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BOOK OF ABSTRACTS

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Centro de Desarrollo de Productos Bióticos
— MÉXICO —

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Trainee Symposium in Development of Biotic Products 2026

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The Doctoral Program in Science in Biotic Product Development is an academic program of the National Polytechnic Institute (Instituto Politécnico Nacional, IPN) and is hosted at the Research Center for Biotic Product Development (Centro de Desarrollo de Productos Bióticos, CEPROBI). Its mission is to educate highly qualified professionals capable of conducting cutting-edge scientific and technological research on biotic resources and their products. The program advances this mission through key research lines, including plant biotechnology, the study of medicinal species, and the development of functional foods and nutraceuticals, with an emphasis on the valorization of agricultural materials and their by-products.

Research within the program focuses on generating frontier knowledge with tangible impact and meaningful engagement, benefiting both direct and indirect producers. In this framework, the Symposium offers doctoral students a valuable platform to present their research in a second language and to exchange ideas with other researchers.

The Second Edition of the Trainee Symposium in Development of Biotic Products was organized by CEPROBI, to whom I extend my sincere appreciation. I also recognize the Organizing Committee for its dedication and careful attention to every aspect of the planning process. On behalf of the Doctoral Program in Science in Biotic Product Development, I thank the academic community for its interest and participation. I hope this experience will continue to inspire the consolidation and strengthening of this initiative, always in accordance with the principles, philosophy, and values of the National Polytechnic Institute.

Dra. Silvia Evangelista Lozano
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CONCEPTUAL PRESENTATION

Analysis of control parameters on the molecular interaction of sorghum starch films, NCC, and glycerol

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The excessive global consumption of conventional plastics worldwide, along with the environmental management challenges associated with the control and disposal of plastic waste, represents a critical threat to both public health and ecological stability. Single-use plastics, especially those designed for food packaging and containers, remain among the most demanded materials and consequently the main contributors to the persistent accumulation of non-biodegradable waste. In response to this growing problem, the search for sustainable and biodegradable alternatives has intensified significantly over the last decades. Since the 1970s, the casting method has been widely adopted as a key technique for producing biopolymer films from biological raw materials. Among these materials, starch has been extensively studied due to its thermoformable behavior, natural abundance, low cost, and intrinsic ability to form continuous polymeric matrices. However, despite the widespread use of casting, scientific literature reveals substantial variability in the parameters employed for preparing film-forming solutions. Conditions such as stirring speed, agitation time, and gelatinization temperature are frequently adjusted according to the botanical origin of the starch, resulting in heterogeneous outcomes and complicating efforts toward process standardization. Furthermore, there is a noticeable lack of studies that clearly describe the direct correlation between the components of the film-forming solution, namely the base polymer, plasticizer, and reinforcing agents, and the control parameters applied during gelatinization, evaluated specifically from a molecular interaction perspective. This knowledge gap limits a deeper understanding of how these variables influence the final characteristics of biopolymer films, including their mechanical strength, thermal behavior, permeability, and structural homogeneity. Biopolymer films produced from sorghum starch (*Sorghum bicolor* (L.) Moench) have been characterized mainly through the evaluation of their physical, chemical, mechanical, and barrier properties. These characteristics can be enhanced through reinforcement strategies, particularly the incorporation of glycerol as a plasticizer and cellulose nanocrystals (CNC) as structural reinforcement. Therefore, assessing the effects of processing parameters on the molecular interactions among starch, glycerol, and CNC is essential for establishing clear relationships between formulation conditions and the resulting material performance. In this context, the present work proposes a comprehensive analysis of molecular interactions arising from variations in control parameters during the preparation of film-forming solutions. The objective is to determine how these conditions influence the physicochemical and morphostructural properties of sorghum starch-based biopolymer films reinforced with glycerol and cellulose nanocrystals, contributing to the development of more stable, efficient, and sustainable bioplastic materials.

***Aedes aegypti*: key vector in the transmission of diseases**

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Aedes (Stegomyia) aegypti is a species of mosquito widely distributed in tropical and subtropical regions around the world, below 1,700 meters above sea level. However, it has been recorded at higher altitudes, such as 2,250 meters, suggesting its high adaptability. It is considered an invasive species because it has several characteristics that confer it adaptive advantages over others, such as egg resistance and association with humans, mainly in urban areas with inefficient drainage and water supply systems that provide breeding sites. Rising global temperatures have allowed *Ae. aegypti* to spread and reproduce in areas that were previously considered too cold for its survival. It is an insect with a life cycle of 10 to 14 days, undergoing complete metamorphosis with egg, larva, and pupa stages, developing in an aquatic environment, and the adult stage in a terrestrial environment. Females are hematophagous, requiring blood proteins for egg production and are the main vector of the dengue, Zika, and chikungunya viruses, which cause thousands of cases of these diseases annually in Mexico. In 2025, the Ministry of Health reported 16,956 confirmed cases, with the states of Veracruz, Sonora, Jalisco, Sinaloa, and Guanajuato accounting for 56% of them. Effective monitoring and control of *Ae. aegypti* populations are crucial for managing disease transmission. Currently, integrated pest management is used, which consists of physical control through habitat modification by cutting vegetation around homes, protecting domestic containers, and eliminating breeding sites to prevent infestation, known as debris removal, as well as chemical control of larvae and adults. However, the indiscriminate use and mismanagement of these methods have led to vector resistance, making control difficult. This effect can be seen even in a few generations. The development of these resistance mechanisms is a complex and dynamic process, as mosquitoes can quickly evolve new ways to resist insecticides. This leads to a race between insecticides and mosquitoes, with insects evolving faster than new chemicals can be developed. This resistance hinders control initiatives and requires continuous monitoring and the development of new strategies for controlling this vector.

