting that the new edible food packaging based on whey protein tested in the present work has great potential to be used by food industry with the aim of inhibiting microorganisms commonly responsible for food spoilage/food-borne diseases.

References

[1] M. Kozłowska, A.E. Laudy, J.L. Przybył, M. Ziarno, E. Majewska, Chemical composition and antibacterial activity of some medicinal plants from Lamiaceae family. Acta Pol. Pharm. - Drug Res. 72 (2015) 757-767.

[2] R. Ribeiro-Santos, D. Carvalho-Costa, C. Cavaleiro, H. S. Costa, T. Gonçalves Albuquerque, M. C. Castilho, F. Ramos, N. R. Melo, A. Sanches-Silva. A novel insight on an ancient aromatic plant: The rosemary (*Rosmarinus officinalis* L.). Trends in Food Science and Technology (2015), 45: 355-368.

Keywords: Active packaging, Antimicrobial properties, Food safety, Whey protein.

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WHEY PROTEIN FILMS WITH AROMATIC PLANTS EXTRACTS: OPTIMIZATION OF THE CASTING PROCESS

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A food package is a system that provides a safe and easy handling during transportation, distribution and storage, from the food processing until it reaches the consumer [1]. The demand of consumers for foods with extended shelf-life and higher quality, has encouraged food industry to develop new technologies to deliver foods with improved quality and safety and healthier. In line with this, active and intelligent packaging have emerged. According to the European Commission, an active material is “intended to extend the shelf-life or to maintain or improve the condition of packaged food” and they are “designed to deliberately incorporate components that would release or absorb substances into or from the packaged food or the environment surrounding the food” [2]. A film based on whey protein is biodegradable and presents very interesting technological properties such as good mechanical resistance and good gas barrier in a low humidity ambient [3]. The goal of this work was to optimize the casting process of a whey protein film that incorporates plant extracts. This film is intended to prevent lipid oxidation of fatty food.

Films were prepared by solvent casting and they were composed by whey protein, water, glycerol and plant extracts. First, different amounts of glycerol were tested (5-15%, w/w) and then, different amounts of plant extracts (1- 5%, w/w) were assayed. Different drying conditions (temperature and time) were also evaluated.

Results revealed that 5 and 10% (w/w) of glycerol, allowed obtaining the best results. In this case, films presented good appearance and flexibility. In what concerns to the amount of plant extract, the film with 1% of plant extract gave better results because it allowed obtaining films that were easily 1% (w/w) removed from the surface and they presented homogeneous appearance.

The aim of the study, i.e. the addition of whey protein films with plant extracts, was successfully achieved. The optimized addition method can be considered appropriate for preparing a suitable active system in any routine analytical laboratory, thereby avoiding the need for specific equipment like an extruder. Further studies will be required in order to check for the efficient of this new active film in the inhibition of lipid oxidation of fatty foods.

References

[1] M. de F. Poças and R. Moreira, *Segurança Alimentar e Embalagem*. 2003.

[2] European Commission, “Regulation (EC) No. 450/2009,” *Off. J. Eur. Union* L135 (2009) 3–11.

[3] S. Galus and J. Kadzińska. *Food Hydrocoll.*, 52 (2015) 78–86.

Keywords: Active packaging, Antioxidant, Aromatic plants, Casting, Whey protein.

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EFFECT OF LAURIC ACID AND WHEAT GLUTEN ON FUNCTIONAL AND CHEMICO-PHYSICAL PROPERTIES OF THERMOPLASTIC ZEIN AND STARCH BIO-MATRIXES

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Edible films can help to meet many challenges involved with the marketing of foods. They can control mass transfer between components of a product as well as between the product and the environment. The main components are generally recognized as safe structure such as lipid, proteins, cellulose derivatives, starch and other polysaccharide. Generally, the functional, organoleptic, nutritional and mechanical properties of an edible film can be modified by the addition of various chemicals in minor amounts. Plasticizers, such as glycerol, sorbitol or polyethylene glycol are often used to modify the processability and the mechanical properties of the edible films. These compounds decrease intermolecular attraction between adjacent polymer chains increasing the mobility and then the film flexibility. Incorporation of these additives may, however, cause significant reduction in the barrier properties of the film. On the contrary, some lipid-like vegetable oils and fatty acid (mainly lauric acid) can be incorporated to edible film as hydrophobic plasticizers. In this case, the water vapor transfer generally occurs through the hydrophilic portion of the film and then depends on the hydrophilic-hydrophobic ratio of the film components. Thus, in the present work, the addition of a fatty acid (lauric acid-LA) to the film formulation appeared to be an alternative to minimize the water sensitivity of edible films. Furthermore the combined addition of a secondary component, such as wheat gluten, may cause physico-chemical interactions that can further improve film properties. Wheat gluten, as secondary matrix component, could improve the water barrier properties due to the large number of non-polar aminoacids which contribute to hydrophobic interactions. Beside of its effect on barrier properties of edible film, gluten could enhance cohesive and elastic properties.

The objective of the present work is to reduce water vapor permeability and to improve mechanical properties of thermo-plastic zein protein and starch based films using lauric acid as partial substitute of hydrophilic plasticizer and wheat gluten as hydrophobic phase. To this aim, edible bio-matrixes based on zein protein and starch were obtained by melt blending. The effect of a fatty acid (lauric acid) and wheat gluten addition on improving chemico-physical and functional properties of bio-matrixes zein and starch-based films has been evaluated. Results indicate that these additives interact in different way with the two matrixes inducing an improvement in the properties for zein-based films and leaving them unaltered in the case of the starch-based materials. In particular, regarding the zein-based edible films lauric acid increased the tensile modulus, the maximum stress and lowered water vapor permeability due to an increased in hydrophobicity of zein matrix. In contrast, gluten addition reduced the water vapor permeability without affecting the mechanical properties. Finally for the zein-based film the most significant improvement, in barrier and mechanical properties, was observed with the combination of both additives lauric acid (5wt%) and gluten (15wt%).

