International Conference on

# Sustainable Bioplastics

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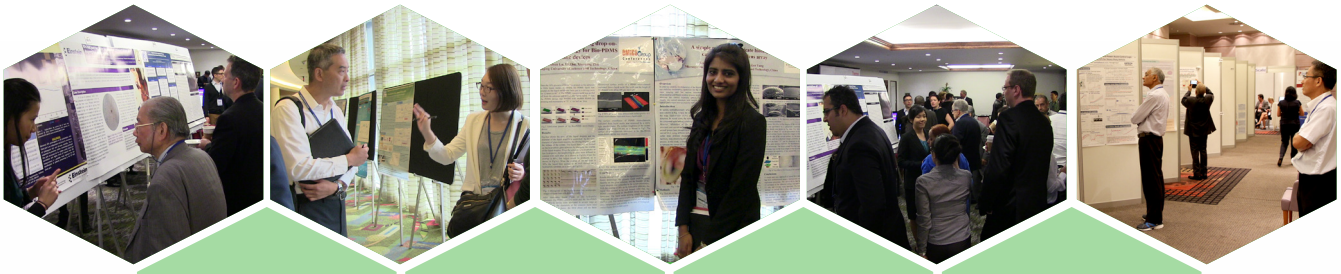
## Posters



Veronica Carbonell, J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Development of stable recombinant *cyanobacteria* for economically competent solar-fuel-factories: ethylene production

**Veronica Carbonell**
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Greenhouse gas emissions and limited fossil fuel reserves increase the need to find alternative ways to generate substitutes for petroleum-derived products such as ethylene. Ethylene is a simple alkene of commercial value due to multitude of large-scale uses in plastic industry and ever growing demand. One of the promising approaches is to use *cyanobacterial* cells as biological factories, through their photosynthetic capacity to produce ethylene using atmospheric $CO_2$ and water as substrates. The biosynthesis of ethylene has been studied in *Synechococcus* sp 7942 by over-expressing the heterologous ethylene forming enzyme (efe) from *Pseudomonas syringae* which converts the endogenous metabolic precursor 2-oxoglutarate to ethylene. As a volatile gas, ethylene then diffuses out from the cell and spontaneously separates into the culture headspace for collection and analysis. We have studied different aspects of observed genetic instability which have earlier compromised prolonged ethylene production in *Synechococcus*, and have developed stable production strains capable of sustained autotrophic ethylene biosynthesis. Although the production levels still remain below the threshold required for commercial applications, cyanobacteria have been intensively studied in this respect, and a range of molecular biology tools and production platforms are being developed and characterized.

## Biography

Veronica Carbonell is Licentiate on Environmental Sciences by the University of Miguel Hernandez with strong international background and has participated in international programs such as Erasmus at Free University of Brussels (Belgium), FARO at John Innes Center (UK) and IAESTE at Silesian University of Technology (Poland). Currently, she is pursuing her PhD from the University of Turku, Finland.

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**Notes:**

Carmem Cicera Maria da Silva Campelo et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Study of frying oil use in biodiesel production, applying techniques of environmental management in university city UEMS/UFGD

**Carmem Cicera Maria da Silva Campelo[2], [3]Sabrina Zanatta[1], Janderson de Souza Leal[1], Gustavo Graciano Fonseca[4] Farayde Matta Fakhouri[3,5]**
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The frying oil is gaining prominence due to growing demand for biofuels, as raw material appears as an alternative energy lowering environmental impact. The difficulty of an effective oil gathering in micro and macro sphere to supply the biodiesel production from this raw material is evident. Lack of application of a standard operating procedure in the oil handling in commercial scope, affects its quality, compromising the collection intended for biodiesel production and even more for food consumption. Through three feeding points in the university town, frying oil samples were collected named A, B, C, which were physic-chemically characterized. In the establishments were applied an evaluation questionnaire about the handling and use of oil and then was elaborated a training with application of a standard procedure in order to minimize impurities in the raw material. In parallel, gathering points were set in the university town (UEMS and UFGD), generating socio-environmental awareness and highlighting the importance of conscious disposal of household waste, thus promoting the importance of an efficient collection not only of commercial oils, but also of household. The oil collected in the feeding sites presented very different physic-chemical characteristics from the commercial soybean oil, mainly in the parameters of acidity, water content, fat and impurities, making them unsuitable for food and also for the biodiesel production, which strengthens the idea of awareness about the effective collection.

## Biography

Carmem Cicera Maria da Silva Campelo is a bacharelor's in chemistry from Universidade Federal do Piauí (2003), has Master in Chemisty at the same institution. She is a professor at the State University of Mato Grosso do Sul. Curretly she is at a phd student at program at the Faculty of Exact Science and Techology (FACET) at the Federal University Grande Dourados (UFGD). Her experience is based on chemistry with focus on Physical Chemistry, acting in cenostigma macrophyllum, lupeol and biodisel.

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**Notes:**

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# Study of the degree and speed of disintegration of PLA commercial grades as a function of material shape and thickness

**Elena Domínguez, Enrique Moliner, Eva Verdejo and María Lopez**
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Biodegradable polymers are being increasingly used in several applications, such as packaging, disposable non-wovens and hygiene products, consumer goods and agricultural products. A wide variety of biodegradable polymers have been developed, both from petrochemical and renewable sources. Polylactic acid (PLA) is the most demanded biodegradable polymer in the market, which is mainly used for the manufacture of compostable packaging. ISO 13432 establishes the requirements for packaging to be considered as recoverable through composting and biodegradation, including the test scheme and evaluation criteria for the final acceptance of packaging. The test scheme typically involves the following analysis and testing: chemical characterization (heavy metals and volatile organic compounds), biodegradation, disintegration and eco-toxicity (of the composted product). Test on disintegration is usually the most limiting factor for plastic products to be accepted as compostable. This paper will present the main findings of a study on the degree of disintegration of different PLA commercial grades. Samples of pellets and sheets with various thicknesses were tested under simulated composting conditions in a lab-scale test. The degree and speed of disintegration of these samples were measured and compared with each other. Hence, the effect of the shape and thickness of the product on the disintegration was evaluated. Based on these findings, recommendations for product design and waste conditioning prior to composting were provided to ensure the compostability of PLA products.

## Biography

Mrs. Elena Dominguez Solera, holds a Bachelor Degree in Chemical Engineer from the Universidad Politécnica of Valencia (Spain) with a Master in Technology of Polymeric Materials and Composites. Researcher at the Department of Sustainability and Industrial Recovery of AIMPLAS since 2015. Among the activities which carry on, are included: research in the fields of new material developments, manufacturing processes, recycling/recovery of materials and eco-design. She also has experience in the field of bioplastics/biocomposites and implements laboratory tests (according to established standards and relevant legislation) for determination of biodegradability (in different environments) and compostability of these materials.