Squalene extraction from *Botryococcus braunii* cultures

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Squalene is a hydrocarbon used in preventive medicine for its anti-inflammatory, antioxidant, and anticancer properties. However, it is primarily obtained from shark liver oil, which is not a sustainable strategy. Therefore, alternative sources of squalene have been sought such as the use of plants, bacteria, fungi and yeast, nevertheless, the extraction yield of the hydrocarbons is low. The use of microalgae like *Botryococcus braunii*, which is found in freshwater and brackish ponds and lakes around the world, where it often can be found in large floating masses, represents another alternative source of squalene. *Botryococcus braunii* can synthesize hydrocarbons intracellularly and excrete them into the extracellular matrix, which reduces the density of the colonies thus leading to their floating on the water surface. The external hydrocarbon content in *B. braunii* reaches up to 86% of the dry biomass, of which 40% corresponds to the presence of botryococcines, squalene, and methylsqualene, all of which originate from presqualene diphosphate. Hydrocarbon extraction from *B. braunii* could be performed using chemical extraction such as the use of solvents particularly hexane. However, the cells and sub-colonies of *Botryococcus* are interconnected by gelatinous strands. In the case of *B. braunii* the colonial matrix of B-Race is composed of three distinct structural levels 1) each colony is enclosed in a sheath called the “the retaining wall”, 2) the intracolony space is filled with liquid hydrocarbon structured by a hydrocarbon network and 3) each cell is surrounded by a cell wall and various thin layers. For that, the use of solvents is not enough for obtaining high yields of hydrocarbons. So, the use of mechanical, physical and enzymatic methods as pre-treatment would disrupt the cell, allowing the solvent to get in contact with the intracellular lipids. In this research, the proposed methodology is to evaluate five methods of disruption and two solvent systems. Later the structure of the colony of *B. braunii* will be analyzed in optical microscope and the obtained images will be analyzed with imageJ to determine the possible changes that each pretreatment provoked to the colony, such as texture, area and dispersion of the individual cells. Subsequently the composition of metabolites will be analyzed by Thin Layer Chromatography and Fourier Transform Infrared (FTIR) spectroscopy with Attenuated Total Reflectance (ATR), while squalene quantification will be carried out by Gas Chromatography-Mass Spectroscopy. The results obtained will allow the establishment of strategies to obtain a higher squalene extraction yield compared to conventional methods.

Potato starch films with CNCs and ZnO nanoparticles for efficient CO₂ removal

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Atmospheric pollution by carbon dioxide (CO₂) poses a global and persistent threat to public health, as it is one of the primary greenhouse gases responsible for climate change. International air quality standards regulate the maximum emission limits for each productive sector; however, strategies specifically focused on gas capture remain limited compared to technologies applied in aquatic or soil environments. In this context, the development of biodegradable materials with CO₂-removal capabilities has emerged as a promising and sustainable alternative. Potato starch (*Solanum tuberosum*) has been extensively investigated as a base matrix for biodegradable biopolymer films due to its thermoplastic nature, availability, and low cost. However, its mechanical fragility and sensitivity to moisture limit its functional performance. To overcome these limitations, cellulose nanocrystals (CNCs) have been effectively incorporated, as they improve the mechanical and barrier properties of starch-based biopolymers by reinforcing the polymer network through hydrogen bonding and other molecular interactions. Likewise, zinc oxide nanoparticles (ZnO-NPs) have gained attention in environmental applications due to their stability, low toxicity, and photocatalytic behavior, making them suitable components for gas interaction systems. In this study, the rheological behavior of film-forming solutions containing reagent-grade potato starch, CNCs, and ZnO-NPs will be analyzed using viscoelastic modulation to determine the optimal conditions for producing composite films via the casting method. The films will be prepared using different concentrations of ZnO-NPs (1%, 3%, and 5% w/v), and their physical, mechanical, chemical, and barrier properties will be evaluated before and after exposure to CO₂ concentrations of 200, 500, 1000, and 1500 ppm for 24 hours in airtight acrylic chambers. This evaluation will help to determine their potential for CO₂ removal as a sustainable strategy to mitigate atmospheric pollutants. Additionally, the relationship between the internal microstructure of the materials and their CO₂-adsorption capability will be examined to better understand the mechanisms involved. Factors such as crystallinity, nanoparticle dispersion, polymer–filler interactions, and thermal stability will be analyzed to determine their influence on gas-removal performance. Complementary techniques, including Fourier-transform infrared spectroscopy, thermogravimetric analysis, and scanning electron microscopy, will be used to identify functional groups involved in gas interactions and to visualize morphological changes. Ultimately, this research aims to contribute to the design of environmentally friendly materials capable of improving indoor air quality and supporting the development of next-generation sustainable pollution-mitigation technologies.

Bioactive compounds from plant residues as inducers of cell migration and proliferation

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Fibroblast migration and proliferation are central events in cutaneous wound healing, where these cells repopulate the wound, contribute to extracellular matrix deposition, and support angiogenesis and tissue remodeling. Plant-derived bioactive compounds have gained increasing attention for their ability to modulate cellular physiology, particularly through antioxidant, antiinflammatory, and regenerative effects. Among these botanical sources, *Agave angustifolia* Haw., an abundant agricultural resource in Mexico, contains specialized metabolites such as β -sitosterol, saponins, and flavonoids with reported biological activity on skin cells. These compounds modulate key signaling pathways involved in the wound healing process, particularly those regulating inflammation and proliferation, positioning this species as a promising candidate for the development of sustainable products aimed at enhancing tissue repair. However, many plant based therapeutic options rely on harvesting specific plant vital organs, such as leaves, roots, or stems, which compromises plant survival and leads to long term sustainability challenges. For this reason, current strategies prioritize the use of agroindustrial residues as sources of bioactive compounds, promoting circular economy practices and reducing the ecological impact associated with traditional plant extraction. Despite the growing interest in plant extracts for enhancing fibroblast responses, there is limited conceptual integration regarding the mechanisms through which their phytochemicals modulate cell migration and proliferation. Current biological models highlight the role of growth factors derived from platelets and fibroblasts. Phytochemicals like β -sitosterol have been associated with the modulation of inflammatory mediators and stimulation of extracellular matrix synthesis. These processes suggest that extracts derived from *A. angustifolia* are capable of interacting with similar pathways, potentially accelerating fibroblast migration and proliferation *in vitro*. This conceptual presentation aims to integrate principles from cell culture, wound healing biology, and key methodological considerations for assessing fibroblast migration, including the scratch wound model.

