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THE BOOK OF ABSTRACTS

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Contents

Lead Speakers

1. Blockchain Framework to Enhance Food Safety in Supply Chains

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Food safety has emerged as the topmost priority in the current fast-paced food industry era. According to the World Health Organization (WHO), around 600 million individuals, approximately 1 in 10 people worldwide, experience ailment due to tainted food consumption, resulting in nearly 0.42 million fatalities annually. The recent development in software and hardware sectors has created great opportunities to improve the safety concerns in food supply chain. Traditional food supply chain systems often lack in transparency, traceability, and efficiency, making it difficult to identify the source of contamination and prevent its spread. Blockchain technology emerges as a promising solution to address these challenges by introducing a decentralized, immutable, and transparent ledger system. By integrating blockchain, each transaction and transfer of food products can be securely recorded, enabling stakeholders to track the journey of food items from farm to fork in real-time. This capability facilitates rapid identification of contaminated products and troubleshooting of recalls to minimize the impact of foodborne illness outbreaks. Incorporating blockchain technology into food supply chains offers several key benefits, including enhanced transparency, increased consumer trust, improved recall and audit processes, and opportunities for reducing costs. The successful adoption of blockchain in food supply systems need collaborative efforts among stakeholders, investment in infrastructure, and resolution of technical and regulatory hurdles.

2. Evaluation of non-destructive testing techniques to detect glyphosate residue in pulses

Sindhu Sindhu, Annamalai Manickavasagan

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The pesticide residue in pulses causes significant trade impediments in the supply chain. The objective of this research was to develop and investigate non-destructive testing techniques (NDTT) for the detection of glyphosate residues in selected Canadian-grown pulses at five concentration levels (0 ppm, 5 ppm, 10 ppm, 15 ppm and 20 ppm). Methods were developed to artificially spike glyphosate in organically grown pulses (chickpea, yellow pea, red lentil, large green lentil, French green lentil, and black beluga lentil) using two solvents (water and ethanol). Based on glyphosate absorption, water proved to be a better solvent than ethanol, and therefore used for the sample preparation to develop NDTT. The Fourier transform infrared (FTIR) spectroscopy technique was developed and tested for glyphosate residue detection in intact pulses and pulse flour. For intact pulses, FTIR spectroscopy based model was developed using partial least squares regression (PLSR) technique and variable importance in projection (VIP) and selectivity ratio (sRatio) based variable selection method. The correlation coefficient for prediction (R^2p) was 0.93, 0.92, 0.96, 0.91, 0.96, and 0.92 for yellow pea, chickpea, large green lentil, red lentil, black beluga, and French green lentil, respectively. Similarly, FTIR spectroscopy based model was developed to determine the glyphosate residue in red lentil flour and large green lentil flour. The VIP-PLSR model yielded R^2p of 0.931 and 0.985 for red lentil flour and large green lentil flour, respectively.

The effectiveness of surface-enhanced Raman spectroscopy (SERS) was studied to determine the glyphosate residue in intact chickpeas and yellow peas. The PLSR model along with spectral pre- processing showed the maximum accuracy with a R^2p of 0.95 and 0.99 for chickpea and yellow pea, respectively. The feasibility of using near-infrared (NIR) hyperspectral imaging (HSI) system in the 900-2500 nm wavelength range was investigated to detect the glyphosate residue levels in intact black beluga lentil, red lentil, large green lentil, and French green lentil. The VIP-PLSR method showed highest performance with a R^2p of

0.933, 0.925, 0.940 and 0.941, for black beluga lentil, red lentil, large green lentil, and French green lentil, respectively.

All tested techniques (FTIR spectroscopy, SERS, and NIR HSI) yielded more than 0.9 correlation coefficient for prediction, and hence have the potential to use in the rapid detection of glyphosate residues in pulses. Further research is warranted to investigate the effect of moisture content, pulse varieties, cultivation regions, crop seasons, and other variables on the performance of these systems before their integration into the supply chain.

3. Development and evaluation of pulse-based synbiotic products

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The limitations of dairy-based functional foods, such as lactose intolerance, milk allergies, and shelf life, necessitate the development of vegan or non-dairy functional foods. The development of synbiotic (blend of both prebiotics and probiotics) non-dairy beverages can serve as a novel option for consumers. The prebiotic-rich pulses such as kidney beans and mung beans can be used as potential raw materials to develop these products.

The objective of this research was to develop pulse-based synbiotic beverage and instant beverage powder using kidney beans (KB) and mung beans (MB) as prebiotics and Lacticaseibacillus casei as the probiotic. The products were evaluated for their nutritional profile (proximate composition, probiotic viability, prebiotic activity score (PAS)), invitro properties, sensory acceptability and shelf-life.

The optimized parameters yielded acceptable quality of synbiotic beverage and powder. The synbiotic beverage made using KB and MB (7:3) showed good PAS (0.18 ± 0.00), high probiotic survivability (8.18 log CFU/mL), lesser enteric pathogen growth (5.54 log CFU/mL), ability to tolerate harsh gastric and bile conditions (probiotic viability >7 log CFU/mL), lesser antinutrients and maximum sensory acceptability value (7.06 ± 0.02). Similarly, the spray-dried synbiotic instant beverage powder encapsulated using gum acacia showed PAS (0.19 ± 0.00), high probiotic survivability (8.39 log CFU/mL), ability to tolerate harsh gastric and bile conditions, and acceptable sensory acceptability value (6.90 ± 0.08). The synbiotic beverage had a shelf-life of 65, 50, and 25 days at 5, 15, and 25 °C, respectively. Similarly, the synbiotic instant beverage powder showed the highest encapsulation efficiency (89.37%), and desirable powder characteristics with a shelf-life of 63, 35, and 35 days at 25, 30, and 35 °C, respectively.

Hence, the use of optimized concentrations of kidney beans and mung beans holds the potential to serve as a delivery matrix for the development of non-dairy synbiotic foods with acceptable sensory properties, enhanced shelf-life and associated gut health benefits.

Oral Presentations

Ph. D. Students

1. An overview of spectroscopic techniques to detect contamination in cheese

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Microbial detection and enumeration in food products is an inevitable part of food quality and control. Most of the traditional methods such as standard plate count are time consuming and laborious. Nucleic acid-based methods are rapid but are destructive in nature and require enrichment in itself as a prerequisite. The objective of this investigation was to assess the utility of non-destructive spectroscopic techniques, namely Near Infrared (NIR) spectroscopy, Fourier-Transform Infrared (FT-IR) spectroscopy, and fluorescence spectroscopy, in the analysis of cheese microbial quality.