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**Notes:**

Hiléia K S Souza et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Natural deep eutectic solvents based on choline chloride as a green plasticizer to produce chitosan based films

**Hiléia K S Souza, Andrea C Galvis-Sánchez, Maria Cidália R Castro and Maria P Gonçalves**
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There is a worldwide interest in replacing the use of oil-based synthetic plastics with biodegradable, nontoxic packages. The development of new package products can benefit various industrial activities, particularly the production, distribution and commercialization of foods. Chitosan (CH), a polysaccharide derived from chitin, is a promising biopolymer to be used for this issue, since chitin is the second most abundant polysaccharide in nature and can be obtained as a reject of the seafood industry in coastal regions, inland or even associated to shrimp aquaculture production. Besides, the environmental benefits related to the removal of seafood residues and the replacement of petroleum-based-packages, chitosan can be considered an active package material, since its physicochemical properties, such as molecular weight and degree of deacetylation, can confer special activities to chitosan, including antimicrobial activity, which can be very useful in food packing. We present previously unexplored approach based on the use of natural deep eutectic solvents (NADESs) as potential biodegradable plasticizer. Specifically, we report the use of different NADESs as precursors for the fabrication of transparent chitosan films prepared by compression molding. Film structure was studied with FESEM and the optical, water permeability and mechanical properties were also evaluated. Significant differences were verified in the behavior of the biofilms under the different experimental conditions.

## Biography

Hiléia K S Souza has received her PhD in the Department of Chemistry, Faculty of Sciences, University of Porto. Currently, she is doing her Post-doctoral research in the line of Food Quality and Safety at the Requimte- Laboratory for Green Chemistry, Clean Technologies and Processes at the University of Porto. Her main research interests now are centered on the study of Biomolecules (polysaccharides and proteins) and their application in the Food Industry. She has published more than 30 papers in international peer reviewed journals.

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**Notes:**

Sarah Montes et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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## Keratin-based biomaterials

**Sarah Montes, Itxaso Azcune, Germán Cabañero, Hans Grande and Ibon Odriozola.**
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Currently, there is an increasing interest in the development of environmental friendly materials obtained from renewable resources. Poultry industry generates huge amounts of feather waste each year. Chicken feathers have high level of keratin content (up to 90%), a structural fibrous protein, which can become a suitable bio-resource of raw materials. Isolation of keratin protein from chicken feathers can be carried out by using different reducing agents which break down disulphide and hydrogen bonds of the keratin fibres to obtain useful materials. Other authors have combined feathers with reducing agents and plasticizers during melt blending for producing films with poor mechanical properties. In the present work, we show the use of keratin as raw material for the preparation of a fully bio-derived bioplastic by conventional processing techniques such as melt blending. Chicken feathers were processed by this technique together with suitable plasticizers and biobased plastics. The resulting materials were characterized in terms of thermal, viscoelastic and mechanical properties, showing their promising potential of substitution of conventional plastics.

### Biography

Sarah Montes has done her Degree in Polymer Chemistry and Master in Applied Chemistry and Polymers from the University of The Basque Country. Currently, she is a scientific research at IK4-CIDETEC specialized in the development of polymeric composites/nanocomposites, especially biobased polymers and in the characterization of polymeric materials. She has been the coordinator of the ECLIPSE European Project. She is the author and co-author of 5 scientific papers and 2 patents.

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**Notes:**

Asma Alhosni, J Bioremediat Biodegrad 2016, 7:6(Suppl)
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## MDBP- microbial degradation of bio-polymers

**Asma Alhosni**
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Over the last six decades, the use of plastic materials has had a major impact on our daily lives and has become essential for modern societies due to their extensive and diverse range of applications. However, the recalcitrant nature of many plastics means that they are problematic in terms of disposal and are a major industrial waste product and environmental pollutant. The use of biodegradable polymers can aid in resolving a number of waste management issues as they are degraded ultimately to $CO_2$ and water and can be directed to conventional industrial composting systems. Four different biodegradable polymers, namely polycaprolactone, polyhydroxybutyrate, polylactic acid and poly(1,4 butylene) succinate were used to study the time required for biodegradation to occur in soil and compost under laboratory conditions. Degradation of polymer discs was measured by monitoring changes in disc weight, thickness and diameter over a period of more than ten months at three different temperatures: 25°C, 37°C and 50°C. Degradation rates varied widely between the polymers and the incubation temperatures. Polycaprolactone showed the fastest degradation rate under all conditions and found to be completely degraded when buried in compost and incubated at 50°C after 91 days. Fungi from the surface of the polymers discs following colonization were isolated and identified by ITS rDNA sequencing.

### Biography

Asma Alhosni is a PhD student at the University of Manchester. She has completed her MSc from Nottingham University in UK. Currently, she is working as a Lecturer at the Higher College of Technology in the Sultanate of Oman.

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**Notes:**

Somayeh Mollasalehi, J Bioremediat Biodegrad 2016, 7:6(Suppl)
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## Influence of the water soluble polymer polyvinyl alcohol on compost and soil fungal communities

**Somayeh Mollasalehi**
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The water soluble biodegradable polymer polyvinyl alcohol (PVA) is widely industrially used in textile sizing and paper coating as well a variety of other applications. While some individual microbes and consortia capable of degrading PVA have been identified in the laboratory, there have been few studies that have examined its impact on naturally occurring microbial communities. In this research, terminal restriction fragment length polymorphism (TRFLP) were used to monitor changes in the fungal community profile in compost and soil at 25°C and 45°C following PVA addition over a six weeks period. In compost, the response to the presence of PVA was complex. At both 25°C and 45°C, in the absence of PVA, the community shifted over 6 weeks, with greatest change noticeable after 2 weeks. In the soil at 25°C, the community changed in the presence compared to the absence of PVA with the greatest shift in the community occurring after four weeks before returning to a profile similar to that seen in the absence of PVA after 6 weeks. Overall, this study has shown that PVA causes a significant shift in the fungal community with a number of T-RF's detected only in the presence of PVA. However, these were minor components of the community and the presence of PVA did not cause a major shift in the dominant species.

### Biography

Somayeh Mollasalehi has completed her PhD from the University of Manchester and is currently working as a Researcher at the University of Manchester, UK.