Flavonoids: their role in wound healing

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A wound is an injury or loss of skin or tissue continuity caused by trauma or disease, and it remains a significant public health problem worldwide. The wound healing process can be complicated, with leading causes including diabetes *mellitus* and poor wound management. In addition, lifestyle habits such as poor diet, poor hygiene, physical inactivity, and stress compromise proper wound healing. Wound healing is a complex process that involves various physiological responses, including pain, inflammation, and scar formation. As researchers seek new molecules with pharmacological benefits, flavonoids have been extensively studied and shown to have multiple effects, including anti-inflammatory, analgesic, angiogenic, antioxidant, and re-epithelializing properties. These effects are demonstrated through biological studies, both *in vitro* and *in vivo*, including inhibition of proinflammatory cytokines, collagen synthesis, and pain pathways, such as nitric oxide. This work aims to explore how flavonoids modulate the molecular markers involved in healing. Wound healing occurs in four stages: homeostasis/coagulation, inflammation, proliferation, and remodeling. The first stage consists of forming a blood clot (made of platelets, cross-linked fibrin, and fibronectin) to stop blood loss and prevent infection. It also serves as a temporary extracellular matrix, stores growth factors, and facilitates the migration of vascular cells such as leukocytes and fibroblasts. Certain compounds, such as rutin, kaempferol, quercetin (flavonols), apigenin, and luteolin (flavone), participate in regulating different pathways and molecular markers throughout the healing process. During the inflammatory phase, they contribute to the upregulation of antioxidant enzymes like catalase (CAT), glutathione peroxidase, and superoxide dismutase (GPX), which help maintain reactive oxygen species (ROS) homeostasis. They also reduce inflammatory mediators such as tumor necrosis factor (TNF- α), interleukins (IL-1 β and IL-6), interferon (IFN- γ), prostaglandin E2 (PGE2), and cyclooxygenase (COX), while increasing anti-inflammatory mediators like IL-10. In the proliferative phase, flavonoids promote the release of various cellular factors, including interleukin-13 (IL-13), connective tissue growth factor (CTGF), and transforming growth factor beta (TGF- β), as well as fibroblast proliferation, thereby supporting tissue formation. During remodeling, flavonoids regulate matrix metalloproteinase (MMP) activity and participate in collagen synthesis and breakdown. This coordination of factors involved in tissue repair improves healing outcomes. By supporting wound healing, reducing inflammation, regulating reactive oxygen species, and promoting scar tissue formation, flavonoids could serve as an alternative for developing plant-based treatments for both acute and chronic wounds.

Natural deep eutectic solvents for the extraction of antioxidant bioactive compounds

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Currently, the pharmaceutical, food, and cosmetic industries have shown a growing interest in bioactive compounds extracted from plant matrices due to the diverse biological properties they offer. As a result, over the past 50 years, various extraction methods and solvents have been developed and employed to ensure the efficient recovery of target compounds. However, traditional methods often involve processes and solvents that pose risks to both the operator and the environment. In this context, the development of new “green” extraction solvents has become a necessity. In search for safer and more sustainable alternatives, Natural Deep Eutectic Solvents (NADES) have emerged as a promising option due to their low toxicity, biodegradability, stability, and ability to modulate their physicochemical properties. These characteristics have positioned them as ideal candidates for the extraction of various compounds, including those with antioxidant activity. Therefore, it is essential to demonstrate the effectiveness of NADES in extracting antioxidant compounds compared with conventional solvents, as well as to identify which NADES formulations are most efficient in maximizing extraction yield and antioxidant activity. Among the methodologies proposed to evaluate the effectiveness of NADES, the formulation of different mixtures incorporating salts, amino acids, diols, and organic acids in variable molar ratios is considered. These mixtures can be characterized through analyses of viscosity, polarity, pH, and conductivity to determine the properties most closely associated with their extraction capacity. To further enhance extraction yield, NADES may be combined with non-conventional techniques such as ultrasound-assisted or microwave-assisted extraction, evaluating different times, temperatures, and plant material/solvent ratios in antioxidant-rich plant matrices. In this research, qualitative and quantitative identification of target compounds using High-Performance Thin-Layer Chromatography (HPTLC) and spectrophotometric methods such as Folin–Ciocalteu is proposed. The antioxidant activity may be assessed using DPPH and ABTS assays, comparing the results obtained with those achieved using traditional solvents. Finally, the application of statistical analyses, such as ANOVA and post hoc tests, could allow the identification of significant differences between treatments and the correlation of NADES physicochemical properties with their extraction performance. Overall, this research aims to provide solid evidence of the potential of NADES as sustainable, efficient, and versatile alternatives for the extraction of valuable compounds from plant matrices, thereby contributing to the development of safer and more environmentally responsible processes.

Methodology for identifying microplastics in corn tortillas from the state of Morelos

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Mexico is the leading country in Latin America in terms of plastic waste disposal, having exported 11,212,367 metric tons between 1988 and 2018, representing 5% of the global total. However, 50% of this waste ends up in landfills, which causes environmental problems such as microplastic (MPs) pollution. The presence of MPs is currently known in different food groups. In beverages such as bottled water, beer, mineral water, iced tea, milk, energetic drinks, sodas, and wines, MPs such as polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), polyester (PES), polyamide (PA), and nylon, have been identified. In foods such as salt, sugar, soy sauce, vegetables, and seafood, the main type of MPs identified have been fibers. However, the presence of MPs in nixtamalized foods is unknown. Tortillas are a staple food in Mexico, with per capita consumption at 75.4 kg per year. This food can be purchased at various local establishments, as well as in commercial stores, and is commonly packaged in low-density polyethylene (LDPE) bags, which could release plastic particles or MPs into the food. The objective of the study was to identify and quantify the presence of MPs in tortillas, as well as to characterize them chemically. To achieve this objective, tortillas were purchased in commercial stores (A and B) and tortilla shops (C, D, and E) located in three metropolitan areas of the state of Morelos, namely Cuernavaca, Cuautla, and Puente de Ixtla. Samples of tortillas purchased were processed using chemical extraction to obtain the MPs, which were quantified by optical microscopy and identified by Fourier transform infrared spectroscopy (FTIR). With this study, we aim to contribute to the knowledge about the contamination of nixtamalized foods by microplastics.