The technical application of near-infrared (NIR) spectroscopy has been demonstrated in the detection of Clostridium infection in Danbo cheese and the classification of Listeria monocytogenes, Staphylococcus aureus, and Escherichia coli strains present in Kashkaval, a type of Bulgarian yellow cheese. These examples underscore the efficacy of spectroscopic techniques in enhancing food safety measures and microbial characterization within cheese production processes. FT-IR spectroscopy was employed to identify surface microflora in smear cheese, specifically Tilsit cheese. Fluorescent spectroscopy was utilized to detect the origin of Pseudomonas in the processing line of raw milk cheese. These studies involved spectral data analysis and employed chemometric techniques such as Partial Least Square regression (PLS), Principal Component Analysis (PCA), and Soft independent modeling of class analogy (SIMCA) for data analysis. Correlation with standard microbial techniques was conducted to achieve accurate and rapid detection of microbial contaminants in cheese.

The findings indicate the effectiveness of these spectroscopic methods in detecting and quantifying various pathogens in cheese, achieving classification accuracies ranging from 74.60% to 98.8%. These results have significant implications, suggesting that non-destructive spectroscopic techniques could serve as reliable and efficient alternatives to traditional culture-based methods for microbial analysis in cheese.

2. Bio-fabrication of fungal mycelium based vegan leather and packaging material from agri-food resources

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Each year, almost 48 million metric tonnes of agri-food residues are generated in Canada, with the majority being disposed of as waste. Being rich in nutrients, these residues have the capability to support the growth of microorganisms during fermentation processes. In this context, we have valorized this nutrient rich agri-food biomass into value-added products from fungi. Fungi possess a variety of enzymes capable of breaking down these complex nutrients into valuable biomaterials and products, including alternatives to leather and plastic packaging. In this work, we explored how different growth media, varying in their carbohydrate and protein content, affect the growth, composition, and mechanical properties of fungal mycelium biomaterial. We investigated the potential of various fungal species like Pleurotus ostreatus, Ganoderma lucidum, and Hericium erinaceus to produce mycelium materials by submerged fermentation on various growth media. Characterization by Fourier Transform Infrared Spectroscopy (FTIR) depicted that the composition and material properties of mycelium biomaterial could be tailored based on the substrate used. Mycelium produced on substrates rich in nitrogen and carbohydrates promoted the production of proteins, polysaccharides, and lipids. Conversely, substrates with higher levels of carbohydrates such as glucose led to the formation of mycelium biomaterial enriched in chitin. Thermogravimetric Analysis (TGA) and Differential Scanning Spectroscopy (DSC) illustrated the thermal degradation patterns within the temperature range of 225-330°C, indicating a notable thermal stability of these mycelium materials. These findings are of significant importance for transforming agri-food resources into tailorable mycelium materials which had properties of leather and/or conventionally used packaging materials.

3. Yellow cassava garri: Fermentation process, dry-frying kinetics, and physicochemical properties

Christopher Joseph Etti, Mfoniso Ubon Ufia, Annamalai Manickavasagan

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Yellow cassava samples were fermented with three different fermentation periods of 2 days, 4 days, and 6 days and subjected to dry-frying to produce Garri at 40°C, 50°C, and 60°C temperatures using a hot plate. Ten widely used thin-layer empirical models in describing the drying behaviour of agricultural products were fitted to the experimental data to select the appropriate model for predicting the dry-frying kinetics of Cassava (Manihot esculenta). The proximate composition, anti-nutritional factors (hydrogen cyanide (HCN) and phytate), flow properties, and sensory parameters were determined using standard methods. The page model showed an excellent fit for dry-frying kinetics under certain conditions of the experimental data with the coefficient of determination (R^2> 0.995), Chi-Square (X^2< 0.0007), and the sum of squares error (SSE < 0.0006) for 6 days fermentation period. The proximate analysis of raw and fermented cassava at different periods was within the range; 56.43-65.49% moisture content, 1.73-1.87% ash content, 1.70-2.80% crude fibre content, 1.25-2.89% crude protein content, 0.37-0.50% lipid content and 29.27-35.52% carbohydrate content. There was a significant difference (P<0.05) in the anti-nutrient composition of Garri when compared with the raw cassava. The average HCN and phytate content was generally reduced after 6 days fermentation. Flowability of the Garri (using Carr index and Hausner ratio) was majorly free flowing and good flow for all samples at different temperatures.

4. Fluorescence Fingerprints of Vegetable Juices for Food Safety, Quality and Stability Monitoring

Maleeka Singh, Xiaoli Liu, Valeria R. Parreira, Opeyemi U. Lawal, Maia Zhang, Angie Homez-Jara, Xue Jun, John Shi, Lawrence Goodridge, Maria G. Corradini

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Fluorescence fingerprints, or excitation-emission matrices (EEMs), provides a rapid, and comprehensive tool to scout progressive deterioration in perishable products, such as highly consumed vegetable products. This study assessed the efficacy of EEMs to report on the safety and quality of spinach juices (untreated vs. pasteurized vs. antimicrobial agent) and subsequently, remaining shelf life. Spinach was blended with deionized water (1:1 w/w) into juice-like products. Untreated, pasteurized (72°C, 15s), and supplemented with gallic acid (8 mg/mL) samples were stored at 4 and 15°C for 7 days. Samples were tested daily, at least in duplicates. EEMs (λex=250-530nm, λem=270-750nm, slits=2 and 3 nm) were collected using a spectrophotometer. Distinctive features (e.g., discriminative bands) of the EEMs were verified by LC-MS/MS. Microbial growth during storage was monitored by plating on Tryptic Soy Agar after serial dilution and incubating at 37ºC for 17 h. Three main EEMs regions exhibited most changes during storage for treated (n=28) and untreated (n=14) samples, albeit the extent of changes was different among treatments. The features were attributed to aromatic amino acids, polyphenols, and chlorophyll a using LC MS/MS. A fluorescence index (FI) based on ratio of the relative intensity of the bands and an ANN approach were compared for their ability to classify samples into fresh and spoiled (55 vs. 90% correct) according to the microbial growth results.EEMs allowed identifying distinctive features useful to rapidly discriminate fresh from spoiled spinach products even after processing. This may improve shelf-life reporting, thereby ensuring that consumers receive safe and high-quality foods.