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**Notes:**

Farayde M Fakhouri et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Flexible edible films based on babassu: Physical and barrier properties

**Farayde M Fakhouri[1,2] José Ignacio Velasco[3], Amanda Dambrós Pereira[1], Silvia M Martelli[1], Marcelo Antunes[3] and Lucia Helena Inocentini Mei[2]**
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The trend towards environmental preservation and the need for new sources of raw materials to reduce dependence on oil are a major incentive for the development. The use of edible and biodegradable films obtained from renewable materials, thus reduce the use of petroleum-derived polymers. The babassu (*Orbignya sp*) is a palm of great socio-economic importance in Brazil, especially in the states of Maranhão, Piauí, Tocantins and Mato Grosso. The babassu consists of exocarp, mesocarp and endocarp. The mesocarp is composed of 60% starch. The starch structure resembles the structure of starch found in cereals such as corn. The starch is widely used in the preparation of biodegradable films for its thermoplastic capacity. The starch gelation temperature ranges from 63-73ºC, similar to corn starch, in addition to presenting a considerable amount of amylose. In this context, the objective of this study was to use the flour made from babassu mesocarp to produce biodegradable films by thermoplastic extrusion process. For the process, an extruder brand BGM (EL-25 model, SãoPaulo, Brazil) was used with the processing conditions demonstrated by Farayde (2009). For the preparation of the sample babassu mesocarp flour was used and as a plasticizer, 30% glycerol in relation to the mass of flour. After extrusion, the film was conditioned for 48 hours at 25°C and 50% RH so as to be characterized as to its thickness, permeability to water vapour (PWV) and for its solubility in water and acid. The film extrudate showed a dark coloration through the naked eye and was malleable to the touch and had an average thickness of 0.5353 mm. The babassu film was 100% soluble in acid and approximately 40% soluble in water.

## Biography

Farayde M Fakhouri is a Food Engineer at Universidade Estadual Paulista, and has done her Masters and PhD at the University of Campinas and Postdoctorate in the State University of Londrina in new materials for packaging. She is a Professor at the Federal University of Grande Dourados, Research Collaborator of the Department of Materials Engineering and Bioprocess of FEQ/Unicamp, member of the groups searches LMEI (Unicamp), MFBIOPACK (UFGD) and POLIBIOTEC (UEL), supervisor and founder of the Junior Company (EJIPTA/UFGD). Currently, she is at a postdoctoral program at the Polytechnic University of Catalunia at the Faculty of Materials Science and Engineering. Her experience is focused on packaging from renewable sources, thermoplastic extrusion and functional foods.

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**Notes:**

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# Physical and barrier properties of flexible films based on arrowroot obtained by thermoplastic extrusion

**Amanda Dambrós Pereira[1], Fabio Yamashita[2], Lucia H. Inocentini Mei[3], José Ignacio Velasco[4], Marcelo Antunes[4], Farayde M. Fakhouri[1,3]**
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The arrowroot is a plant from Latin America and is natively in Venezuelan forests. The size of the rhizomes is between 10 and 25cm are fusiform shape, elongate and have small segments, separated by light provided bottlenecks scales. The arrowroot can get to have 20% of starch and fibers remaining. Therefore the aim of this was to use trablho starch and arrowroot fiber for the production of biodegradable films by thermoplastic extrusion process. It was used glycerol, 30% relative to the weight of starch as platificante. Four samples were prepared, as follows: i) pure starch, ii) Starch + 0.5% fiber, iii) Starch + 1% fiber and iv) Starch + 1.5% fiber. Utilizing the BGM brand extruder (Model EL-25, SaoPaulo, Brazil) used and the processing conditions Fakhouri (2009). After extrusion the films were conditioned for 48 hours at 25°C and 50% RH, so that it was characterized for thickness, permeability to water vapor (PWV) and for its solubility in water and acid. The films with the naked eye showed a whitish and when colocaração greater the fiber concentration in the sample, the more resistance to the touch. The esperssuras were 0.2440; 0.3018; 0.6063 and 0.2760 mm respectively for sample i, ii, iii and iv. The PVA showed an increase with the increase in the fiber sample. Little difference was observed when 0.5% of fiber was added to amosta (range 12 to 13 g.mm/m2.d.kPa), when most fiber was incorporated into the film, a considerable increase in the vapor permeability water was observed, possibly due to possible rupture zones in the filmogenic matrix. The arrowroot starch films made arrowroot fiber were 100% soluble in acid and showed a 30% solubidade in water for pure starch film and 26.6266% for film with 1.5% fiber.

## Biography

Amanda Dambros Pereira is currently graduate in Food Engineering at the Federal University of Grande Dourados (UFGD), project director at Enterprise Junior UFGD of Food Engineering (EJIPTA), scholarship of scientific initiation by CNPq / UFGD and participant of the research group MFBIOPACK (UFGD). She has three completed scientific initiations (PIBIC and PIVIC). She has experience in the field of Food Science and Technology, with an emphasis on food technology, especially in Technology vegetables and edible packaging products and / or Biodegradable drawn from different sources of starch. She has training in Thermoplastic Extrusion.

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**Notes:**

Cristina Tostes Filgueiras et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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## Comparison of barrier properties and water and acid solubility of films based on collagen

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Collagen is an animal protein, and in the human body its function is to contribute to the structural integrity of the tissue. In the last decades it has been widely used in the food industry and, within this, also in catgut. In this context, the aim of this study was to observe the solubility in water and acid, as well as the barrier properties of pure collagen films and those who have immerse in a bath with antimicrobial agents before use in meat sausages. The films were characterized for thickness, water vapor permeability (PWV) and solubility in water and acid. The use of bath with antimicrobial agents did not cause a change in the thickness of the films (0,122 mm). An increase can be observed when water vapor permeability was observed, films that have passed through the bath had an WVP 35, 73, and the films without the treatment showed a value of permeability of 26,03 g.mm/m$^2$.d.kPa. When solubility in water and acid difference was analyzed, were observed differences between samples. Both exhibit a decrease in value when they pass through the bath showing that the bath influences the solubility of the films. Thus, the use of the bath , although not cause difference in thickness causes an increase in the permeability to water vapor and a decrease in water and acid solubility of the films.

### Biography

Cristina Tostes Filgueiras Graduated in Food Engineering from the Federal University of Viçosa (1992), Master of Agricultural Microbiology, Federal University of Viçosa (1996) and PhD in Food Science from the State University of Londrina (2009). It has experience in the field of Food Science and Technology and is currently Adjunct Professor III of the Federal University of Grande Dourados (UFGD) and Tutor Fellow Tutorial Education Program - PET / Food Engineering.