Impact of physical exercise on the gut microbiota and the prebiotic potential of agavins

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The gut microbiota can be modified by various factors such as diet, environment, and physical exercise. Scientific evidence shows that moderate physical exercise modulates the gut microbiota, making it more diverse and functional than in sedentary populations, through mechanisms that are still being studied. However, intense exercise above 60-70% of VO_2max , poorly programmed exercise, poor post-training recovery habits, and the use of ergogenic aids can trigger dysbiosis, driven by physiological and oxidative stress associated with physical activity, which can compromise intestinal permeability, promote digestive discomfort, and consequently reduce athletic performance. Agave fiber, known as agavins, has been shown to have beneficial effects on human health by acting as a prebiotic, serving as a substrate for intestinal bacteria, and promoting the production of short-chain fatty acids (SCFAs) such as acetate, butyrate, and propionate. These metabolites help maintain the integrity of the intestinal barrier, thereby reducing inflammation and improving athletic performance. For athletes, fiber intake should be considered important, as they tend to consume large amounts of simple sugars with low fiber content, prioritizing refined carbohydrates to optimize glycogen and protein reserves and stimulate hypertrophy. Despite the importance of intestinal health in sports, there has been insufficient research to demonstrate the effects of dietary fiber supplementation on the microbiota and its relationship to athletic performance. Studies focused on this area could lead to the implementation of dietary interventions that improve intestinal health and, with it, the quality of training in this population. Therefore, the objective of this research is to evaluate the effects of agavins on the gut microbiota and physical performance in adults who exercise, and to investigate whether they can function as an ergogenic aid that modulates the gut microbiota in this population.

Therapeutic potential of secondary metabolites in diabetic peripheral neuropathy

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Diabetic peripheral neuropathy (DPN) is one of the most common and disabling chronic complications of diabetes *mellitus*. It is a disorder characterized by progressive damage to the peripheral nerves, mainly sensory nerves, as a result of sustained hyperglycemia and other pathogenic factors such as oxidative stress, inflammation, and microvascular dysfunction. Clinically, DPN can manifest as neuropathic pain, hyperalgesia, allodynia, numbness, loss of protective sensation, muscle weakness, and altered reflexes. These alterations affect the biopsychosocial spheres of the individual, since they lead to a significant decrease in quality of life, sleep disorders, and an elevated risk of diabetic foot ulcers, infections, and amputations. In Latin America, a pooled prevalence of DPN of approximately 45.8% has been reported in people with diabetes. In Mexico, the figures vary but are consistently high. Recently, national studies have reported prevalences ranging from 42.6% to 95% in patients with diabetes treated in health services. Currently, the treatments for DPN include pregabalin and duloxetine; however, they show limited efficacy (30% to 60%) and adverse effects, underscoring the need to explore natural, safe, and accessible therapeutic alternatives. The use of natural products as therapeutic alternatives has gained interest in the treatment of various diseases, including DPN. Some plants such as *Artemisia dracunculus*, *Cannabis sativa*, *Ginkgo biloba*, and *Phoenix dactylifera* have shown antihyperalgesic effects in murine models of DPN; however, they usually require high doses, with no hypoglycemic effects, and not acting directly on the pathways activated by hyperglycemia, which limits their clinical application. Secondary metabolites have also demonstrated therapeutic potential in models of neuropathic pain. Among them are the flavonoids, terpenes, alkaloids, phenols, and carotenoids, which are capable of modulating pain-related mechanisms. The compounds such as quercetin, chlorogenic acid, and rutin act as opioid receptor agonists having a potent antioxidant activity. Similarly, tannic acid, a triterpene, exhibits antinociceptive effects associated with its anti-inflammatory action, while gersenisin, an alkaloid, promotes myelin repair by regulating pro-inflammatory mediators such as TNF- α . Other compounds, such as hydroxytyrosol, may alleviate diabetes-induced neuropathic pain. Despite their potential, these metabolites require further research about their safety, mechanisms of action, and efficacy for their therapeutic application in DPN.

Localization of hydrogen peroxide in plant tissues: principles and applications of the DCFH-DA technique

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Reactive oxygen species (ROS) are highly reactive forms of molecular oxygen, including free radicals with one or more unpaired electrons, such as superoxide (O_2^-), hydroperoxyl (HO_2), hydroxyl ($OH^\cdot$), peroxy (ROO_2), and alkoxy (RO), as well as non-radical derivatives such as singlet oxygen (O_2), ozone (O_3), and hydrogen peroxide (H_2O_2). Reactive oxygen species (ROS) are produced during oxygen metabolism and act as physiological regulators of various cellular processes. If ROS levels exceed the antioxidant system's capacity to eliminate them, their accumulation causes oxidative stress, which can damage proteins, lipids, and even nucleotides, leading to severe cell damage or death. Among ROS, hydrogen peroxide (H_2O_2) in plants is relatively stable, allowing it to cross cell membranes. This molecule plays a fundamental role in regulating plant biological processes, such as growth, development, and senescence. It also participates in plant defense mechanisms against biotic and abiotic stresses. To better understand the role of H_2O_2 in plants, both qualitative and quantitative techniques have been developed. This work describes the basis of a technique that uses 2',7'-dichlorodihydrofluorescein diacetate (DCFH-DA) to localize H_2O_2 in plant tissues, highlighting its applications in plant biology. The basis of this technique lies in the lipophilic and non-fluorescent properties of DCFH-DA, as well as its ability to penetrate cell membranes. Once inside the cytoplasm, esterase enzymes remove the acetyl groups, converting them into 2',7'-dichlorodihydrofluorescein (DCFH), a non-fluorescent molecule. This remains trapped within the cell and is oxidized by H_2O_2 , producing 2',7'-dichlorofluorescein (DCF). This molecule is highly fluorescent and can be detected using a fluorescence microplate reader (fluorimeter), which is used to quantify total oxidative stress by measuring the intensity of fluorescence generated by DCF. Another tool is flow cytometry, which is used to quantify and analyze fluorescence, cell by cell, thus determining ROS levels in cell populations and simultaneously in individual cellular events. Another analysis to observe DCF activity is performed using confocal microscopy. Thanks to a FITC filter system, the fluorochrome is excited at approximately 460 nm and emits fluorescence at approximately 520 nm. This generates green DCF fluorescence within cells, providing qualitative images of ROS distribution in plant tissues. These analyses can be combined to obtain more precise data on the function of reactive oxygen species, and specifically hydrogen peroxide, in plants.