5. Green Technologies for Protein Extraction from Legumes and Grains: Opportunities and Challenges

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Conventional protein extraction methods from legumes and grains pose significant challenges, including protein denaturation, high chemical use, hazardous effluent generation, high production costs, and low yields. Environmentally friendly extraction technologies have been emerging as alternatives for protein extraction. The successful technologies include, enzyme-assisted extraction, high hydrostatic pressure assisted extraction, reverse micelles extraction, microwave-assisted extraction, ultrasound-assisted extraction, Barometric membrane technologies, High voltage electrical treatments, subcritical water extraction, and so on. These techniques have proved significant benefits in terms of environmental sustainability, extraction efficiency, and preservation of techno-functional properties of proteins. Nevertheless, the commercial scalability of these techniques remains a challenge, necessitating a thorough understanding of their underlying mechanisms.

This review provides a comprehensive analysis of both conventional and emerging protein extraction methods, highlighting their implications for the food industry and their potential to enhance the techno-functional attributes of derived proteins from legumes and grains. Furthermore, the elucidation of the mechanistic principles governing these eco-friendly extraction methodologies is discussed, alongside the identification of challenges and prospects for their broader adoption. By synthesizing current knowledge in this field, this review shows the advancement of sustainable protein extraction practices, thereby facilitating the development of value-added protein ingredients in food processing.

6. Effect of milling techniques on pinto bean starch isolation

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In industries, air fractionation is the commonly used technique for starch extraction from the bean flour. However, less purity and prominent beany flavor are major drawbacks. The isoelectric precipitation method for pure starch isolation involves wet milling which require longer duration pre-soaking and milling in the presence of excess water, making the process industrially infeasible. The current study deals with the pinto bean starch isolation by isoelectric precipitation from dry milled flours of different mills (blade mill, burr mill, stone mill, and hammer mill) at different levels of milling severities. Each mill has a unique impact on the properties of flour that influences the starch yield. In all mills, the increase in milling severity reduced the average flour particle size (430 to 87 µm) and subsequent increase in starch damage in flour. The starch damage was higher (>1 %) in flour produced by shearing (Burr and stone mill) when compared with the flour produced by impact and cutting force (Hammer and blade mill). The total starch content in the flour varied among different mills (54.22 to 44.27 %). The particle size distribution of flour showed significant impact on the starch yield while the percentage of damaged starch in the flour has no effect on isolation. The purity of all the isolated starches ranged between 97 to 99%. Except for the burr mill (28.9 to 31.2 %), The yield from all the dry milled flours was significantly higher (32 to 38.9 %) than the yield from conventional wet milling (31 %). The highest yield of 38.9 % was observed in blade grinding for 5 minutes. Therefore, the dry milling of beans before starch isolation using isoelectric precipitation can result in higher yield with lesser processing time and water requirement.

7. Real-Time Detection of Peanut Allergens in Wheat Flour using NIR Spectrometry and Machine Learning

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Peanut allergen contamination poses significant challenges in food safety, often leading to product recalls in Canada. Current identification methods are reactive and hampered by delays in sampling, laboratory testing, and decision-making processes. This study introduces a proactive approach using near-infrared (NIR) spectrometry coupled with machine learning algorithms for real-time detection of peanut allergens in wheat flour, commonly used in bakery products. By automating data collection and analysis, we aim to provide immediate feedback to mitigate contamination risks. Employing the Texas Instruments DLP® NIRscan™ Nano Evaluation Module integrated with Raspberry Pi Module, spectral signatures of wheat flour samples will be directly acquired from the production line. The dataset encompasses one hundred samples each of uncontaminated and contaminated wheat flour, will be subjected to meticulous analysis. A comprehensive machine learning pipeline will be enacted, encompassing tasks such as partitioning into training and test sets, feature preprocessing, model selection, hyperparameter tuning, feature selection, and model evaluation. The dataset will be divided into an 80% training set and a 20% test set, with 10-fold stratified cross-validation executed on the training set to optimize model performance. Feature correlation analysis informs feature selection, while transformations and standardization techniques augment the efficacy of classification algorithms. From the similar previous studies, it has been observed that the Light Gradient Boosting Machines (LGBM) and eXtreme Gradient Boosting machines (XGBoost) showcased superior performance, achieving above 90% balanced accuracy in discerning the presence or absence of a subject. Evaluation metrics encompassing balanced accuracy, sensitivity, specificity, macro precision, and macro F1-scores will be harnessed to evaluate model efficacy.

8. Separation and recovery of protein from dairy waste using bentonite

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The recovery of valuable components from dairy processing waste products is an approach that creates an economic opportunity for producers while reducing the environmental burden of treating and disposing of this waste. For this purpose, bentonite clay has been investigated as an adsorbent material to recover protein from cheese whey. In this process, powdered bentonite clay is mixed with whey to adsorb and physically separate whey proteins from the bulk liquid. This approach presents several potential advantages compared to traditional membrane filtration, as it can be achieved using minimal equipment and operator experience, allowing for easier application at the source of production. The removal of major whey proteins has been monitored using HPLC following contact with bentonite clay while operating under varying bentonite dosages and temperature conditions. Complete removal of major whey proteins was observed using a bentonite dosage of 35 g/L after 6 hours of contact at a pH of 4.7. When considering the removal of individual whey proteins, it was found that alpha-lactalbumin (α-LA) displayed a higher adsorptive affinity towards bentonite than beta-lactoglobulin (β-LG) under these conditions. Modification of temperature using a fixed adsorbent concentration of 20 g/L revealed that the overall removal of major whey proteins was diminished at 4°C but remained relatively constant between 20 and 40 °C. In particular, the removal α-LA was significantly affected by changes in temperature, with removal increasing from 54.27% to 91.49% as the temperature during adsorption was raised from 4 to 40°C.

9. Unraveling the Structural Basis for Mushroom Spoilage

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Mushrooms align with consumers' preferences for sustainable and nutritious products of non-animal origin. However, their shelf life is short; 3-15 days. Limited information exists on the role of microstructure on mushroom stability. Hence, this study correlated the main quality attributes of four kinds of mushrooms with internal structure and shelf-life.White (WM), cremini (CM), oyster (OM), and shiitake (SM) mushrooms were purchased locally and stored (12°C, RH=92%) for 21 days. Size, defects, colour values and indexes were assessed using image analysis and a colorimeter at set time intervals. Mushroom specimens (parts and species) at day 0 were also fixated (10% formalin) and dehydrated using a critical point dryer to obtain micro-computed tomographs (micro-CT) at the BMIT-BM 05B1-1 line (Canadian Light Source Synchrotron). Microstructural differences, porosity and tortuosity were estimated from the reconstructed tomographs. All measurements were performed in at least 5 replicates.WM exhibited the highest overall colour difference (~30AU), followed by OM, SM, and CM. However, OM's size decreased and defects appeared faster, followed by shiitake, white, and cremini. Regardless of the mushroom type, gills were the tissue with faster deterioration. Gills in OM had a high surface-volume ratio, making them more susceptible to deterioration. Based on the tomographs, the OM's shorter shelf life could also correlated with the higher porosity of its tissues (OM=0.81±0.01, SM=0.67±0.01, WM=0.65±0.04, CM=0.53±0.12). Mapping loss of quality attributes and their potential causes in a highly desirable commodity such as mushrooms can guide the development of effective shelf life extension strategies and mitigation approaches.