**Notes:**

Carmem Cicera Maria da Silva Campelo et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Viability study the use of glycerol transesterified in the production of biofilms

**Carmem Cicera Maria da Silva Campelo[1,2], Rafaela Silva Cesca[2], Roseane Sousa Silva[1], William Renzo Cortez-Vega[3], Gustavo Graciano Fonsecal[4]**
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The utilization of biodiesel as a renewable fuel is growing because of its contribution to the environment. The increase demand of biodiesel produces an increase of glycerin. Studies have purified the glycerin using chemicals treatments to eliminate residues and a physical treatment that eliminates the alcohol and water. New applications for glycerine have been studied as a plasticizer, this being used in the biofilm production. Was utilized glycerin derived from thermally degraded oils (soybean oil) used by 1h, 3h and 5h at 175°C. These samples were treated by evaporation and hydrolysis in order to remove impurities. After obtaining the glycerol was produced biofilms of fish protein (Pintado (*Pseudoplatystoma corruscans*)). Through the analysis was observed that the glycerin extracted of the oil used for 5 hours obtained higher yield because the impurities contained in parallel reactions. The characteristics physical-chemicals showed dependence with the time that the oil was degraded. Were too evaluated the properties of tensile strength, elongation and opacity of the biofilms, using commercial glycerin as standard. With the more pure glycerin, extracted of the oils analyzed, was observed a decrease of the elongation and a increase in resistance when compared with the commercial glycerin, this was due to low mobility of polymeric chains. The biofilm obtained by glycerin from the heated oil for 5 hours showed more flexibility in the structures of the film raising values of the elongation and reducing the tensile strength. The glycerin utilized don't caused difference significant the analysis of opacity compared to standard.

## Biography

Carmem Cicera Maria da Silva Campelo is a bacharelor's in chemistry from Universidade Federal do Piauí (2003), has Master in Chemisty at the same institution. She is a professor at the State University of Mato Grosso do Sul. Curretly she is at a phd student at program at the Faculty of Exact Science and Techology (FACET) at the Federal University Grande Dourados (UFGD). Her experience is based on chemistry with focus on Physical Chemistry, acting in cenostigma macrophyllum, lupeol and biodisel.

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# Physical and barrier properties of flexible films based on arrowroot obtained by thermoplastic extrusion

**Amanda Dambrós Pereira[1], Fabio Yamashita[2], Lucia H. Inocentini Mei[3], José Ignacio Velasco[4], Marcelo Antunes[4], Farayde M. Fakhouri [1,3]**

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The arrowroot is a plant from Latin America and is natively in Venezuelan forests. The size of the rhizomes is between 10 and 25cm are fusiform shape, elongate and have small segments, separated by light provided bottlenecks scales. The arrowroot can get to have 20% of starch and fibers remaining. Therefore the aim of this was to use trablho starch and arrowroot fiber for the production of biodegradable films by thermoplastic extrusion process. It was used glycerol, 30% relative to the weight of starch as platificante. Four samples were prepared, as follows: i) pure starch, ii) Starch + 0.5% fiber, iii) Starch + 1% fiber and iv) Starch + 1.5% fiber. Utilizing the BGM brand extruder (Model EL-25, SaoPaulo, Brazil) used and the processing conditions Fakhouri (2009). After extrusion the films were conditioned for 48 hours at 25°C and 50% RH, so that it was characterized for thickness, permeability to water vapor (PWV) and for its solubility in water and acid. The films with the naked eye showed a whitish and when colocaração greater the fiber concentration in the sample, the more resistance to the touch. The esperssuras were 0.2440; 0.3018; 0.6063 and 0.2760 mm respectively for sample i, ii, iii and iv. The PVA showed an increase with the increase in the fiber sample. Little difference was observed when 0.5% of fiber was added to amosta (range 12 to 13 g.mm/m2.d.kPa), when most fiber was incorporated into the film, a considerable increase in the vapor permeability water was observed, possibly due to possible rupture zones in the filmogenic matrix. The arrowroot starch films made arrowroot fiber were 100% soluble in acid and showed a 30% solubidade in water for pure starch film and 26.6266% for film with 1.5% fiber.

## Biography

Amanda Dambros Pereira is currently graduate in Food Engineering at the Federal University of Grande Dourados (UFGD), project director at Enterprise Junior UFGD of Food Engineering (EJIPTA), scholarship of scientific initiation by CNPq / UFGD and participant of the research group MFBIOPACK (UFGD). She has three completed scientific initiations (PIBIC and PIVIC). She has experience in the field of Food Science and Technology, with an emphasis on food technology, especially in Technology vegetables and edible packaging products and / or Biodegradable drawn from different sources of starch. She has training in Thermoplastic Extrusion.

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**Notes:**

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# Influence of adding microcapsules and oil and bacuri (Attalea phalerata Mart.) In optical and mechanical properties of films composed starchy

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Edible or biodegradable films are being increasingly used for preservation of fruits and vegetables and in some cases, as a partial substitute movies to oil derived base, thus contributing to environmental preservation. Oil from the Attalea phalerata Mart. known as bacurizeiro is rich in carotenoids. Thus the aim of this study was to evaluate two types of incorporation of this oil in movies arrowroot starch-based: i) crude oil and ii) microencapsulated oil by complex coacervation technique. The composite films were produced by casting technique in proportion 4 (starch): 1 (gelatin). The starch solution was prepared by solubilizing it, 10 g starch in 100 ml of distilled water at 85 °C. The gelatin solution was obtained using 5 g of gelatin in 100 ml of distilled water at 70 °C. Ten percent oil or microcásula bacuri oil, relative to the weight of the macromolecule has been incorporated the end filmogenic solution. The films were dried at 25 °C for 24 hours. The films were visually different coloring compared to the containing microcapsules were also more homogeneous to the naked eye. The films showed no brittle areas and were easy detachment of the drying rack. Films containing oil possessed a larger value of the chroma. The tensile strength and elongation of the films showed that the addition of microcapsules formed films with higher tensile strength that ranged from 17.13 to 48.49 MPa for the films containing oil and microcapsules, respectively, showing better incorporation when that property is assessed under the conditions studied.

## Biography

Farayde M. Fakhouri graduated in Food Engineering from the Universidade Estadual Paulista (UNESP), Master in Food and Nutrition, PhD in Food Technology from the University of Campinas (Unicamp) and Post Doctorate from the State University of Londrina (UEL ) in the area of new materials for packaging, with improvement in reactive extrusion in Univesité of Mons (UMONS) and currently performs post doctorate at the Polytechnic University of Catalonia (UPC) in the School of Materials Science and Engineering. She has published about 20 papers in reputed journals and has Been serving the editorial board member of an repute.