Modulating intestinal dysbiosis: the role of live probiotics, diet, and encapsulation

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Intestinal dysbiosis, defined as an imbalance in the composition, diversity, or function of the gut microbiota, has been identified as a central driver in the pathogenesis and progression of numerous non-communicable chronic diseases, including obesity, type 2 diabetes, cardiovascular disorders, inflammatory bowel disease, metabolic syndrome, and even neuropsychiatric disorders. This dysbiotic state disrupts intestinal barrier integrity, leading to increased permeability (“leaky gut”) and the translocation of microbial components, such as lipopolysaccharides (LPS), into the bloodstream. This process triggers chronic low-grade systemic inflammation and impairs the production of critical microbial metabolites, particularly short-chain fatty acids (SCFAs), like butyrate, which are essential for maintaining epithelial homeostasis, regulating immune responses, and supporting gut–brain axis communication. In this context, nutritional strategies are key in modulating microbiota. While postbiotics offer benefits such as increased stability and safety, it remains essential to preserve viable probiotic bacteria, as their beneficial effects, including SCFA production, competitive exclusion of pathogens, reinforcement of tight junctions, and active immunomodulation, depend on metabolic activity that cannot be replicated by inactivated cells. To ensure effective delivery and functionality, advanced formulation technologies are needed. Among these, microencapsulation has emerged as one of the most promising and widely recommended approaches. It protects viable probiotic bacteria from gastric acidity and digestive enzymes, significantly improving their survival through the upper gastrointestinal tract and enabling targeted release in the colon, where they exert their health-promoting effects. Moreover, symbiotic co-encapsulation systems, which combine probiotics with prebiotic fibers and functional foods with prebiotic potential, not only enhance bacterial viability but also generate synergistic effects that amplify metabolic, anti-inflammatory, and barrier-protective outcomes. These integrated biotic formulations represent a rational and innovative strategy in functional nutrition, holding significant promise for restoring microbial balance, reducing systemic inflammation, and supporting the prevention or adjunctive management of chronic diseases linked to gut dysbiosis. Importantly, the efficacy of such systems hinges not only on selecting of compatible strains and prebiotic substrates but also on the physicochemical properties of the encapsulating matrix, which must ensure stability during storage and allow controlled release under intestinal conditions. Continued research into optimized delivery platforms is therefore crucial to translating the therapeutic potential of probiotics into reliable clinical and public health benefits.

RESEARCH RESULTS PRESENTATION

High-energy mechanical processing to improve the functionality of a *Hibiscus sabdariffa* beverage

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Nowadays consumers demand foods that, in addition to their nutritional value, offer health benefits. This has driven the use of sustainable technologies, especially non-thermal processes, to preserve or increase bioactive compounds without affecting sensory quality or safety. These treatments are known as high-energy mechanical processing, including ultrasound (US) and high-pressure methods such as high-pressure homogenization (HPH) and ultra-high-pressure homogenization (UHPH). These mechanical treatments are used in the microbiological control of food, but they have also been observed to increase the availability of bioactive compounds. Roselle (*Hibiscus sabdariffa* L.) is a traditionally used plant with culinary and therapeutic applications, particularly for blood pressure control. This plant is mainly used to prepare beverages for its taste, but also to take advantage of its bioactive compounds' health benefits. The objective of this study was to determine the impact of high-energy mechanical processing on the functionality of an *H. sabdariffa* beverage. The *H. sabdariffa* beverage was subjected to HPH at 100 MPa, UHPH at 100 and 200 MPa, and US treatments. The functionality of the *H. sabdariffa* beverages was measured as anthocyanin content, total phenolic compounds, antioxidant capacity, and angiotensin-converting enzyme inhibition percentage of the beverages and their digestion products, obtained using INFOGEST 2.0. The results showed there was no significant difference in the phenolic content of the beverages subjected to high-energy mechanical processing compared to the untreated beverage ($p > 0.05$), but there was a significantly higher content in their digestion products. Treatment with UHPH at 200 MPa increased the availability of anthocyanins, and all mechanical treatments increased the resistance of anthocyanins to digestion. The beverages subjected to mechanical treatments, as well as their digestion products, showed greater antioxidant capacity by the DPPH and FRAP methods, except for the US treatment in the FRAP method, where there was no difference compared to the untreated beverage. All beverages and their digestive products showed high inhibition of angiotensin-converting enzyme. In conclusion, the UHPH treatment at 200 MPa improved the functionality of the beverage as well as the bioavailability of bioactive compounds. The relevance of this study lies in being the first to use high-energy mechanical processes to improve the functionality of *H. sabdariffa* beverages.