Oral Presentations

Masters Students

1. Aquafaba: Plant-based egg replacement

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Aquafaba is the cooking water from boiling legumes. The most common legume to get aquafaba is chickpea. This viscous liquid has good gelling, foaming and emulsion properties. Among cooking enthusiasts, aquafaba is a popular egg replacer for vegan sauces, baked goods and desserts. Studies show some sensory acceptability of aquafaba as an additive to foods. While other research in aquafaba is ongoing with considerations to legume type, preprocessing, cooking process and post processing. There is potential for aquafaba as a plant-based egg replacer, but more research must still be done before commercial viability.

2. Influence of microwave oven and packaging parameters on the temperature distribution during microwave cooking

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The heating uniformity of food during microwave heating depends on factors like cold or warm-start of magnetron, power distribution, packaging geometry, and product orientation. This study investigated the heating uniformity of a domestic microwave oven (2450 MHz, 1000 W) modified with a fibre optic temperature measuring system. The results showed that the cold-start at full power took 4-4.5 min to heat 500 g of water from 20°C to 100°C. However, subsequent 2nd and 3rd warm-start heating, at 5 min cool-down intervals, required significantly longer come-up times to achieve the same water temperature raise (5-6 and 7-7.5 min, respectively). After three warm-start and cool down cycles, the come-up times stabilized at 6.5-7.3 min. To assess the effect of package geometry and food arrangement, baby potatoes (450 g; 3-5 cm diameter) were stacked in 3, 2, and 1 layer in the cylindrical (5.2 cm radius, 14.7 cm depth), cuboidal (14.5 L x 14.5 W x 8.5 H cm), and rectangular (19.5 L x 12.5 W x 4 H cm) polypropylene containers, respectively, and microwaved for 6 min at full power. The potatoes near the container periphery and headspace of the container took 1.5-2 min and 3-3.3 min to reach 100°C. While the potato in the middle of the container took around 6, 3 and 2 min to reach 100°C in rectangular, cuboidal, and cylindrical containers, respectively. The study suggests that minimizing the potato layers and adjusting the cooking time according to oven's earlier usage would help improving the temperature uniformity during microwave cooking.

3. Pesticide residue in food products: An analysis of testing methods and recalls for imported and exported products in Canada

Rebecca Fong, Annamalai Manickavasagan

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Pesticides are used on crops all over the world to help produce grow and thrive. For any food product that is made using produce that had a pesticide applied, there is always a risk of the pesticide leaving a residue on the crop. Pesticide residue becomes a concern when it surpasses the Maximum Residue Limit (MRL) for the specific crop and pesticide being used, as designated by the Pest Control Products Act. MRLs will often differ between countries, which creates a barrier to trade and can affect food supply. When products that surpass the MRLs are used in further processing or sold to consumers, it can threaten public health and needs to be contained through food recalls. To combat this, testing must be done to ensure that products are obeying the MRLs. The Canadian Food Inspection Agency (CFIA) has compiled data of testing for pesticide residue from various years through the National Chemical Residue Monitoring Program, Children's Food Project, and testing of Selected Metals and Pesticide reports, all available on the government's open data portal. This work focuses on analyzing the results of pesticide residue on various food products as determined by the CFIA through testing programs from 2014 to 2021. The analysis will highlight food products at a higher risk of carrying pesticide residue, as well as determine any import or export products that are more likely to be rejected due to residue.

4. Structuring and Exploratory Analysis of Undeclared Allergens based food recalls in Canada

Ranpreet Singh, Annamalai Manickavasagan

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The current research focuses on the investigation of the food recalls in Canada related to the allergens that were not declared from 2011 to 2024. This research data was extracted from the website of the Canadian Food Inspection Agency (CFIA). The data is obtained using a Python-based technique of web scraping to make sure that the dataset is complete and accurate for the period. The study provides trends and patterns related to food recalls and manufacturing sectors, distribution zones in Canada, seasonal hikes, and uncovers common threads in the recurrence of recalls among a wide range of industries, apparent in the connection of the situation with given production techniques. The geographical analysis of food recall distribution zones showed areas where this phenomenon is more common to see regional differences in food safety practices or allergen prevalence. In addition, the study points out the most frequent undeclared allergens that led to recalls during the research period that will be of great importance for public health and those in charge of food safety. This study adds to the comprehension of food recall patterns in Canada and suggests useful data for developing food safety as well as, allergen management and public health.

Poster Presentations

Ph. D. Students

1. Analytical analysis of thermoelectric refrigeration integrated with phase change material

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In the quest for efficient and eco-friendly refrigeration, this study presents an analytical analysis of a thermoelectric refrigeration system integrated with phase change material (PCM). The core of this investigation lies in conducting a non-dimensional analysis of the system, extending its applicability across diverse geometries and ambient conditions through derived correlations. Refrigeration plays a critical role in preserving food and other perishables, reducing bacterial growth rates and substantially extending shelf life beyond what is achievable at room temperature. Conventional refrigeration methods, reliant on consistent electricity for the vapor compression cycle and often employing harmful refrigerants like Chlorofluorocarbons (CFCs), pose environmental risks, including ozone layer depletion. The proposed TE refrigerator with PCM integration addresses these concerns by eliminating the need for such refrigerants. This innovation is not only environmentally benign but also uniquely suited for small-scale applications, as it eschews traditional components like compressors and evaporators. Furthermore, its reliance on PCM for storing cooling capacity renders it ideal for areas with unstable electricity access. This study's findings underscore the potential of this novel refrigeration technology in various settings, advocating for the importance of non-dimensional analysis in broadening the system's application scope. The proposed model stands out as a sustainable, versatile solution for food preservation, offering a glimpse into the future of environmentally responsible refrigeration technologies.