Keywords: Zein, Starch, Lauric acid, Gluten, Properties.

EFFECTIVENESS OF AN ACTIVE WHEY PROTEIN FILM AGAINST LIPID OXIDATION

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Active packaging is an emerging concept used by food industry to protect and extend the shelf-life of foods. There are active packages designed to have a desirable migration of compounds from the package to the food, protecting the food from degradation factors, like lipid oxidation. Lipid oxidation is one of the main causes of loss of quality in foods, especially of fatty foodstuffs. This reaction can alter the organoleptic properties of foods, leading to the formation of unpleasant flavors and/or odors and potential toxic compounds. Lipid oxidation also changes the nutritional value and reduces the shelf-life of products [1].

Aromatic plants are known since ancient times for their biological properties which include antioxidant capacity. Rosemary (*Rosmarinus officinalis* L.) is one of those plants with antioxidant capacity higher than some synthetic antioxidants such as butylated hydroxyanisole (BHA) [2]. Its extract and essential oil has been recognized as GRAS (Generally Recognized as Safe) by the Food and Drugs Administration (FDA) [3] and the European Commission has authorized rosemary extract as food additive [4,5].

In the frame of the present study, salami slices were packaged with an active whey protein film, incorporated with rosemary extract, and stored for 7, 15, 30, 60 and 90 days. A whey protein film without the plant extract was used as control. To evaluate the effectiveness of the active film against lipid oxidation, the Thiobarbituric Acid Reactive Substances (TBARS) assay was used [6]. This assay measures the malondialdehyde (MDA) content, with is a marker for the oxidative stress of foods.

The results showed that the salami slices packaged with the active whey protein film presented lower MDA (mg/kg) content than the salami packaged with the control film,. These results showed that the rosemary extract incorporated in the whey protein film protects the salami from lipid oxidation. Further studies shall be carried out in order to evaluate other markers of lipid oxidation such as peroxides and aldehydes.

References

[1] D.J. McClements, E.A. Decker. *J. Food Sci.* 65 (2000) 1270–1282.

[2] R. Ribeiro-Santos, D. Carvalho-Costa, C. Cavaleiro, H.S. Costa, T.G. Albuquerque, M.C. Castilho et al. *Trends Food Sci. Technol.* 45 (2015) 355–368.

[3] Food And Drug Administration (FDA), Substances Generally Recognized as Safe, Code Fed. Regul. 3 (2015).

- [4] Commission Directive 2010/67/EU from European Parliament and European Food Safety Authority. Off. J. Eur. Union. (2010) 17–26.
[5] Commission Directive 2010/69/EU from European Parliament and European Food Safety Authority. Off. J. Eur. Union. (2010) 22–31.
[6] D.D. Miller, Food Chemistry: A Laboratory Manual, 2nd ed., Wiley, 1998.

Keywords: Active packaging, Lipid Oxidation; Malondialdehyde, TBARS, Whey Protein Film.

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DEVELOPMENT OF CHITOSAN AND METHYLCELLULOSE FILMS CONTAINING NATAMYCIN AS ANTIMICROBIAL AGENT

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Elaboration of edible films and coatings has been possible thanks to the filmogenic capability of natural biopolymers. Chitosan is a natural carbohydrate polymer derived by deacetylation of chitin, which exhibits antimicrobial activity as well as film-forming properties. Also cellulose derivatives films are appreciated for their flexibility, total transparency, and resistance to fats and oils. Many antimicrobials are proposed to be used in the formulation of edible films in order to inhibit the spoilage flora and to decrease the risk of pathogens. Natamycin is a natural antimycotic polyene, produced by *Streptomyces natalensis*. Approved as a food additive in over 40 countries, natamycin is commonly employed in dairy-based food products to prevent yeasts and moulds contamination. The aim of this work is to develop and evaluate chitosan and methylcellulose films incorporated natamycin as antimicrobial agent.

Chitosan films (1.5% w/v) were prepared by dissolving chitosan in acetic acid aqueous solution 1% (v/v). Subsequently, the solution, containing glycerol as plasticizer (0.2 g/g biopolymer), was kept under stirring for 2 h at a constant temperature of 80 °C and then 12 h at room temperature.

Methylcellulose (3% w/v) was mixed with water-ethanol (50:50 v/v), and then homogenised for 5 minutes. After the addition of glycerol (0.4 g/g biopolymer), the solution was kept under stirring and heated to 80 °C for 2 hours. To eliminate the adverse effect of the temperature, antimicrobial agent was added to film solutions at room temperature. The solutions were then casted in 8.5 cm polyacrylic plates and dried at 30°C for 12 hours. All of the films were transparent. The average thickness ranged between 38 to 51 µm, and, 56 to 76 µm, for chitosan and methylcellulose films, respectively.

Migration of natamycin from chitosan and methylcellulose films were evaluated at 10 °C and 20 °C, respectively, in 95% ethanol (v/v). Aliquots of 0.5 ml of the simulants were removed at present time intervals, filtered and analysed by HPLC.