**Notes:**

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# Sustainable Bioplastics

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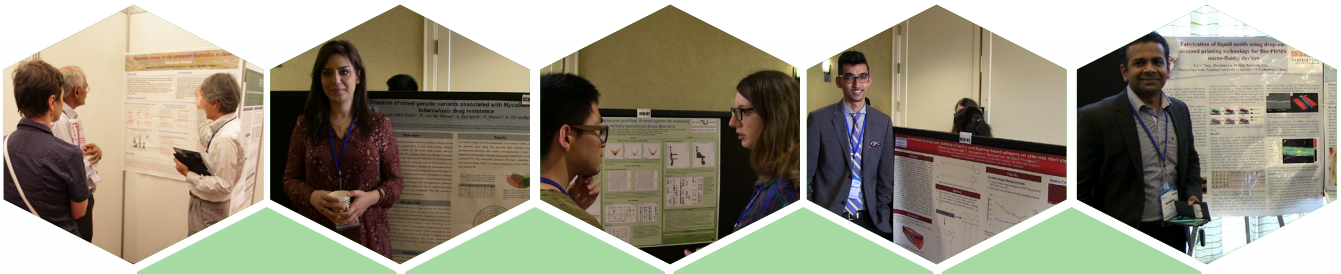
## e-Poster



Lúcia Helena Innocentini Mei et al., J Bioremediat Biodegrad 2016, 7:6(Suppl)
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# Thermal properties of biofilms obtained from epoxidized fatty esters *Pseudoplatystoma corruscans, mesopotamicus Piractus* and *Glycine*

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For the formation of a biofilm it is ideal that it is composed of at least a macromolecule such as starch (polysaccharide) and gelatin (protein). Biofilms obtained from these two types of polymers, indicate good mechanical properties and good barrier to gas vapour, $O_2$ and $CO_2$ present, little resistance to water vapour permeability, they are significantly soluble. An outlet for repairing such low permeability to water vapour is the inclusion of lipids to these polymeric bases. This study aimed to evaluate the thermal properties (DSC) films produced from lipophilic corn starch, gelatin (4:1) and ester fatty epoxidized (15% by weight of the starch) of two species of fish, *Pseudoplatystoma corruscans* (EPPI) and *Piractus mesopotamicus* (EPPA), and plant species Glycine max (EPSO). The determination of the glass transition temperature (Tg) analyses were performed by differential scanning calorimetry, using a TA Instruments calorimeter (USA), Model TA 2010. The sample film pattern composed of starch and gelatin showed only lower Tg two of the samples, 99.29°C except for sample EPPI which showed glass transition temperature 64.90°C, as another animal species, EPPA indicated two Tg ranges, 123.72°C and 136.19°C and EPSO indicated only approximately 122.96°C, or these temperatures, biofilms exhibit a change in physical properties of the starting material, which passes from a rigid state to a viscous state.

## Biography

Lucia Helena Innocentini Mei did her Graduation, Master and PhD in Chemistry from the State University of Campinas. She is Titular Professor in Polymer Science - UNICAMP, with emphasis on polymers: Biodegradable, biomaterials, composites and blends. She participated in the group of experts Pásticos Environmentally Degradable organized by ICS (International Center for Science and High Technology Trieste/Italy) -UNIDO (United Nations Industrial Development Organization). Her most recent research focuses on nanofibers and nanocomposites, natural or biodegradable polymers. She is developing projects with companies and State research institutions, such as Petrobras and private. She is a Winner of Inventor 2010 Petrobras Award.

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## What makes cellulose auxetic?

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The 1D bundles of cellulose microfibrils (lignified flax fiber) and 2D networks of cellulose microfibrils form tunicate, bacterial and microfibrillated celluloses were strained in tension, and their molecular deformation followed by Raman spectroscopy in order to fully understand the origins and magnitudes of in-plane auxetics for the information of innovation. Cellulose is found to exhibit three distinct yielding. Both crystalline and amorphous cellulose are found to be auxetic so long as intermolecular hydrogen bonding remains intact. Auxetics of crystalline cellulose is found to be around unity (-1) while that of cellulose amorphous is found to be around twice (-2) that of crystalline cellulose with the possibility of 1D bundles of cellulose microfibrils registering auxetics higher than -7 in the absence of lignin. Though 2D networks of cellulose microfibrils enhance strain to failure, they also significantly limit auxetics of single 1D cellulose microfibrils in networks. Differences in auxetics between crystals and amorphous must predominantly arise from differences in intermolecular geometry. Similarity of in-plane auxetics of cellulose to the off-axis auxetics of zeolites (especially thomsonite zeolites) indicates the possibility of combining both semi-crystalline materials to produce functionalized composites with photo-electromechanical properties.

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## Soy-based bio-nanocomposites: Evaluation of the processing conditions and nanoclay incorporation

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Bio-based plastics are composed by a biopolymer matrix, a plasticizer and some additives to improve the processability or properties of the final product, like nanoclay which is used to increase the water uptake of these biomaterials. For that reason, the overall objective of this work is to clarify the influence of nanoclay content (montmorillonite) in the mechanical and physicochemical properties of bio-nanocomposites obtained from soy protein. These materials were prepared by means of two different processes: an injection moulding process and an extrusion process, using in both cases soy protein (SPI) and natural montmorillonite (MMT-$Na^+$), being the nanoclay concentration and the processing conditions critical parameters to take into account. Thus, several systems were obtained and evaluated, containing from 0 to 9 wt. % of MMT. Bioplastics' mechanical characterization is performed by dynamic mechanical thermal analysis (DMTA) using a RSA3 rheometer and tensile tests by an electromechanical testing system. X-rays diffraction, confocal laser scanning microscopy (CLSM) and SEM were assessed to analyze the nanoclay incorporation into the material, as well as their structure. Moreover, water uptake capacity is an interesting barrel property which has also been evaluated. An increase in nanoclay content tends to create laminar structure, being this change in structure involved in remarkable changes in mechanical properties as well as in water uptake capacity (the presence of nanoparticles in the protein matrix can improve water uptake).

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## Characterization of biodegradable poly (propylene carbonate) for food packaging application

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The development of new generation of renewable materials, in particular, thermoplastic and biodegradable polymers are desirable for packaging and many other applications to tackle the major issues of disposing non-degradable polymers in landfills. Aliphatic biodegradable polymers such as poly(propylene carbonate) (PPC) can be considered as an alternative to non-degradable polymers. PPC is a partially renewable polymer from feedstock such as $CO_2$ and propylene oxide (PO). In this study, we assess the potential of PPC for food packaging application. To this context, we compared the physicochemical properties of PPC with commercial polymers such as low density polyethylene (LDPE) and poly (butyrate adipate terephthalate) (Eco-Flex) that are currently used for food packaging. Our results demonstrated that tensile modulus of PPC was three-fold more than biodegradable Ecoflex and comparable with non-degradable LDPE. Furthermore, tear resistance of PPC was five-fold higher than LDPE. More importantly, permeability of PPC to oxygen and water vapor was lower than these polymers. This property is pivotal for food packaging as it prolongs the food shelf life by reducing the spoilage rate. Finally, we confirmed that PPC is chemically resistance to a diverse range of food products such as juices, oils and alcoholic beverages due to the fact that its weight loss was negligible after six months in the food simulated media. Our results also showed that the degradation rate of PPC in landfill condition is comparable to biodegradable Eco-Flex. In summary, we demonstrated that PPC has superior properties to be contemplated as an alternative to polyethylene and other polymers for food packaging to reduce the environmental foot-print of non-degradable polymers.