2. Comparison of zein-hydroxypropyl methylcellulose composite films formed by latex formation and phase separation

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Typical multi-layer film systems are formed by depositing two or more distinct layers, which can potentially lead to poor interfacial adhesion. Self-stratification allows the formation of multi-layer films in a single step. This study investigated two methods for preparing composite coating consisting of zein particles embedded in hydroxypropyl methylcellulose (HPMC) matrix with distinctive morphologies. In the phase-separation method, zein and HPMC (4 and 4% w/w, respectively) were co-dissolved in 70% w/w aqueous ethanol. In the latex method, zein particles were produced by precipitating a zein solution (4% w/w in 90% w/w aqueous ethanol) into water (pH = 10), followed by dispersing the particles (1% w/w) in aqueous HPMC solution (4% w/w). These solutions were cast on a glass plate at 20°C and 75% relative humidity, and allowed to dried for 12 h. The size distribution of zein particles was determined using a particle size analyzer. Polymer interaction was investigated using Fourier transform infrared spectroscopy. The morphology and roughness of the films were analyzed by scanning electron microscopy and atomic force microscopy, respectively. The phase-separation method resulted in zein particles (1460 ± 60 nm in diameter) homogenously distributed in the HPMC matrix. For the latex method, the zein particles (208 ± 13 nm diameter) tended to partition towards the films' bottom surfaces. The latex method had top surface roughness of around 10.7 ± 1.4 nm, while the phase-separation method was 227.7 ± 26.8 nm. Zein-HPMC interactions were not detected in films prepared from both methods, indicating substantial polymer phase separation. This study shows that zein particles of various sizes with a controlled distribution in an HPMC matrix can be prepared using the phase separation or latex methods. The zein-HPMC coating system can be promising for bioactive encapsulation and delivery applications.

3. Development and application of iron oxide nanoparticles for the removal of antibiotics (tetracycline) from the food chain

Charles Wroblewski, Rahul Islam Barbhuiya, Gopu Raveendran Nairc, Jayasankar Subramanian, Abdallah Elsayed, Ashutosh Singh

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Contamination of food products with pharmaceutical compounds is a concern regarding food safety, public health, and the sustainability of agricultural ecosystems. Among these compounds, antibiotics have been extensively used in both human medicine and livestock farming to combat bacterial infections. However, misuse and overuse of antibiotics, coupled with inadequate disposal practices in agricultural operations, food processing, households, and healthcare facilities have led to the pervasive contamination of water bodies with antibiotic residues. This contamination poses challenges in ensuring food safe particularly through the propagation of antibiotic-resistant bacteria. This research focuses on employing iron oxide (Fe3O4) nanoparticles to enhance food safety by removing tetracycline (TC), a commonly used broad-spectrum antibiotic, from wastewater in agricultural settings. Iron oxide nanoparticles were synthesized and meticulously characterized using techniques such as transmission electron microscopy, x-ray diffraction, and Fourier-transform infrared spectroscopy. The adsorption of TC onto iron oxide nanoparticles was investigated using UV-Vis spectroscopy, revealing its dependence on factors such as exposure time, temperature, and nanoparticle mass loading. Higher mass loading of nanoparticles resulted in increased efficiency, with the maximum sorption rate observed during the initial stages of exposure. These findings highlight the promising potential of iron oxide nanoparticles as a sustainable and environmentally friendly solution for mitigating antibiotic contamination in agricultural wastewater, thereby safeguarding food safety and preserving the health of aquatic environments.

4. Development of Novel Food Packaging Based on Microencapsulated Phase Change Material to Improve Food Insecurity

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Food spoilage during transportation and storage is a major contributor to food insecurity, as a result of inefficient infrastructure and technology for maintaining the temperature and freshness of food. Poor storage facilities and a lack of refrigeration can cause food to spoil, making it unsafe for consumption and leading to significant food waste. To address this issue, more effective thermal insulated packaging (TIP) is required to provide higher protection time for food products. This research is focused on designing and manufacturing efficient TIP based on Microencapsulated Phase Change Material (MPCM) that can play a significant role in reducing food insecurity. This technology can compete with existing models in terms of environmental friendliness, compactness for safe transportation and storage, cost-effectiveness, and energy efficiency. Depending on the material used for producing MPCM, thickness and environmental conditions, it can provide a higher thermal protection time compared to other insulation materials. The high enthalpy during the phase change of PCM avoids temperature fluctuations and provides a uniform temperature within TIP. Also, it provides the possibility to adjust the required temperature range needed for the specific food which helps to maintain the quality of the product until it reaches the final consumer. The produced MPCM particles are made of organic materials covered by resin in micron size which can be recycled and do not have a destructive impact on the environment. However, currently, the cost of MPCM particles is relatively high for industrial applications that can be addressed by mass production and improving encapsulation efficiency.

5. Development of oil encapsulated starch nanoparticles via nanoprecipitation

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The increasing demand for plant-based protein has led to a higher need for processing various pulses in grain fractionation and refining industries. Field pea grains, which are grown worldwide, contain high protein levels ranging from 25% to 30% (on a dry basis). However, the pea starch, a byproduct of protein refining, is not widely used in the agricultural and food sectors due to its high amylose concentration (~40%), which can cause it to harden quickly. Therefore, this study utilized a new method involving in-house spraying to create starch nanoparticles, aiming to encapsulate natural antimicrobial compounds like essential oils, thus adding value to this underused starch byproduct. The process of making oil-encapsulated starch nanoparticles (OESNP) was further refined using a Box-Behnken experimental design to analyze how various factors such as initial starch concentration, homogenization speed, duration, sample injection rate, and antisolvent quantity influenced the outcome. The resulting OESNP were thoroughly examined to understand their molecular interactions, size, and structure using techniques like Dynamic light scattering (DLS), X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), and Fourier transform infrared (FTIR) spectrophotometry. The optimized sample demonstrated high entrapment efficiency (80-90%) and small particle size (<500 nm). Additionally, the OESNP displayed notable antimicrobial properties against common plant pathogens, indicating their potential application in the agricultural and food sectors.