After 6 days methylcellulose films reached the equilibrium, releasing about 70% of natamycin; on the contrary, chitosan film was far from the equilibrium conditions after 24 days, being released less than 15 % of the initial amount of natamycin in the film.

Chitosan maintains its structure in a neutral environment but solubilized and degraded in acidic environment. As 95% ethanol (v/v) solution had neutral pH, chitosan film demonstrated higher stability with compact structure, which will make the natamycin diffusion through the film matrix difficult. Moreover, the presence of ethanol at high concentration in the solution limits the film hydration and the weakening effect of the polymer network, as demonstrates the slow rates of migration obtained. Promising results were achieved, but further studies are needed to test the effectiveness of these films on possible food systems.

Keywords: Edible film, Chitosan, Methylcellulose, Natamycin.

SENSORY CHARACTERIZATION OF SALAMI PACKAGED IN A ACTIVE WHEY PROTEIN FILM

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In today's world, food packaging is present in our day-to-day and it is a common habit to acquire packaged food. The function of packaging is to protect food from external factors such as humidity, temperature and light, inform consumers about the nutritional value of the food and protects from internal factors, responsible for food degradation. The lipid oxidation is one of the factors that originates food degradation and represents a danger to public health, since it can originate irreversible food changes and leave food unfit for consumption. Active food packaging offers a solution for this problem. Natural antioxidants from aromatic plants may be incorporated into active packaging to be released during storage in order to extend the food shelf life.

A whey protein film incorporated with a rosemary extract was developed for packaging fatty foods, in order to inhibit lipid oxidation. The studied product was salami sliced packaged with the whey protein film incorporated with a rosemary extract for two periods of time: 30 days and 90 days (stored at 5 °C, protected from light). Salami slices packaged with whey protein film without plant extract was used as control.

Descriptive sensory analysis was used for salami characterization using a trained panel constituted by 12 individuals. An on-line questionnaire was previously performed to former Culinary Arts students, Chefs and general consumers. Questions included socio-demographic data and requisites for participating in the panels. Requisites for the trained panel were: not being sick or having a chronic disease that could affect sensory perception, not being pregnant, interest in performing the tests, availability and to like the analyzed product. Unpackaged commercially available salami was used for training the panel and for descriptors generation. The panel evaluated the samples with a 1-5 descriptive scale for the following descriptors: regarding the taste salty, smoky, acidity, bitterness, spicy and spices; regarding the texture greasy, fibrous, juicy and softness; regarding other parameters red color, typical smell, typical aroma and an appellative appearance.

The panel found the unpackaged sample salty, with a smoky flavor, a little acid and bitter. Regarding the texture, the panel found the salami with a greasy, fibrous, soft and juicy texture. The panel also found that the product is reddish, with a typical smell and aroma, and an appellative aspect. In the second session the panel evaluated the salami packaged with the active film. Regarding the salami slices packaged with the whey protein film incorporated with the rosemary extract, the panel found the salami less salty than the original sample and with low smoky flavour and that the salami is a little acid and bitter. The new active whey protein film can be considered appropriate to package fatty foods, once it has not negatively affected the organoleptic properties of the model food and it has the potential to enhance food shelf-life. However, further studies are required in order to check the effectiveness of this new packaging to inhibit the lipid oxidation of packaged food.

Keywords: Active films, Salami, Sensory analysis, Whey Protein.

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NANOPARTICLES IN FOOD PACKAGING: BIODEGRADABILITY AND POTENTIAL MIGRATION TO FOOD - RISKS AND BENEFITS

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Among the latest innovations in the food packaging industry, the use of biodegradable polymers is highlighted due to its sustainable appeal that matches with the actual consumers demand for more environmental friendly products. Yet, due to their poor technological performance, nanoparticles (NPs) are being used as reinforcements to improve barrier and mechanical properties. Additionally, incorporation of NPs may also improve other characteristics of the biopolymers, such as antimicrobial or antioxidant properties, or may result in an intelligent material, when nanofillers are nanosensors. However, being a novel technology, there are gaps on its knowledge that pose questions to the scientific community, especially regarding its toxicity and ecotoxicity. In fact, the NPs can affect the biodegradability of the biocomposites and have potential to migrate to the foodstuff packaged and to the environment. The use of nanofillers as reinforcements results in changes on the polymer crystallinity. The increase on the crystallinity degree results on a stronger light barrier, slowing the photochemical degradability, and decreases oxygen and liquids diffusion through the polymer matrix, reducing the oxidation processes and chemical reactions. Both processes protect the polymer from deterioration, once the cleavage of the polymeric chemical chain is delayed. This was observed when Montmorillonite (MMT) was incorporated into methyl cellulose (MC). Contrariwise, nanocomposites of PLA incorporated with different clays accelerated the polymer degradation, particularly at higher clay content. Regarding migration of NPs from food packaging to foodstuff, the scarce studies on this subject indicate that it is low and slow, increasing with nanoparticle size and polymer dynamic viscosity reduction. Anyway, the even low migration of NPs to food may represent a source of human exposure when they are uptaken from food, and the toxicity will depend on the particles toxicity, size, morphology, rates of migration and ingestion. Concerning ecotoxicity, the evolution of nanotechnology in food packaging raises the issue of incidental environmental contamination due to the release of nanoscale compounds during the degradation process, as also the possibility of bioaccumulation/bioconcentration in the food chain. Some studies indicate that the risk associated with the exposure to nanomaterials will be determined in part by the processes that control their environmental fate and transformation. Yet, the complexity of the nanocomposites and of the biodegradation and migration processes, which depend on many factors, require more studies that may help to clarify the mechanisms associated with it.