Characterization of Agavins and *Drosophila melanogaster* glue to analyse its potential as a new bioadhesive

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Within medicine and dentistry, there is an increasing demand for advanced adhesive systems that can serve as tissue glues or minimally invasive alternatives to traditional surgical techniques. A promising research direction focuses on bioadhesion mechanisms found in nature. This study adopts a comparative approach to investigate the adhesive properties of two natural biomaterials: pupal glue from *Drosophila melanogaster* and agavins from *Agave angustifolia*. *Drosophila melanogaster* larvae secrete a protein-rich glue to attach securely to surfaces before pupation, exhibiting adhesion strengths between 137 and 244 kPa on both hydrophobic and hydrophilic substrates. Although several glue-related genes have been identified, their roles in secretion, adhesion, and hardening remain unclear. Conversely, *A. angustifolia*, widely used in Mexican folk medicine, produces agavins, a complex β -fructans known for their technological capabilities of gel-forming and crosslinking. The aim of this project was to analyze the adhesive properties of each biomaterial and assess whether their combination could yield a novel, non-toxic, biodegradable tissue adhesive suitable for diverse surgical applications. Purified agavins were obtained via ion-exchange chromatography, and an 80% agavins formulation with BDDE as a crosslinking agent was selected for its gel-like consistency. Fly glue was collected from attached pupae and larval salivary glands using optimized protocols. Physicochemical and morphological characterization were performed using FTIR, ESEM, DSC, and nanoindentation, while cytotoxicity was evaluated on L929 fibroblast cells via MTT assays following ISO-10993 guidelines. FTIR confirmed carbohydrate purity in agavins (C–O–C peaks at 900–1200 cm^{-1}) and protein presence in fly glue (amide and N–H signals). ESEM and confocal microscopy revealed distinct structural features, including a protein-rich network in fly glue. DSC analysis showed thermal transitions at 47.5 °C, 53.4 °C, and 60.94 °C for controls, while purified agavins remained stable up to 150 °C. Composite samples exhibited increased melting points (50.03 °C, 57.44 °C, and 63.35 °C) and higher enthalpy values (up to 11.10 J/g), indicating stronger intermolecular interactions and improved thermal stability. Cytotoxicity assays revealed no significant morphological alterations, confirming biocompatibility. These findings demonstrate that combining agavins and *Drosophila* glue enhances adhesive and thermal properties, supporting their potential as next-generation surgical tissue adhesives that are biodegradable, non-toxic, and effective for clinical use.

Flavonoids-Enriched fraction from *Baccharis conferta* modulates inflammasome-related interleukins in an acute kidney injury model

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Acute kidney injury (AKI) is a clinical syndrome characterized by sudden and reversible loss of kidney function. This disorder involves an accumulation of reactive oxygen species (ROS), which in turn activates proinflammatory molecular pathways. Redox imbalance can activate transcription and, consequently, the NLRP3 inflammasome, promoting the maturation and release of IL-1 β , initiating neutrophil and macrophage recruitment, and amplifying the inflammatory response. Subsequently, IL-6 participates as an effector cytokine, contributing to tubular and glomerular dysfunction. It is worth noting that some flavonoid compounds can reduce ROS, thus indirectly decreasing the activation of pro-inflammatory interleukins. *Baccharis conferta* Kunth is a source of molecules with relevant antioxidant and anti-inflammatory activity. Therefore, the objective of this study is to evaluate the genetic response to a flavonoids-enriched fraction (Fef) in a murine model of AKI by measuring IL-1 β and IL-6 gene expression and ROS levels. Flavonoid identification was performed using LC-MS. Male NIH Swiss mice were used, and AKI was induced by administering a single dose of 5 mg HgCl₂/kg. Four treatment groups (n=6) were analyzed: (1) vehicle with 0.1% Tween administered orally, (2) HgCl₂ + vehicle, (3) 20 mg/kg Fef, and (4) 20 mg/kg Fef + HgCl₂. Reactive oxygen species (ROS) were measured using a fluorometric method with 2',7'-dichlorodihydrofluorescein (H₂DCF-DA). Gene expression was assessed by real-time reverse transcription polymerase chain reaction (RT-qPCR). Administration of Fef decreased IL-1 β gene expression by ~60% in the pro-inflammatory response to HgCl₂-induced inflammation, while IL-6 expression was reduced by ~28%. IL-1 β can indirectly influence IL-6, acting as part of a key inflammatory mechanism to counteract its effects at the tissue level. These results suggest that Fef acts as an electron donor, neutralizing free radicals, thus reducing ROS levels (35%), while simultaneously reducing oxidative stress and regulating the expression of some transcription factors, such as NF- κ B, involved in the expression of IL-1 β , IL-6, and TNF- α . Fef contains the flavonoid cirsimaritin as its main constituent; this molecule may donate electrons, preventing oxidative damage to lipids, proteins, or DNA. Fef treatment reduces oxidative stress, thereby breaking the inflammatory cycle at the gene expression level, which could ultimately affect renal tissue structure.

Environmental factors influencing endogenous phytohormone accumulation in *Pouteria campechiana* seeds

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Plant hormones, or phytohormones, are low-molecular-weight organic compounds that regulate plant development, growth, and stress tolerance. Their biosynthesis, distribution, and activity are mainly determined by environmental conditions: temperature, humidity, and light, which contribute to the plant's morphological and physiological variability. In addition, abscisic acid (ABA), gibberellins (GA), auxins (IAA), and cytokinins are essential phytohormones that accumulate during embryogenesis and ultimately affect seed dormancy, germination potential, and seedling emergence rate. Numerous studies show that the mother plant largely determines the initial levels of these regulators. *Pouteria campechiana* is a fruit tree in the Sapotaceae family, also known as the yellow sapote or canistel. It is endemic to southeastern Mexico and is currently regarded as an underutilized species. It is a species that exhibits high morphological variability and early germination, known as viviparity. This study aimed to assess the effects of maternal phenology and environmental factors on endogenous phytohormone levels in *P. campechiana* seeds. Seeds from three regions in Morelos—Jiutepec, Yautepec, and San Isidro—were germinated in agrolite across five developmental stages. The environmental, climatic and phenological variables from each region were compiled, standardized, and integrated into a factorial analysis to understand their relationships with phytohormone accumulation. Each stage's seeds were freeze-dried, ground, and extracted with methanol, then purified using C18 cartridges. ABA, GA₃, IAA, and t-zeatin were purified and quantified by TLC and densitometric analysis. The results revealed apparent spatial and temporal variation in phytohormone concentrations. The region of Jiutepec showed the highest levels of growth-promoting phytohormones (IAA, GA₃, and t-zeatin) and a significant incidence of viviparity. Climatic factors, such as humidity, precipitation, and temperature, explained these differences. The factorial analysis identified three environmental and phytohormonal axes that explain the disparities among regions. This demonstrated that germination in *P. campechiana* depends on the combined effects of both climate and endogenous regulation, as evidenced by decreasing ABA levels and elevated IAA associated with premature germination. The study clarifies how environmental factors affect viviparity in *P. campechiana* and advances our knowledge of the hormonal profiles typical of recalcitrant tree seeds. These findings encourage the creation of new approaches to control germination and protect neglected tropical species. Overall, they support the development of strategies to manage germination and conserve underutilized species.