6. Eco-Friendly Wax Coatings for Paper Packaging: Effects of Coating on Mechanical and Barrier Properties

Fatemeh Jahangiri, Akhilesh Kumar Pal, Amar Mohanty, Ryan Clemmer, Stefano Gregori, Manjusri Misra

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The aim of this study was to assess the quality of paper coated with different eco-friendly waxes (bees-, soy-, bio- and emulsion wax) for food packaging applications. A food-grade kraft paper was bar-coated with a single layer of molten wax on both sides. We thoroughly characterized waxes in terms of their functional groups, thermal properties and crystal morphology. Moreover, the morphological, mechanical, and water vapor barrier properties of the wax-coated papers were studied. The water and oil contact angles were also analyzed to determine the resistance of wax-coated papers to moisture and grease penetration. The wax coating represents 10-20% of the base paper with a coating thickness of 5-10µm. The analysis of scanning electron microscope (SEM) images indicated the penetration of waxes into the paper cellulosic fibers, thereby effectively reducing the porous structure of the paper. Both water and oil contact angles of the uncoated paper saw an improvement after wax coating. Among the four waxes, beeswax-coated paper exhibited the highest improvement (by ~77%) in water vapor barrier compared with the uncoated paper. While the percentage elongation at break (EB%) reduced for all four wax-coated papers, tensile strength (TS) and modulus (M) increased compared with uncoated paper, with beeswax showing the highest percent improvement in TS (by ~26%) and M (by ~46%). Overall, our results indicate that wax coating has great potential to improve the performance of paper-based packaging as an alternative for petroleum-based coating materials.

7. Edible coating as a postharvest management strategy for shelf-life extension of stone fruits

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Edible coatings (EC) are sustainable, natural, and promising strategies for enhancing the shelf-life of fruits and vegetables. These environmentally friendly methods provide barrier properties against gases and moisture as well as mitigate oxidative browning. It acts like a modified atmospheric storage. Essential oil, plant extracts, and nanoparticles are some of the active ingredients that can be added to ECs to improve their functional properties. The type of coating varies depending on the type of fruits and vegetables. Peaches, nectarines, plums, apricots, and cherries belong to the genera Prunus and belong to the category of stone fruits. Stone fruits are very popular and have high global demand due to their nutritional content and delightful taste. In the marketing year 2023-2024, the European Union (EU), expects a rise in production of peaches and nectarines by 12%. The Niagara Peninsula is Ontario's primary producer of stone fruits. This region yields 60% sour cherries, 80% plums, 75% sweet cherries, 72% pears, and 90% peaches, nectarines, and apricots. However, postharvest quality deterioration is a major concern. It includes weight reduction, shriveling, over-ripening, chilling injury (CI), internal breakdown, and decay. EC is widely employed to mitigate these issues which enhances storage stability and shelf-life. Stone fruit exhibits a positive response to applied edible coatings. The ripening process and quality degradation of the fruits are minimized using EC; therefore, it is a promising approach to prolonging the shelf-life and minimizing postharvest losses of stone fruits.

8. Innovative Home Compostable Flexible Packaging: Engineered High Performance Trilayer Blown Film Structures

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Biodegradable polymers and their blends are getting more attention as an eco-friendly replacement for common plastics specifically in food packaging applications. Specifically, biopolymers with the capability of degradation in home composting conditions are more attractive as they can be decomposed into water, carbon dioxide, and other biomass in the home composting facilities of consumers. In this research, we developed single-layer and trilayer films made of home-compostable biopolymers, namely poly (butylene succinate co adipate) (PBSA), poly (butylene adipate co terephthalate), and Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), incorporated with mineral fillers (Talc). Although PHBV is known as a biopolymer with very low melt strength and low film processability, both single-layer and trilayer films produced from this biopolymer could be processed successfully in common film-blowing machines commonly used for making plastic films without any special modifications. These films also indicated satisfactory mechanical properties such as high tensile modulus (280-400 MPa) and %elongation at break (180-350%) which are competitive with common plastic films made mainly from petroleum-based plastics such as polyethylene as well as commercialized compostable films in the market. The high content of incorporated filler could also reduce the final cost of the developed material so that it could be considered a candidate for real commercial applications.

9. Plant proteins on the physical properties of a meat composite gel: texture, rheology, microstructure, cooking loss, and NMR T2 relaxation

Weilun Lin, Shai Barbut

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Recently, significant interest has been drawn to understanding the effect of novel hypoallergenic plant proteins in meat products. Four plant proteins—two types of pea proteins (PP-A and B), a brown rice protein (BP), and a faba bean protein (FP)—were incorporated into a meat batter at 0, 3, 6, 9, and 12%. Instrumental hardness measurements were positively correlated with plant protein inclusion levels. Among all treatments, PP-A produced the highest springiness and reduced the most cooking loss. The rheological measurement revealed that PP-A achieved a similar final storage modulus G' to the meat-only control. Micrographs suggested that PP-A aggregated into large clusters, possibly enhancing structural support for the meat composite gel. NMR T2 profiles were consistent with cooking loss measurements and showed restricted water mobility with the addition of plant proteins. In conclusion, PP-A showed promising results in improving the water binding, texture, and structure of a meat composite gel.

10. Protein functionality in high-protein plant-based cheese

Stacie Dobson, Alejandro G. Marangoni

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Waxy starch, plant-protein isolates, and coconut oil were combined to create a novel high-protein (18w/w) plant-based cheese. We determined that by using native waxy starch, we can enhance its existing viscoelastic properties by modulating gelatinization through the addition of plant protein and fat. Plant protein isolates were assessed for their functional properties where low solubility, low emulsification capacity, and greater water-holding capacity correlated with low surface-active proteins. The opposite; high solubility, high emulsification capacity and lower water holding correlated to greater surface activity. Upon assessing the proteins in our cheese formulation it was determined that low surface active proteins resulted in cheeses with superior sample melt and stretch reaching 2-4times greater than those observed for commercial plant-based cheeses. Whereas, high surface active proteins resulted in cheese with little to no melt or stretch. The rheological melting curves showed that samples with low surface active protein exhibited a significant decrease in the Storage modulus (G') between 40-80°C, indicating that the starch had undergone better gelatinization, leading to the loss of structure. On the other hand, samples with high surface-active proteins did not experience the same extent of G' decrease and, instead, maintained a more solid structure with less softening of the sample. FTIR spectromicroscopy of the cheese systems identified that low surface active protein behaved as a particulate filler with starch making up the majority of the cheese structure thus allowing the starch to stay connected but have the proteins act as junction points to aid in sample breakdown when heated. Whereas with high surface active protein, FTIR identified that the protein acted as the main structural matrix thus limiting the softening and melting of the cheese product. Ultimately by focusing on the functional properties of the proteins and utilizing the characteristics to modify foods, it is possible to have superior product performance.