Keywords: Biopolymers; Risk assessment; Nanoparticles; Nanotoxicology; Ecotoxicity; Food safety.

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CINNAMON: ANCIENT KNOWLEDGE WITH NEW PERSPECTIVES IN FOOD PACKAGING

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Since ancient times, the human species have been using plants and spices for many purposes. Cinnamon is obtained from the trees belonging to genus *Cinnamomum*. The most important species of cinnamon include *Cinnamomum zeylanicum* Blume or *C. verum* J. Presl. (true cinnamon), *Cinnamomum aromaticum* Nees or *Cinnamomum cassia* (L.) J. Presl (Chinese cinnamon or cassia cinnamon), *Cinnamomum burmannii* (Nees & T. Nees) Blume (Indonesian cinnamon) and *Cinnamomum loureiroi* Ness (Vietnamese cinnamon).

The aim of this work was to carry out an extensive bibliographic review in order to highlight the nutritional value of cinnamon (macro and micronutrients) and to explore its fields of application, including food packaging.

Regarding cinnamon's nutritional composition, this aromatic plant is known for providing protein, fiber, vitamins (A, B and C) and minerals (Ca, P, Na, K and Fe), contributing for a diverse and healthy diet. The variation in macro and micronutrients can be explained by the differences in species, varieties, growth conditions, harvesting season, soil properties, climate, geographical origins and environmental conditions.

Cinnamon is a natural product with numerous benefits for human health and it can be used in different forms as whole, ground, as extract or essential oil. Indeed, it can also be used in foods as aromatic plant, enhancing or adding flavors, or as dietary source of natural antioxidants and antimicrobials to improve food quality and safety. In addition to the food industry, the fields of application of cinnamon include the pharmaceutical industry, as therapeutic drug; the cosmetic industry and the food packaging industry. In last field, it can be used in active food packaging as sachets or incorporated into polymeric matrices or coatings. However, it is foreseen that, in the future years, new products and applications will arise based on cinnamon exploitation.

Keywords: Aromatic plant, Cinnamon, Food Packaging, Minerals, Vitamins.

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FABRICATION AND CHARACTERIZATIONS OF A MULTI-LAYER FILM WITH LUMINESCENCE PROPERTY FOR ANTI-COUNTERFEITING APPLICATIONS IN THE FOOD PACKAGING

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The aim of this work was to develop an innovative tri-layer film, with the inner-layer showing luminescence properties for anti-counterfeiting applications in food packaging products. Chemical routes to obtain solid solutions of gold particles in thermoplastic polymer like Ethylene Vinyl Acetate (EVA), starting from metal-organic precursors like (gold-2-mercapto-1-methyl imidazole complex, AuMMI and gold linear-thiolate, AuSC14H29) were used [1,2,3]. The annealing of this systems generated gold nanoparticles embedded in EVA; the use of particular temperatures and times of thermal treatment (about 100°C for 5 min in an hot plate), compatible with the EVA process temperatures, created a system of a unique and specific dimensions of the metallic nanoparticles (about in the range of 1-5 nm) in the polymeric matrix. These systems were structurally and morphologically characterized with X Ray Diffraction (XRD) and with Transmission Electron Microscopy (TEM) analysis. The peculiar property of these metal-polymer nanocomposites, was the luminescence, extremely legated with the nanoscopic dimension achieved of the gold nanoparticles. These plastics nanocomposites were totally transparent under visible light, instead under UV illumination (excitation at $\lambda=384$ nm – emission at $\lambda=530$ nm for AuMMI nanocomposites; excitation at $\lambda=254$ nm – emission at $\lambda=633$ nm for AuSC14H29 nanocomposites) they showed strong green and red emissions, respectively. The gold/EVA film has been incorporated between two external layers of polylactic acid films trough a hot-lamination process. The developed multilayer film showed good luminescence property, particularly interesting for anti-counterfeiting applications, being tunable with the annealing process parameters and with the chemical sulfur precursors used in the synthesis of gold nanoparticles in polymer.

Keywords: Luminescence, Gold, Thiolates, Nanocomposites, Anti-counterfeing.

BIOACTIVE COMPOUNDS OF CINNAMON - A VALUABLE AROMATIC PLANT FOR FOOD PACKAGING

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Spices and aromatic plants are used since ancient times for culinary, medicine and aromatic purposes. In culinary they are used to add or enhance flavours to foods or culinary preparations and in cosmetics they are used due to their pleasant fragrances. Due to their known biological properties, such as antioxidant and antimicrobial activities, they are also used for medicine purposes both by traditional and current medicines.

Cinnamon is one of these spices and it can be used in its various forms: whole or ground forms and as extract or essential oil, usually obtained from cinnamon's bark or leaves. There are about 250 species of cinnamon and *Cinnamomum zeylanicum* and *Cinnamomum cassia* are the most common.

The aim of this work was to compile and discuss the bioactive compounds of cinnamon based on an extensive bibliographic review. The final goal was to evaluate the interest of this aromatic plant in food packaging.

The prevention and treatment of several chronic diseases, such as diabetes, Alzheimer's and Parkinson's diseases, is well documented. In addition, cinnamon has also been used to control the glucose blood levels in diabetes, as antineoplastic, repellent and as anti-inflammatory.

Besides the well-known antioxidant and antimicrobial activities of cinnamon, this spice also showed to have an insecticidal effect against *Aedes albopictus*, *Culex quinquefasciatus*, and *Armigeres subalbatus*, among others. This effect is related to the α -methyl cinnamaldehyde, benzaldehyde and trans - cinnamaldehyde, volatile compounds of cinnamon essential oil.