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## RECURF: Re-using circular urban fibers and bio-based plastics in urban products

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Within the RECURF project the Amsterdam University of Applied Sciences studies how the combination of textile waste fibers and bio-based plastics can produce new materials with unique properties. These materials have distinctive characteristics and application possibilities. With the new materials innovative products can be developed. We are researching whether this generates an interesting circular business model, with both economic and ecological value. There is a growing focus at national level and in Europe on the transition towards a circular economy and closing the loop. The RECURF-project focuses particularly on the possibilities to process the new material combinations of bio-based plastics and textile residues in circular products for interior and exterior uses. Research is being done to: Mechanical and aesthetic properties of the composites; appropriate processing techniques and design strategies; environmental impact and end-of-life scenarios, circularity; and circular business models with an interesting value proposition and revenue model for the companies. Outputs include material samples and data sheets, inspiring examples of applications in the form of product prototypes and case descriptions and circular business models. Several companies are participating in the project. They represent the whole bioplastics chain. The use of fibers from residual flows can cheapen bio-based plastics and contribute to the improvement of functional features, such as strength, flexibility and isolation value. But above all, it produces materials with a unique look and feel and thus a new aesthetic quality. For producers and processors of bio-based plastics, it delivers new materials with opportunities and new markets.

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## Usage of petrochemical plastic vs. bioplastics: A proposal of sustainable education

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**Problem Statement:** Worldwide, there have been some advances in obtaining material from organic waste that can be substitutes of petrochemical plastics. Its importance is because the gas emission from the greenhouse effect is lower in the process of bioplastics than the petrochemical derivatives. From the Summit of Rio, the Protocol of Kyoto and the Copenhagen Accord, among others, propose guidelines in the usage of bioplastics to be incorporated in education programs from the first levels.

**Methodology & Theoretical Orientation:** Based on a documental analysis of international instruments of environmental policy such as the Copenhagen Accord and the previously mentioned; and scientific documents that leads towards the advantages of the bioplastics usage. The goal of this work is to propose guidelines for education programs, orientated towards the preference of this type of materials, being considered as an educational and cultural challenge.

**Results:** Copenhagen Accord, among others, promote the sustainability of the natural renewable resources and stimulate commitments of promoting education and sustainable investigation in technologies for developing countries and the mitigation of greenhouse gases. The scientific documents reveal that the bioplastics degenerate in few weeks, its manufacture implies less environmental pollution, less energetic consumption and unrenewable raw material, they don't contain harmful additives for health, they don't modify either the smell or the flavor of stiff food; as well as the emission of greenhouse gases in the petrochemical industries.

**Conclusion:** Relying on the environmental agreements of international cooperation for the promotion of sustainable education. Intensifying the investigation of the bioplastics, it makes possible the creation of biodegradable material industries.

**Recommendations:** Spreading in educational branches the advantages of the usage of bioplastics to promote its preference; extending the study to university level with the creation of careers, programs and doctorate that form professionals on developing biodegradable technologies, and specialization programs of sustainable education for teachers and professors in educational levels.

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## Ionic conduction mechanism study of plasticized carboxy methylcelluose biopolymer electrolytes

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The study of ion conduction mechanism in biopolymer is important for designing better performance of biopolymer electrolyte for electrochemical devices. A solution casting method was successfully used to fabricate a biopolymer electrolyte system consisting of carboxymethylcellulose (CMC) as polymer host, oleic acid (OA) as ionic dopant and glycerol (Gly) as plasticizer. The CMC-OA-Gly biopolymer electrolytes were characterized using electrochemical impedance spectroscopy to study the ion-conduction mechanism. The optimum room temperature conductivity achieved is $1.64 \times 10^{-4}$ S $cm^{-1}$ for sample containing 40 wt% Gly. Conductivity mechanism of this biopolymer system fits the small polaron hopping (SPH) model.

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## Highly efficient and versatile photoinduced thiol-ene crosslinking to prepare antibacterial and antioxidant materials derived terpenes

**Estelle Renard**
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Bio-based networks derived from eugenol were prepared with an eco-friendly process by photoactivated thiol-ene reactions. Allyl derivative eugenol, prepared by a nucleophilic substitution was combined with linalool, a monoterpene present in the lavender essential oil, well known for its antibacterial activity, with eugenol, or carvacrol, sustainable antioxidant molecule components of the essential oil of clove and oil of thyme, respectively. The photoactivated thiol-ene reaction is a quick room temperature straightforward way to obtain renewable cross-linked networks. Several systems have been developed including, covalent grafting of linalool, eugenol, or inclusion of carvacrol moieties to obtain functional materials. Two bacteria strains were used *in vitro* to evaluate the resistance to bacterial adhesion and the DPPH method was used to determine the antioxidant properties of the networks. As expected, the results showed a strong anti-adhesion activity against *S. aureus* and *E. coli* due to the presence of eugenol moieties and carvacrol release. Moreover, the phenol groups of grafted eugenol or free carvacrol provide an antioxidant activity characterized by a radical scavenging activity higher than 90%.

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## Thermal characterization of vegetable tannin reinforced TPU-based bio-composites

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The aim of this study was to investigate the use of vegetable tannin as a potential reinforcement material in polymer composites for the production of footwear sole material. For this purpose, the acorn cups and the waste of acorn obtained after the tannin extraction was used as the reinforcement material for thermoplastic polyurethane (TPU) based composites. Alkali treatments were applied for modifying the surface of acorn cups and pulps to increase the compatibility between the filler and polymer matrix. The preparation of the composites with different filler loadings (10, 20 and 30 wt%) was performed via hot melt extrusion. The effect of surface modification on the thermal and morphological characteristics of the bio-composites was investigated in terms of Fourier transform infrared (FT-IR) spectroscopy, differential scanning calorimeter (DSC), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM) analyses. The FT-IR results showed that the vegetable fillers were incorporated into the polyurethane matrix successfully and partial structural modifications were occurred as a result of the alkali treatments. Although the thermal resistance of composite materials at low temperatures was found slightly lower than the TPU, higher thermal resistance values were obtained at higher temperatures. Overall results showed that the homogenous dispersion of vegetable fillers within the polymer matrix was achieved successfully and the obtained bio-composite materials were found to be a good candidate to use as bio based footwear sole material.