Wheat pasta with a high dietary fiber content and its relationship to quality characteristics

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Durum wheat pasta is a food matrix composed of a network of proteins (gliadins and glutenins) that envelop the starch granules, giving the product firmness after cooking. Durum wheat starch with high-amylose content ($\geq 50\%$) has molecular and structural characteristics that differ from those of normal and waxy starches, thereby, affecting the nutritional properties and technological quality of pasta. High-amylose starches exhibit limited swelling during cooking, leading to partial disorganization and reduced enzymatic hydrolysis, as they reach the colon for fermentation by the microbiota, similar to dietary fiber. The objective of this research was to determine the total dietary fiber and resistant starch contents of pasta made with high-amylose durum wheat (HAP) and to relate them to the pasta's quality characteristics. The pasta was made by sheeting, using commercial durum wheat semolina as a control sample (CP). Resistant starch and integrated total dietary fiber were assessed according to Megazyme kits. All analyses were performed in triplicate. The quality of the product was evaluated by cooking quality (optimum cooking time and cooking loss) and firmness using the texture analyzer. The integrated total dietary fiber content was higher in HAP (11%) than PC (4%). The integrated total dietary fiber components were pectin, cellulose, hemicellulose, lignin, resistant oligosaccharides and included resistant starch. The high-amylose starch presented a compact structure with high enzymatic resistance. The resistant starch, considered part of dietary fiber, had a higher HAP content than PC due to its limited swelling capacity, resulting in a smaller volume within the food matrix. HAP required 3 min more of cooking and presented higher cooking losses than CP, but its firmness was lower, requiring less cutting force because network proteins-starch discontinued by the high dietary fiber content that limit the interactions between the proteins with gelatinized starch. HAP could be an alternative for producing food with high dietary fiber content and specific quality characteristics.

Morphological and mechanical characterization of Ecovio® bags added with agricultural waste

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Currently, minimally processed agricultural products are packaged in bags made from synthetic polymers, which cause environmental pollution. In addition, food packaging can be an important source of contamination by organic additives used in its manufacture, which probably migrate into food. Therefore, in recent decades, biodegradable packaging has been developed using natural polymers such as starch and gelatin, and polyesters such as polylactic acid (PLA) and polybutylene adipate-co-terephthalate (PBAT). Recently, the commercial resin Ecovio® has been used to produce biodegradable packaging. Incorporating agricultural waste into this commercial resin would help to reduce costs, by adding value and contributing to the circular economy. Furthermore, agricultural waste, as part of a polymer matrix, works as a filler, which changes the mechanical properties of the pure resin. The objective of this study was to investigate the effect of adding orange peel flour (OPF) or nopal flour (NF) on the morphology and mechanical properties of bags made with Ecovio® for further application as packaging for minimally processed products. SEM images of cross-sections of pure Ecovio® bags revealed a heterogeneous and rough surface, with the presence of amorphous microstructures characteristic of a biphasic resin like Ecovio®. The formulations with 3 y 5% of NF showed an apparently homogeneous surface, although micropores were present. The NF was well distributed within the polymer matrix, which contributed to the surface homogeneity. The OPF microparticles appeared to be embedded in the Ecovio® resin, suggesting good interfacial adhesion and better phase compatibility. The mechanical properties of the bags indicated that the addition of canola oil decreased the Young's modulus and increased the elongation at break (plasticizing effect) compared to pure Ecovio®. Comparing Ecovio® and flours with the same percentage (3% or 5%), a similar Young's modulus value was obtained; however, the value of elongation at break was increased, for the bags containing OPF compared to those containing NF. Similarly, a higher percentage of flour resulted in lower elongation at break, due to the reinforcing effect of the filler (flours). Finally, the highest elongation at break (526.35 ± 33.40 MPa) was for the Ecovio® bag with 5% OPF therefore, this formulation could be the best option as flexible packaging for vegetable preservation.

Hierarchical structure of banana starch

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This study examines the multiscale structural organization of starch granules from banana varieties, addressing the limited information available on their micro- and nanoscale architecture. Reported studies indicate wide morphological diversity in banana starch depending on the features and understanding granule shape, surface roughness, and the internal arrangement of growth rings is essential for linking structure with physicochemical, functional, and digestibility characteristics. The objective of this work was to characterize the morphology, size distribution, and internal structural organization of starch granules using atomic force microscopy (AFM), laser diffraction, and confocal microscopy. Starches from four genotypes (Enano gigante, Morado, Macho, and Dominico) were isolated and analyzed by AFM to evaluate nanoscale topography, block dimensions, and hardness distribution, by laser diffraction to determine particle size parameters (D10, D50, D90); and by confocal microscopy with APTS labeling to visualize concentric growth rings, hilum position, and birefringence patterns. AFM revealed remarkable pronounced structural heterogeneity between genotypes. The blocklet sizes ranged from 20 to 38 nm, consistent with the blocklet model of starch organization. Enano gigante exhibited the highest roughness (38 nm), indicating lower compactness and a highly heterogeneous whereas Dominico and Macho showed lower roughness (20 nm), suggesting denser and more orderly surfaces. Morado presented intermediate roughness, characterized by pronounced peaks and depressions that imply a higher proportion of amorphous regions. AFM mapping further highlighted variations in nanoscale hardness and relief within granules, reflecting internal heterogeneity. Laser diffraction revealed unimodal particle-size distributions with D50 values ranging from 16.86 to 26.07 μm across all genotypes. The isolation procedure influenced the distribution, because granules larger than 40 μm were retained during sieving. Light microscopy revealed substantial variability in granule geometry: Morado and Macho showed elongated, filamentous granules, whereas the remaining varieties were predominantly oval or lenticular. Confocal microscopy revealed smooth, intact surfaces, well-defined concentric growth rings, and characteristic birefringence patterns. Enano gigante and Dominico exhibited centrally located Maltese crosses, while Morado and Macho showed birefringence shifted toward the equatorial region, likely due to the anisotropic crystal orientation. In conclusion, this study provides the first AFM-based structural characterization of native banana starches and demonstrates substantial diversity in granule size, shape, roughness, and crystal orientation. These structural differences may influence hydration behavior, gelatinization, susceptibility to enzymatic hydrolysis, and overall functional performance during food processing, offering valuable insights for potential industrial applications.