The main volatile compound of cinnamon essential oil extracted from bark is cinnamaldehyde (56-78%), which is responsible for its sweet taste and its antimicrobial activity, while the major compound of cinnamon essential oil extracted from leaves is eugenol (60-77%), which is responsible for its antioxidant activity.

Due to its numerous biological properties, cinnamon can be used as an active principle by the pharmaceutical industry, as a fragrance by the cosmetic industry, by direct application to food, or it can be incorporated in active food packaging. As a result of its various and easy forms of use, this spice presents a vast potential of new applications in food packaging with health benefits for the consumers.

Keywords: Active packaging, Aromatic plant, Bioactive compounds, Cinnamon.

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BORATE-CROSSLINKED CHITOSAN/GRAPHENE OXIDE FILMS: TOWARD ENHANCING SIMULTANEOUSLY GASES BARRIER AND MECHANICAL PROPERTIES

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Polymers obtained from renewable sources, generally biodegradable under normal environmental conditions, can be a viable solution to the waste disposal of plastic food packaging materials. In order to compete with synthetic plastics, they should have comparable mechanical and/or barrier properties. This is especially difficult to achieve with respect to moisture barrier properties, because of the hydrophilic nature of most biopolymers which is in contrast with the hydrophobic nature of most synthetic polymers used in food packaging. Chitosan, a polysaccharide obtained by deacetylation of chitin, is one of the most interesting biopolymers obtained from natural sources. In addition to the biocompatibility characteristics, chitosan bacterio- and fungi-static properties are very useful for food preservation.

As for other biopolymers, many strategies have been explored to improve the barrier and mechanical properties of chitosan-based films. These include the addition of other biodegradable aliphatic polyesters and, recently, the addition of inorganic nanoparticles including graphene.

In this work, we report on the role of borate ions, originated from hydrolysis of sodium tetraborate decahydrate (borax), in the crosslinking of chitosan (CS) and graphene oxide (GO) through a solution casting approach to produce high barrier composite films originating from a biopolymer. CS/GO films containing 10wt% borax and 1wt% GO exhibit two fold increments in tensile strength as compared to that of pristine CS. Also, the oxygen permeability of borate-crosslinked CS/GO composite film shows a one order of magnitude decrease with respect to the pristine chitosan. Solid-state ¹¹B NMR spectra indicated that the esterified borate orthoester formed between borate ions and GO or CS is responsible for the significant enhancement in both mechanical and barrier properties. These crosslinked graphene-based chitosan films offer new opportunities for a broad range of applications including packaging.

Keywords: Chitosan, Graphene, Barrier Properties, Mechanical Properties.

STUDY OF MAJOR COMPOUNDS OF ESSENTIAL OILS BY GC-MS FOR APPLICATION IN ACTIVE FOOD PACKAGING

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Several researchers have highlighted essential oils (EOs) as being natural products with potential use in the preservation of the quality of food. The chemical composition of EOs is greatly influenced by factors such as the plant species, and the part of the plant or the extraction method. Besides the direct application of EOs to foods, they can also be incorporated in food packaging. EOs have proven to exhibit antimicrobial and antioxidant action on packaged food through the migration of the active compounds of packaging to the food surface. In the present study, the major volatile compounds of commercial EOs of *Ocimum basilicum* L. (basil), *Cinnamomum cassia* (L.) J. Presl., *Cinnamomum zeylanicum* Blume (cinnamon) and *Rosmarinus officinalis* L. (rosemary) have been determined by Gas Chromatography coupled with Mass Spectrometry (GC-MS). In this analysis a Hewlett Packard-5890 series II with a flame ionization detector (GC-FID) was used. This was equipped with a Factor Four-VF-5ms capillary column (Varian) (30 m x 0.25 mm, 0.25 µm film thickness). The amount of the injected samples was 1µL in split mode (1:30) and helium (1 mL/min) was used as carrier gas. The oven temperature was programmed as follows: 60 °C at 2 min, 60 to 110 °C at 2 °C/ min, 110 to 150 °C at 3 °C/ min, 290 °C at 15 °C/ min.

Results revealed the number of identified compounds in each studied EO ranged between 12 and 23, comprising 99 % of the total volatile composition of each oil. The EOs contains a complex mixture consisting mainly of monoterpenes and sesquiterpenes. The main component of *C. cassia* EO was trans-cinnamaldehyde (86.4%) followed by trans-o-methoxy cinnamaldehyde (8.36 %), whereas *C. zeylanicum* EO was found to be rich in eugenol (79.2 %), followed by benzyl benzoate (3.42%). *O. basilicum* EO presented methyl chavicol (75.73 %) and linalool (19.28 %) as major components, and *R. officinalis* EO showed to have mainly 1,8-cineole (49.2 %), camphor (16.0 %) and α-pinene (13.0 %). The results of this study are in accordance with those found in the literature. The study of the chemical composition of the EOs is of great importance in order to better understand the compounds responsible for the preservation of food quality, their proportions and mechanisms of action. Therefore, this study is a contribute for the comprehension of the biological properties of the EOs used as direct or indirect food additives.

Keywords: Basil, Cinnamon, Essential oil, Gas Chromatography, Rosemary.