11. Reduction of antinutrients in kidney bean flour by acidic and alkaline reactive extrusion

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Accompanied by the increasing acknowledgement of the nutritious components and health benefits of kidney beans, its present antinutrients are also gaining attention due to their ability to reduce nutrient availability and cause discomfort. Conventional extrusion can remove antinutrients by heat, pressure, and shear. The functions of extrusion temperature and feed moisture were well-studied. However, the effects of acid or alkali injection into the barrel are not systematically investigated. This study employed three concentrations (0.05, 0.10, 0.25 mol/L) of acetic acid or sodium carbonate solutions, three temperature profiles (40/60/80/80/90, 40/60/80/90/110, 50/70/90/110/130°C) and two feed moistures (25, 30%) during extrusion, and investigated their effects on reducing condensed tannins, trypsin inhibitor activity, phytic acid, and raffinose family oligosaccharides in kidney bean flour. Results showed that the injection of all three concentrations of acetic acid and sodium carbonate solution increased the reduction of condensed tannin compared with water, especially when extruding with the highest extrusion temperature profile. Extrusion effectively reduced the trypsin inhibitor activity by 79-95% overall, regardless of extrusion conditions. Oppositely, extrusion did not show a substantial effect on removing phytic acid. Injecting acetic acid and sodium carbonate solution at 0.15 mol/L concentration resulted in a 72 and 90% reduction of total raffinose family oligosaccharide content, as compared with water (17%). Feed moisture showed less impact than solution concentration and extrusion temperature overall in the study. These results suggest that the injection of acetic acid or sodium carbonate solution during extrusion could promote the reduction of antinutrients in kidney bean flour, except phytic acid.

12. Systematic Evaluation and Survey of Plant-Based Analogues: Potential Chemical Risks & Mitigation Strategies

Chang Chen, Maria G. Corradini

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Plant-based analogues (PBAs) are food products designed to mimic the structural and sensorial properties of their animal counterparts. Despite their increasing popularity, food safety and nutritional concerns associated with their consumption have been raised due to a) natural toxicants and anti-nutritional factors present in plant-based raw materials, b) introduction of novel ingredients to meet technical requirements, c) extensive processing required to develop desired characteristics (e.g., textural) and d) the choice of prioritizing sensory over other characteristics during their design. Potential adverse effects of consuming PBAs in the short and long run are yet unknown and might offset their nutritional and environmental benefits.

This study provides a systematic analysis and ranking of potential food chemical hazards associated with plant-based alternatives. Using plant-based burgers (PBBs) as a case study, a survey has been conducted to gather information on the kind of PBBs currently available in the market, with a particular focus on their primary protein sources and additives. A comparative analysis of composition has revealed that the utilization of additives in PBBs to enhance mouthfeel and flavor (e.g., syrups) can contribute to the formation of processed-induced toxicants (e.g., acrylamide) at a higher rate and extent than in animal products.

This study highlights current research gaps, including the need to design plant-based products and processes based on chemical safety and chemical toxicant potential generation in PBAs. These will be critical in guiding ingredient selection, manufacturing practices and design, regulations, and policies to ensure PBAs are nutritious and safe for consumers and the planet.

13. Thermoplastic starch based ternary blend for packaging film applications: a study on the effect of initiator and cross-linker on prepared blend system

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This study examined the usage of co-plasticized post-industrial wheat starch (CPPWS) to produce poly(butylene-adipate-co-terephthalate) (PBAT) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) based thermoplastic starch (TPS) ternary blend films. The composite films were prepared by melt blending at 165 ˚C subsequently the extrusion cast film was produced at 160 °C. The impact of organic peroxide (OP) as an initiator for the reactive extrusion of PBAT/CPPWS/OP and PBAT/PHBV/CPPWS/OP blends was examined at melt processing temperatures of 160 and 165 °C, respectively. The mechanical results demonstrated that the modulus of PBAT/CPPWS/OP and PBAT/PHBV/CPPWS/OP blends increased by 28 and 38% respectively compared to the respective compositions without OP. Mechanical, thermal, and morphologic analyses indicate that using an initiator was more effective for the PBAT/PHBV matrix than the PBAT matrix. Furthermore, the combined use of OP with a crosslinking agent triallyl iso-cyanurate (TAIC) was studied in PBAT/PHBV/CPPWS/OP/TAIC composite films at crosslinker loadings of 0.5 phr (parts per hundred parts of resin) and 1 phr. Adding an initiator (OP) with the crosslinking agent (TAIC) increased tensile strength, % elongation, and modulus for both 0.5 and 1 phr cross-linker loadings. In conclusion, a crosslinked polymer blend system with improved dispersion and interaction of CPPWS with PBAT and PHBV has been produced by an initiator and cross-linker in the PBAT/PHBV matrix.

14. Truly Green Composites from Bacterial Bioplastics and Renewable Cellulose Fibre: Effect of Compatibilizer on Performance

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High-performance green composites were engineered from polyhydroxy butyrate-co-valerate (PHBV), a bacterial plastic and renewable pulp cellulose fiber. PHBV bioplastic is gaining much attention due to its properties being similar to polypropylene while showing biodegradation in soil and marine environments. Therefore, PHBV can be used for rigid food packaging applications without contributing to waste generation. However, the price of PHBV is a disadvantage that can be mitigated with the incorporation of inexpensive biofillers. In this study, PHBV-based biocomposites were developed with high bio-filler concentrations of up to 25wt%. To aid with the biocomposite processing, tributyl citrate (TBC), a plasticizer, was used to have the optimal melt flow required for injection molding. Moreover, high-performance biocomposites were developed through improved fiber-matrix adhesion by using a compatibilizer, maleic anhydride-grafted-PHBV (MA-g-PHBV). At 25wt% filler concentration, the compatibilized biocomposites demonstrated increased tensile strength, tensile modulus, and %elongation at the break by 44, 23, and 18%, respectively, compared to their uncompatibilized counterparts. This could be attributed to the enhanced interfacial interaction between the different phases in the biocomposites because of the presence of MA-g-PHBV which can also be corroborated from the microscopy images. Therefore, the addition of compatibilizers in small concentrations can help produce high-performance biocomposites useful for packaging applications. Hence, this work could be a step towards replacing traditional plastics with biodegradable composites which would greatly help counter plastic waste generation.