Bioactive compounds of *Tilia americana* in a reserpine-induced Parkinson's disease model

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Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects more than 8 million people worldwide, it leads to significant motor impairment, primarily due to the degeneration of dopaminergic neurons. Current therapeutic approaches focus on mitigating dopamine depletion in the brain, including the use of monoamine oxidase B (MAO-B) inhibitors, an enzyme responsible for the oxidative deamination of monoaminergic neurotransmitters. Although these drugs are clinically effective, their use is often limited by adverse side effects. Consequently, the search for novel molecules, particularly MAO inhibitors and anti-Parkinsonian agents derived from medicinal plants, remains an active and promising area of investigation. The aim of this study was to isolate bioactive compounds from *Tilia americana* and determine their binding affinity energies (ΔG) toward MAO-A and MAO-B using contemporary *in silico* prediction tools, specifically molecular docking. These affinity values were used to identify the most promising candidates, which were then evaluated using an *in vivo* model of reserpine-induced Parkinsonism to determine their therapeutic potential. To achieve this, a methanolic extract (Ta-MeOH) was prepared from the leaves of *Tilia americana*, from which 14 constituents were isolated. Compounds (1–7) were identified as terpenes, (8–9) as flavonoids, compound (10) as a carbohydrate, and compounds (11–14) as phenolic derivatives. These molecules were subsequently assessed by molecular docking against MAO-A and MAO-B, employing the corresponding crystallographic structures retrieved from the Protein Data Bank, co-crystallized with harmine and safinamide, respectively, which served as reference ligands. The results showed that the compounds with the highest affinity for MAO-B were (6) with a ΔG of 10.8733 kcal/mol, followed by (7) with a ΔG of -11.1434 kcal/mol and then (8) with a ΔG of -12.1866 kcal/mol. In CF-1 mice, reserpine administration induced weight loss and significant behavioral alterations, as determined by the Irwin test. Motor impairment was evidenced by open-field and rotarod assessments. The Ta-MeOH extract mitigated these effects by promoting behavioral recovery, restoring body weight, and improving motor activity. Compound (6) exhibited a particularly notable effect on motor function, whereas compound (8) produced beneficial outcomes on both behavioral deterioration and weight loss. Overall, *Tilia americana* and the isolated constituents emerge as promising candidates for the development of interventions targeting the deterioration associated with Parkinson's disease.

Effect of *Argemone mexicana* in a model of Systemic Lupus Erythematosus in BALB/c mice

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Systemic Lupus Erythematosus (SLE) is an autoimmune, systemic, chronic-inflammatory pathology that causes diverse symptoms at the organ and systemic levels. This pathology is due to the loss of immune tolerance of T and B lymphocytes to host antigens, autoantibody formation, deposition of immune complexes in tissues, and production of pro-inflammatory cytokines. SLE can cause various damages, such as non-erosive arthritis, renal damage leading to kidney failure, neurological symptoms such as depression and anxiety, hematological alterations, and an increase in enzymes such as adenosine deaminase, among others. The treatment to reduce or improve the symptomatology includes glucocorticoids, with prednisone being the most common. Nevertheless, these steroids induce adverse side effects such as renal involvement, bone weakness, neurological disorders, hypertension, preeclampsia, and leukopenia, which reduce the patient's quality of life. Therefore, the search for better treatments remains a primary objective, so medicinal plants are an essential source of secondary metabolites with potential pharmacological effects. It has been demonstrated that *Argemone mexicana* has anti-inflammatory, anti-neuroinflammatory, renal, hepatic, and immune-protective effects. The aim of the present research is to evaluate the protective effect of fractions and compounds from the aerial parts of *A. mexicana* in a model of SLE in female BALB/c mice. A single intraperitoneal dose of the hydrocarbon oil 2,6,10,14-tetramethylpentadecane (TMPD) will develop signs and symptoms characteristic of SLE patients after seven months. These include arthritis (joint inflammation) and cytokine dysregulation, parameters that were evaluated. The treatment was administered orally for two weeks at the 2, 4, and 6 months. AmF (10 mg/kg) and AmFlav (5 mg/kg) (derived from the fractionation of the methanolic extract of *Argemone mexicana*) were administered as treatments. The basal group (healthy animals, without TMPD) and the vehicle (animals with TMPD) received 1% Tween 20. We used two positive controls, prednisone (2 mg/kg) and Rutin, because Rutin is the major compound in the AmFlav fraction. Among the results obtained, the fractions AmF and AmFlav significantly decrease articular inflammation, while the concentration levels of IL-6 in the homogenized. They also increased IL-10 levels. Rutin was the only treatment that significantly decreased TNF- α concentration. In conclusion, AmF, AmFlav, and rutin have anti-inflammatory and immunomodulatory effects in the murine model of systemic lupus erythematosus.

Awarded Presentations

The following presentations were recognized by the Evaluation Jury for their scientific quality, originality, and contribution to research in the field of biotic products development.

Víctor Eduardo Alcantar Rodríguez

High-energy mechanical processing to improve the functionality of a *Hibiscus sabdariffa* beverage

Yasmín Esmeralda Camacho Rodríguez

Characterization of Agavins and *Drosophila melanogaster* glue to analyse its potential as a new bioadhesive

Caroleé Chuzeville Munguía

Flavonoids-Enriched fraction from *Baccharis conferta* modulates inflammasome-related interleukins in an acute kidney injury model

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