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BIO-ACTIVE FOOD PACKAGING WITH ESSENTIAL OILS: PROTECTION OF SALAMI AGAINST LIPID OXIDATION

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Essential Oils (EOs) are currently studied as food additives because they have antioxidant activity besides their notable antimicrobial properties. They can be incorporated into active films to prevent foods with a high fat content to oxidise. During the oxidation process, malondialdehydes (MDA) are formed as a result of the degradation of polyunsaturated fatty acids. TBARS (Thiobarbituric Acid Reactive Substances) is one of most commonly used methods for assessing lipid oxidation in foods. In this assay, the MDA is reacted with thiobarbituric acid to form a complex that is measured spectrophotometrically. In the present work, salamis were packaged with whey protein films containing a combination of EOs. The effectiveness of these films against lipid oxidation in meat products was studied during 180 days with storage at 5 °C. A combination of *Rosemary officinalis* L., *Cinnamomum cassia* (L.) J. Presl and *Cinnamomum zeylanicum* Blume EOs were incorporated into whey protein films. Film forming solutions (FFS) were prepared using an aqueous solution of whey protein concentrate followed by the adjustment of pH to 7.0. Then, solutions were heated to 80 °C for 30 min. Afterwards, solutions were cooled down to room temperature. Glycerol and EOs (1, 2, and 2.7 % w/w) were incorporated into solutions by homogenization using an ultra-turrax. The FFS were casted on anti-adherent surfaces and then dried at room temperature. In addition, FFS without EOs was prepared as control films. The salami was selected as model meat product and it was packaged with the whey protein films and stored at 5 °C for 180 days. After different storage periods, the lipids oxidation was assessed by the TBA (Thiobarbituric Acid) assay which was based on the spectrophotometric determination of the reaction between TBA and MDA. The concentration of a coloured pigment produced after heat was calculated by measuring the absorbance at 530 nm. TBARS procedure was used to assess the extent of lipid oxidation. The determination of the degree of oxidation was carried out in salami packaged with whey protein films containing a combination of Eos and after 4, 7, 15, 45, 30, 60, 135 and 180 days of storage. The results showed that the films incorporated with EOs significantly reduced the oxidation status. Until 60 days of storage, the film with 1% EOs was the most effective against oxidation when compared with the control film (without EOs) and the active films, showing minor amount of MDA. For longer storage periods (135 and 180 days), all films were effective against lipid oxidation in comparison with control film. These results demonstrate that, the application of bioactive films with essential oils can reduce the lipid oxidation phenomenon of meat products, extending their shelf life while releasing natural antioxidants to their surface.

Keywords: Cinnamon, Rosemary, Essential oil, Salami, Whey protein

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PHYSICAL AND OPTICAL PROPERTIES OF WHEY PROTEIN FILMS INCORPORATING ESSENTIAL OILS

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Bio-based films have been a subject of great interest in recent years due to concerns about the environmental impact caused by the use of plastic packaging materials from non-renewable sources and/or non-biodegradable. Whey protein, a by-product of the cheese-making industry, has been successfully employed as a raw material for preparation of food packaging. This packaging material may incorporate an active compound, such as an essential oil (EO). EOs have evidenced antioxidant and antimicrobial properties. Moreover, currently consumers are interested in natural products, free of synthetic additives. The objectives of the present work were to study the effect of the incorporation of a combination of 3 EO on the physical and optical properties of whey protein films. Whey protein films were prepared by casting. A combination of *Rosmarinus officinalis* (L.), *Cinnamomum cassia* (L.) J. Presl. and *Cinnamomum zeylanicum* Blume. EOs was incorporated into a whey protein concentrate (WPC) film. Film forming solutions (FFS) were prepared using an aqueous solution of WPC followed by the adjustment of pH to 7.0. The solutions were heated and then cooled down to room temperature. Glycerol and EOs (1, 2, 2.7 and 5% w/w) were incorporated into solutions by homogenization using an ultra-turrax. FFS were casted on anti-adherent surfaces and then dried at room temperature. In addition, control films were prepared without incorporation of EOs. Films were flexible, an aroma was notice, which was more intense at higher concentration of EOs. The contact angle (CA), using the water droplet method, indicated that all films have hydrophilic surface because exhibited the CA < 65° after 5s of water droplet application. The ultraviolet (UV) and visible light barrier properties of the film were measured using a spectrophotometer. Negligible light transmission in the UV-Vis range was noted at 200 nm for all films, while at 300 nm, only the film control presented transmission values (0.041 ± 0.01%). In the visible range, at 500 nm, transmission values ranged from 24.3 ± 0.82 % to 2.1± 0.11%, in the case of film with 1% and 5% of EO, respectively. Lightness (L*), redness, (a*), and yellowness (b*) color system were used to evaluate the color of films by a colorimeter. All the films showed lower and the same L* values, statistically, independently of the proportion of EO. Parameter a* increasing with higher of EO. Film without EO and with 1% of EO showed negative and same values of parameter a*, while films with 2, 2.7 and 5% of EO showed positive values this parameter. All films showed positive values of parameter b*. The films were heterogeneous in appearance and hydrophilic; not being suitable for foods that require moisture barrier. However, due to their excellent barrier properties in the UV region and antioxidant properties they are recommended for foods with high fat content. Due to their aroma, they are also recommended for foods in which the addition of an aromatic plant aroma could enhance their final organoleptic properties.

Keywords: Antioxidant, Cinnamon essential oil, Food packaging, Rosemary essential oil.