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## Bio-based polymers based on fast pyrolysis bio-oil

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The use of biomass-based resources is currently a hot topic for both academic and industrial research as an alternative to mitigate the strong dependence on fossil carbon in the chemical and petrochemical industries. The US Department of Energy (DOE) and the US Department of Agriculture (USDA) have prioritized the development of bioenergy and bio-products; and they have the goal to produce 18% of the current US chemical commodities from biomass by 2020, and 25% by 2030. The macromolecular chemistry based on lignocellulosic feedstock represents one of the answers to the quest for polymeric materials capable of replacing their fossil-based counterparts. In particular, fast pyrolysis bio-oil is an excellent candidate for the bio-sourcing of polymeric resin. Their competitive cost, worldwide availability and built-in functionality have catapulted it use as a source of macromonomers for polymer applications. The development of this area has been carried out mainly through the reaction and functionalization of hydroxyl groups in the bio-oil to produce thermosetting resins such as: epoxy, phenolic, polyurethanes, etc. Thus, the main purpose of this project is to cover the major aspects related to the chemical synthesis, physical-chemical characterization and study of thermo-mechanical properties of bio-based resin, where highly functionalized components are synthetized by chemical modification. Results showed that this new bio-based polymeric systems display interesting properties that are close to their commercial counterparts.

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## Synthesis and characterization of bio-based telechelic polyesters

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The production capacity of biopolymers is expected to grow from 5.1 to 17 million tons in the next five years, doubling biopolymers share of the total polymer production. In the European Union, the biobased plastics market is expected to reach 5.2 billion euro in 2030. Some of the key drivers to get more biobased content into products will be new legislation, and consumers, brand owners and manufacturers demanding products that are more than just green and renewable. Among biobased polymers, linear polyesters such as poly(butylene succinate) (PBS) have been extensively studied as they can be synthesized from renewable feedstock. But there is still a need for new biobased aliphatic polyesters with reactive groups which can be utilized for crosslinking, further functionalization or to obtain block copolymers. This would allow to tailor properties, such as the melting point, crystallinity, glass transition and molecular weight, extending the range of PBS applications. The goal of this study was to synthesize telechelic PBS, with all monomers now being available from renewable resources. The endgroups were functionalized using crotonic acid (2-butenoic acid). It was selected for this purpose because of its alkene functionality and the possibility to access it from bio-based feedstock. New grafted biopolymer structures were obtained using two synthesis methods. The resulting polymers with reactive endgroups were characterized to determine their chemical structure and respective thermal properties. This work was funded by the Ministry of Business, Innovation and Employment of New Zealand.

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## Highly bio-based PLA sheet for high heat and transparent thermoformed containers- A breakthrough

**Michel Labonté**
Solegear Bioplastic Technologies Inc., Canada

Plastic or bioplastic materials used for rigid packaging are ideally transparent. Amorphous PET (aPET), developed over the past 30 years, is now the dominant material used in different markets. More recently, PLA a more sustainable material is sometimes used in the food market applications. Unfortunately, neither the fossil-based aPET nor the PLA can withstand temperature over 70°C, limiting their usage. Among semi-crystalline and opaque biopolymers, only clarified semi-crystalline PP has been the exception for decades. Now after long research, Solegear Bioplastics has developed a highly bio-based material with relatively high transparency (haze level <15%). This sustainable material is now available in large scale and can withstand boiled water (100°C) as well as a short stay in the microwave oven. Best of all, it is almost 100% bio-based or plant-based, introducing novel highly sustainable packaging material for rigid packaging applications for the food market.

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## Engineering at the nanoscale: A strategy for developing high performance functional materials

**Sabu Thomas**
Mahatma Gandhi University, India

The talk will concentrate on various approaches being used to engineer materials at the nanoscale for various applications in future technologies. In particular, the case of clay, carbon nanostructures (e.g. nanotubes and graphene), metal oxides, bionanomaterials (cellulose, starch and chitin) will be used to highlight the challenges and progress. Several polymer systems will be considered such as rubbers, thermoplastics, thermoetts and their blends for the fabrication of functional polymer nanocomposites. The interfacial activity of nanomaterials in compatibilizing binary polymer blends will also be discussed. Various self-assembled architectures of hybrid nanostructures can be made using relatively simple processes. Some of these structures offer excellent opportunity to probe novel nanoscale behavior and can impart unusual macroscopic end properties. I will talk about various applications of these materials, taking into account their multifunctional properties. Some of the promising applications of clay, metal oxides, nano cellulose, chitin, carbon nanomaterials and their hybrids will be reviewed. Finally the effect of dewetting up on solvent rinsing on nano scale thin films will also be discussed.

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## Balancing performance and sustainability in natural fiber-reinforced composites

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Natural and synthetic fibers have been used increasingly as matrix reinforcements in various applications. While the latter is popular for its generally superior mechanical properties, natural fibers are environmentally friendly and sustainable. As more businesses are inclining towards going green, natural fibers have been gaining increasing attention in recent years, often as a substitute or as a complementary to glass fibers. However, its utilization is usually bound to applications not requiring high mechanical performance. In this study, we investigate an extended use of natural fiber-reinforced polymeric composites to structural applications requiring higher mechanical performance, through hybridization with carbon fibers, aiming at a good balance between performance and sustainability. Having more than one fiber type in a polymer matrix can potentially give greater flexibility in achieving optimal material behavior and failure characteristics. Experimental investigation was carried out on various flax-carbon reinforced polymer hybrid systems fabricated using a custom-designed composites prepreg extrusion plant, suitable for large-scale industrial output, to impregnate fibers with a recyclable polymer, which are then hot-pressed, producing composite laminates with high fiber volume fraction. The hybrid composite's strengh and stiffness under tension and bending is assessed at various carbon fibre loadings to study the reinforcing effect of carbon in flax-polypropylene composite.