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PROTEIN COATING - TRENDS OF MINIMALLY PROCESSED VEGETABLES

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Currently, consumers are looking for healthy food, closer to natural and which are convenient. Therefore, minimally processed vegetables (MPV) are likely to meet this demand, since these products are gaining space in supermarkets shelves. However, during the processing of this vegetable, there is an increasing activity of some enzymes of the metabolism, such as polyphenol oxidase and peroxidase, resulting in odors, vegetable browning and lignification of cell walls, reducing its quality. Aiming to extend the commercial validity of MPV, conventional packages require improvements. For this purpose, several research areas in food packaging have been investigating packaging techniques capable to improve food preservation properties, based on interaction with the product packaging. One of these techniques is known as active packaging, it, interacting with the food can change characteristics extending its shelf-life, increasing security and maintaining its quality. The use of edible coating for fresh fruits and vegetables has been explored and can reduce moisture loss, respiration rates, avoiding fermentative processes and giving a bright and attractive appearance. Among the compounds used in the coating formulation, the proteins are becoming attractive, since they have in their structure more than 20 different monomers giving a range of functional and potential properties. In the group of the proteins, whey protein has been investigated as a potential source of edible coatings for fruits and vegetables MP. These coatings exhibit good mechanical properties and barrier concerning to oxygen and gases. With the addition of antioxidant agents in the coating, such as ascorbic acid and citric acid, it can prevent browning of the VMP. The use of these active coatings not only maintains the quality of the product but also claim a nutritional enrichment for the consumer.

Keywords: Whey proteins, Edible coating, Active packaging.

Acknowledgments

PROPP/UFF, UFRRJ, CAPES, FAPERJ, CNPq.

MATERIALS REINFORCED WITH NANOCELLULOSE: PROMISING NANOCOMPOSITES FOR FOOD PACKAGING?

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The development of new packaging materials offering new functionalities and lower environmental impact, is now an urgent need. On one hand, the shelf life extension of packaged products can be an answer to the exponential increase of worldwide demand for food. On the other hand, the increase in the price of crude oil, together with the uncertainty related to its durability, has imposed the necessity to manufacture new structures to replace oil-derived polymers in the future. Finally, consumers' awareness towards environmental issues increasingly pushes industries to look with renewed interest to "green" solutions. Thus, in the last years' numerous polymers have been exploited to develop biodegradable food packaging materials.

The usage of biopolymers has been limited due to the poor mechanical and barrier properties. These properties can be enhanced by adding reinforcing nano-sized compounds to form nanocomposites.

Cellulose is probably the most used and well-known renewable and sustainable raw material. The mechanical properties, reinforcing capabilities, abundance, low density and biodegradability of the cellulose nanoparticles make them ideal candidates for the processing of polymer nanocomposites.

The present review focuses on the combination of nanocellulose with polymers such as wheat gluten; starch, gelatine; agar; polyvinyl alcohol (PVA); chitosan. The methods of processing, level of incorporation and the enhanced material properties are discussed.

Future trends are addressed namely regarding regulations and food industry applications.

Keywords: Biodegradable; Food Packaging, Nanocomposites; Nanocellulose;

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POTENTIAL APPLICATIONS OF MULTIFUNCTIONAL EXTRACT OBTAINED FROM CORN INDUSTRY IN FOOD PACKAGING

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Nowadays, in the food industry exists an increased demand, by the consumers, of natural additives that can replace those chemical additives obtained from non renewable resources. In this work extracts with surfactant and antioxidant properties were obtained from corn steep liquor (CSL) with potential applications in food packaging.

The extraction process was carried out using ethyl acetate and the operational conditions consisted of: CSL/ethyl acetate 1:3 (v/v), at 25°C during 45 min with agitation system at 150 rpm.

The antioxidant activity of the extract was determined by the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method; whereas the surface active properties was evaluated by the Wilhelmy plate method in a force tensiometer with a platinum plate (Easy Dyne K20, KRUSS GmbH), at room temperature.

Fatty acid composition of extract was analyzed by gas chromatography coupled to a mass spectrometer (Bruker Scion 451-GC).

Chromatographic separations of polyphenols were carried out on a reverse phase Kromasil C18 column (250 × 3.2 mm internal diameter, 5 µm particle size) (Phenomenex, Barcelona, Spain). The solvents constituting the mobile phase were Milli-Q water 0.1% acetic acid (solvent A) and 100% AcN (solvent B). The gradient program was as follows: 0-5 min, 93% A and 7% B; 5-10 min, linear gradient until reaching 90% A and 10% B at 10 min; 10-20 min, linear gradient until 80% A and 20% B; 20-35 min linear gradient from 70% A to 30% B, 35-40 linear gradient from 93% A to 7% B; and finally, the column was washed and reconditioned. The mobile phase flow rate was 0.5 mL min⁻¹ during the entire analytical run, the column temperature was set at 38 °C, and the sample injection volume was 20 µL. A scan in the range of 190 to 700 nm was continuously performed by DAD.

The extract obtained from CSL after extraction with ethyl acetate showed an appreciable antioxidant capacity (EC₅₀ of 9.65±0.48 g/L) and a surfactant capacity that was able to reduce the surface tension of water in more than 32 units. The extraction yield achieved was about 1% (about 10.22±2.28 g of extract were obtained by kg of CSL).

Regarding the chemical characterization, this extract was composed mainly by C16-C18 fatty acids consisting of linoelaidic acid, oleic or/and elaidic acid, stearic acid and palmitic acid; as well as antioxidants comprising protocatechuic acid, vanillic acid, p-coumaric, sinapic acid, quercetin and ferulic acid, proving that corn steep liquor (CSL) is an interesting natural source for obtaining extracts with antioxidant and biosurfactant properties.

Keywords: Corn steep liquor, Antioxidant, Surfactant, Multifunctional extract, Food packaging

ALGINATE COATINGS ENRICHED WITH CITRUS ESSENTIAL OILS FOR OKRA PRESERVATION

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Okra (*Abelmoschus esculentus* L.), commonly known as lady's finger, plays an important role in human diet owing to its high content of carbohydrates, proteins, fibre, minerals and vitamins. However, okra pods are highly susceptible to postharvest deterioration and have a short shelf-life because of their high respiration rate and moisture content. Recently, considerable attention has been directed toward natural essential oils (EOs), as a promising approach for maintaining fruit quality and controlling postharvest decay in perishable fruits. However, the use of these compounds is often limited due to their intense aroma and their potential toxicity. The incorporation of EOs into edible coating formulations has been investigated as an effective approach to solve some of these problems, by lowering diffusion processes and maintaining high concentrations of active molecules on the surface of the fruit.

Biodegradable coatings based on sodium alginate (NaAlg) either alone or combined with bergamot or bitter orange essential oils were applied on fresh okra pods in order to evaluate their potential to preserve postharvest quality and inhibit the growth of *Cladosporium oxysporum* on artificially inoculated pods. NaAlg coatings were effective at delaying respiration rate, reducing weight loss and maintaining firmness of fresh okra pods during cold storage. Bioactive coatings enriched with either bergamot or bitter orange EO were shown effective at preventing disease incidence up to the third day of storage and reducing fungal decay of inoculated pods by more than 33%, compared with the control and pure NaAlg coatings, at day 8.

Our results demonstrate the potential of the combined application of NaAlg and citrus oils as effective alternatives to synthetic antifungal agents for maintaining quality attributes and controlling fungal decay of fresh okra pods.

Keywords: *Abelmoschus esculentus*, Sodium alginate coatings, Citrus essential oil, Antifungal.

EFFECT OF A CACTUS EXTRACT ON FUNCTIONAL PROPERTIES OF PAPER

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Although many materials based on petrochemical derived polymers have been used for paper coating due to their favorable functionality characteristics, many limitations related to their increasing costs as well as their harmful effects on human health and the environment are pushing researchers to find viable alternatives. There is a growing interest in the development of biodegradable coatings derived from sustainable resources. In this study, a polysaccharide polymer was extracted from cactus. This new biopolymer was characterized in terms of chemical composition and physicochemical properties and then applied as biodegradable coatings on paper. The effect of coating weight on the functional properties of coated papers was studied. Increasing coating weight led to a decrease in water vapor permeability of the resulting coated paper sheets. The application of the polysaccharide extract increased elongation of coated paper but did not significantly affect its tensile strength. Furthermore, the biopolymer provides antioxidant and antimicrobial activities due to its high polyphenol content.

Keywords: Cactus, paper, Biodegradable coating, Barrier properties, Mechanical resistance.

ARE MUSHROOMS A GOOD SOURCE OF ANTIOXIDANTS FOR ACTIVE FOOD PACKAGING?

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Active packaging is gaining considerable attention by consumers and food industry due to its unequivocal advantages such as improvement of food quality and extension of food shelf-life. In this frame, active packaging with antioxidant properties is one of the new packaging concepts that comprise greatest developments.

Recently, in order to look for sources of natural antioxidants, a vast range of foods and food by-products have been evaluated. The aim of this work was to evaluate the content on phenolics and flavonoids of edible mushrooms of different species and cultivated according to different methods in order to check their potential use in active packaging.

The total phenolics content (TPC) and total flavonoids content (TFC) was evaluated. TPC assay is based on the transfer of electrons from phenolic compounds to phosphomolybdic/phosphotungstic acid complexes in alkaline medium. The absorbance of samples is measured spectrophotometrically at 765 nm and results are given in gallic acid equivalents (GAE) per g extract. The content of total flavonoids was evaluated by an aluminium chloride colorimetric assay and results are given in epicatechin equivalents (ECE) per g extract.

The results for commercialized mushrooms, in terms of TPC presented the following in descending order: *B. edulis* >> *F. velutipes* > *A. bisporus* (brown) > *P. eryngii* ≈ *M. oreades* > *A. bisporus* (white) ≈ *L. edodes* > *P. ostreatus* > *C. cibarius*, where the highest value was 19.7 mg GAE/g extract and the lowest 3.45 mg GAE/g extract.

The results obtained for the mushrooms in which the optimized growing process applied agro-industrial by-products presented the following descending order of TPC: *A. cylindracea* (13.6 to 15.4 mg GAE/g extract) > *P. ostreatus* (8.02 to 10.0 mg GAE/g extract) > *P. eryngii* (4.04 to 6.75 mg GAE/g extract).

The TFC was only quantified in *B. edulis* (4.32 mg ECE/g extract), *A. cylindracea* (13.8 - 15.9 mg ECE/g extract) and mycelium of *A. cylindracea* (3.76 mg GAE/g extract).

Although there are variations according to the species and the cultivation process, the results suggested that mushrooms can be a good source of compounds with antioxidant properties, such as phenolics. Therefore, mushrooms can be used to obtain antioxidant extracts to incorporate in polymeric matrices in order to obtain active food packaging.

Keywords: Active Packaging, Antioxidant, Food shelf-life, Mushrooms.

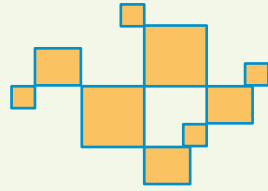
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