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## Cheese whey valorization for polyhydroxyalkanoates (PHAs) production

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Polyhydroxyalkanoates (PHAs) are biopolyesters produced by different bacterial species as energy storage; with respect to common bioplastics they have thermo-mechanical properties similar to those of traditional plastics, that make them potential alternatives to plastics in the future. Nowadays, PHAs production is limited by high production costs due to the use of pure cultures and standard substrates. To reduce these costs, agro-industrial wastes have been started to be used as substrate to feed mixed microbial cultures (MMC). In Lombardy Region (North Italy) about 3.3 million Mg of cheese whey (data of 2013) are produced yearly, that is about 36% of total Italian production and the 2.75% of the global production. Cheese whey, being largely and continuously produced and easily available, could be an interesting substrate for PHAs production to sustain the high demand of plastics of the market. In this work two fermented cheese whey (FCW) were used to produce PHAs by using MMC. PHA accumulation given for fermented FCW1 a PHA yield ($Y_{tot}$) of 0.24±0.02 mg $COD_{PHA}$ mg $COD_{Soluble\ Substrate(SS)}^{-1}$ and a total PHA production, referred to the substrate used, of 60 g PHA $kg_{cheese\ whey}$ total solids $(TS)^{-1}$. For fermented FCW2 results were: PHA yield ($Y_{tot}$) of 0.42±0.03 mg $COD_{PHA}$ mg $COD_{SS}^{-1}$ and PHA from substrate of 70 g PHA $kg_{cheese\ whey}$ $TS^{-1}$. Qualitatively, PHA from FCW1 was composed exclusively by polyhydroxybutyrate (PHB) contrarily to those obtained from FCW2 that were composed for 40% of hydroxyvalerate and for 60% of hydroxybutyrate.

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## Polyhydroxybutyrate and inorganic polyphosphate are essential in structure/function relationship of a cold/pain/steroid receptor TRPM8

**Eleonora Zakharian**
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Protein post translational modifications, such as glycosylation, acetylation, or phosphorylation, are widespread phenomena in cellular physiology. In our study, we focus on post translational modification (PTM) of a cold, pain, and newly recognized testosterone receptor, TRPM8 by a polyester comprised of repeated units of R-3-hydroxybutyrate, which forms a polymeric chain, poly-(R)-3-hydroxybutyrate (PHB). We term this modification PHBylation by analogy with the known protein modifications. However, PHBylation stands out of other PTMs that it is a covalent and permanent attachment of a large hydrophobic polymer that introduces significant conformational changes on the channel protein and therefore impacts its function. Along with PHB, we discovered that TRPM8 is modified with inorganic polyphosphate (polyP), where both polymers essentially contribute to the channel structure/function relationship. We found that PHB was critical for the temperature and ligand-induced TRPM8 channel activity. Furthermore, PHB mediated ligand binding to the channel, while polyP contributed to its voltage-sensitivity. These results indicate that TRPM8 functions in a form of supramolecular complexes with PHB and polyP. The formation of such complexes offers a new concept for model of a mammalian ion channel. It proposes indispensable roles of these PTMs, reflecting (a) temperature- or ligand-induced conformational changes that translate to channel gating; (b) proper protein folding and localization to the plasma membrane; and (c) PHB-poly P-rendered structure of anion-conducting core within the protein, which ensures ion selection and conduction along the uniform energy profile lining the internal cavity between both polymers.

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## Building a sustainable future with bioplastics

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It might be said that, in the beginning, bioplastics got off on the wrong foot and are still trying to make up for it. Back when bioplastics first started to make their appearance in the market, the emphasis was not on the merits and properties of these 'new' materials, but on the end of life. The idea that bioplastics could serve as a panacea, solving problems ranging from the leaching of toxins into the environment to the plastic soup took hold in the minds of the public, an image that has proven exceedingly difficult to dispel. When talking about bioplastics, the first important thing is to make completely clear what they are, and – importantly – what they are not. Understanding this makes it possible to grasp the real reasons why bioplastics are now finally emerging as real players in the industry. We are only at the start of their development, but as new technologies and new materials emerge, it is clear that the potential is massive. To build a future where people, nature, and the economy can all thrive, it is vital to change the way we interact with our resources. Sourcing materials responsibly to protect the ecosystems that we rely on to survive is critical. Bioplastics can play a crucial role as one of the building blocks of a sustainable, circular economy. Bioplastics can also offer a solid business opportunity in unlocking Europe's potential for a resource efficient economy - in which resource use is decoupled from growth. In this environment, bioplastics will be able to unfold their full economic and environmental potential, in Europe and elsewhere.

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## Degradation of PLA during long-term storage

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The degradation of PLA proceeds through hydrolysis of the ester linkages in the polymer backbone. This leads to a significant reduction of molecular weight and thus to a deterioration of mechanical properties. However, up to now there are no studies of PLA-hydrolysis performed under practical conditions and long-term storage. In this work, the influence of molecular weight, granule size, crystallinity, air humidity and temperature on the hydrolytic degradation of PLA was investigated. Two commercially available PLA types with different molecular weights were used in this study. Three different granule sizes were prepared through compounding with a co-rotating twin-screw extruder. The granules were annealed at defined temperatures so that crystallinity degrees in three different magnitudes were generated. Finally, all granules were stored at five different temperatures in the range from 10 to 50°C and a relative humidity of 33 and 75 % for six months. During this time, the viscosity of the samples was monitored with a rotational rheometer. A simple linear function was used to define the relationship between the weight average molecular weight and the zero viscosity in logarithmic form. By fitting the zero viscosity in the simplified kinetic equation, the degradation rate constants for each sample at each temperature were determined and used afterward in the Arrhenius equation to calculate the activation energy of the hydrolytic degradation for each sample. As most significant influences on the hydrolytic degradation of PLA, temperature and air humidity were identified. The degradation rate constants and therefore the rate of the hydrolytic degradation, increase significantly with increasing temperature and air humidity. Furthermore, small granules, high crystallinity and high molecular weight increase the activation energy and thus reduce the rate of PLA degradation during the long-term storage.

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## Starch-Yerba mate films - Biodegradability, antioxidant and plasticizing effect of yerba mate extract on cassava starch edible films

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Packaging has a key role in containing and protecting food since it is highly manipulated by producers and consumers. However, packaging materials are one of the main solid wastes in major cities of the world. Cassava starch constitutes a useful alternative to develop eco-friendly materials to replace that from petroleum due to its advantages such as biodegradability, low cost and availability. The incorporation of additives from natural sources into starch films is a new strategy to improve the shelf-life of food products and the functionality of a packaging. In this sense, antioxidants (yerba mate extract), proteins (from lentil) and micro/nano fillers (from lentil and starch) were investigated because the important properties that they can transmit to a food product such as antioxidant, anti-inflammatory and anti-mutagen, or protean effects, and as reinforcement of food packaging. Starch-glycerol films with antioxidants and protein presented improvements in the strain at break, showing materials with more flexibility, as a typical behavior of a plasticized film. The plasticizing effect of these additives was also confirmed from water vapour permeability, thermogravimetric and mechanic dynamic properties. The use of lentil microparticles and starch nanoparticles showed significant reinforcing effect. The effects observed on cassava starch based films, derived from the incorporation of antioxidants, protein and particles, makes us to think about the different potential uses of these films as coating and/or packaging of food products in order to retard their oxidation, avoid chipping or cracking during handling, increase their shelf life, and/or as reinforcement of their cover.

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