Poster Presentations

Masters Students

1. A Pipeline Approach to Identifying Salmonella Bacteriophages with Tail Spike Proteins

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Bacteriophage (phage) tail spike proteins (TSPs) have gained interest as antimicrobials for foodborne pathogen control due to their lipopolysaccharide- degrading activity. A semi-automated, high- throughput pipeline was developed to identify Salmonella phages with TSPs. 24 Salmonella enterica isolates were used for phage isolation by individually inoculating wastewater samples with 10X tryptic soy broth, then incubated at 37°C overnight. Then the samples were centrifuged and filtered through 0.22mm syringe filters. Using the OT-2 liquid-handling robot, the bacterial host and 100mL of the corresponding wastewater filtrate was added to a 96- well microtiter plate and incubated overnight, measuring OD600nm values to determine phage presence. Then, phages with halo- producing plaques (indicative of TSP activity) were isolated using the double overlay agar method and automated DNA extraction was performed on the QIAcube. For further TSP indication, a high- throughput PCR assay with 13 different TSP primer sets was completed. Phages with TSPs were then confirmed by transmission electron microscopy (TEM) and whole- genome sequencing using MiSeq paired-end sequencing. As a result, this automated procedure from start to finish was completed in 5 days. 48 phages produced plaques with haloes infecting 12 different Salmonella serovars (Anatum, Arizonae, Bareilly, Branderup, Heidelberg, Infantis, Kentucky, Newport, Oranienburg, Poona, Reading, and Typhimurium). The PCR assay produced an amplicon indicating a potential TSP in six phages. TEM confirmed the presence of a TSP in 3 of the 6 phages, and sequence analysis indicated that the TSPs belonged to 2 of the 13 Salmonella TSP groups.

2. Development of a Novel Biopesticide for Fire Blight

Abida Suboor, Nasser Ibrahim, Nikhil Patel, Darlene Nesbitt, Aicheng Chen, Hany Anany, Antonet Svircec, Qi Wang

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Apples and pears are two important plants belonging to the Rosacea species that play a crucial role in the Canadian economy. Fire blight is a disease that is capable of wiping out an entire apple orchard within a season. The bacteria responsible for the disease, Erwinia Amylovora (E. Amylovora), is a pathogen that can be targeted by bacteriophage. Recently, bacteriophages have risen as a promising alternative to the current method of using chemicals to control plant pathogens. For effective delivery of bacteriophage, a 'phage-carrier system' is implemented. In such a system, the bacteriophage is allowed to infect bacteria closely related to E. Amylovora, Pantoea Agglomeran (P. Agglomeran). In order to protect the structure and function of the phage-carrier system, microencapsulation is implemented. This is because along with being and effective layer of protection, microencapsulation prolongs the shelf-life. The most cost-effective microencapsulation technique is spray-drying. With that being said, freeze-drying increase the chances of cell survivability. This project focuses on engineering the microencapsulation of a phage-carrier system, using varying polymers and drying techniques. This study will provide a trajectory to a novel biopesticide for Fire Blight.

3. Impact of protein properties on the functionality of plant-based cheeses formulated with saturated and unsaturated fat

Cameryn L. Sanders, Stacie Dobson, Alejandro G. Marangoni

Department of Food Science, University of Guelph

Plant-based cheeses provide an environmentally friendly alternative to traditional dairy, often incorporating coconut oil to mimic the texture of animal fat. Addressing health and sustainability concerns in plant-based foods is crucial, necessitating the exploration of alternative fat combinations. This study examines the influence of protein properties on the functionality of plant-based cheeses, specifically focusing on saturated and unsaturated fats. Three pea proteins (PP1, PP2, PP3), a faba protein (FP1), and a lentil protein (LP1) were utilized in the cheese formulations. Various ratios of coconut oil to sunflower oil (100%, 75%, 50%, 25%, 0%) were employed to evaluate the impact of saturated fat content on the cheeses' physical characteristics. Textural profile analysis revealed that after setting at 5°C for 24 hours, the hardness of cheeses increased with higher amounts of coconut oil, which increased the solid fat content. The cheese formulated with PP1 at 25% coconut oil exhibited the firmest texture of over 65N due to unique protein-fat interactions, which is similar to the hardness of 68N at 75% coconut oil. Rheological properties of the cheeses were assessed between 20-95°C, focusing on tanδ (ratio of loss modulus to storage modulus) at 95°C as a measure of melt performance. Despite PP1's hardness being 30N greater than other cheeses, it maintained a similar melt and stretch, with tanδ values within 25% of the different samples. This suggests an opportunity to customize protein-fat interactions to achieve the desired hardness while preserving functional properties and improving the sustainability and health benefits of the final product.

4. Improvements on the Functionality of Native Legume Starch Gels Through Amylose-Lipid Complexation

Henry A. Koekuyt, Stacie Dobson, Alejandro G. Marangoni

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The process of isolating protein from pulse sources results in the production of starch as a by-product. Starch derived from pulse sources often contains high levels of amylose, which can lead to the formation of brittle retrograded gels. An effective approach to enhancing the performance of these gels is through the formation of amylose-lipid complexes. Native pea, fava bean and chickpea starches containing 25-30% amylose were complexed with stearic (SA), oleic (OA) and capric acid (CA) as well as glycerol monostearate (GMS) and glyceryl monopalmitate (GMP) in order to deduce any functional benefits associated with amylose-lipid complexation.

Complexation of all the native starches with SA, CA, GMS and GMP at 5%, 7.5%, 10% and 12.5% (w/w; lipid/dry weight of starch) levels significantly reduced the hardness in 10% (w/v; dry weight of starch/water) retrograded gels, as determined by Texture Profile Analysis. The retrograded complexes also showed decreased adhesiveness and cohesiveness. These parameters further suggest that SA, CA, GMS and GMP interact with amylose, decreasing its brittleness. Dynamic oscillatory rheological analysis in showed that the complexed starches had significantly lower storage modulii (G') compared to the native starches ($P<0.05$). The associated stress-strain curves also demonstrated improved strain softening, displaying more plastic-like profiles and decreased shear stress values at the yield points for the complexed samples. Interestingly, the complexed samples show decreases in their linear viscoelastic regions and slightly lower yield points in comparison to the native starches. Wide angle X-Ray Diffraction suggests that complexation of the native starches with fatty acids and monoglycerides changes the crystal morphology of the samples from B-type amylose crystals to Vh-Type amylose crystals. Overall, this research demonstrated that amylose lipid complexation may be a useful tool in modifying the mechanical and rheological properties of legume starches.

5. Valorization of agri-food feedstock to rhamnolipid biosurfactants for applications in promoting soil health

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The use of agri-food resources for the production of bio-products presents a promising frontier in the enhancement of economic and environmental sustainability within the agri-food sector. This work focuses on the bioconversion of low-value side streams from miscanthus and switchgrass biomasses into high-value rhamnolipids bio-based surfactants with significant applications in promoting soil health and agricultural productivity. Through their plant growth promoting and nutrient recycling affects, rhamnolipids are valuable bioactive molecules, whose market value is projected at US$ 6.07 billion by 2030. In this work, rhamnolipids were produced through the fermentation process using the non-pathogenic bacterium Burkholderia thailandensis, and leveraging nutrient-rich and biomass derived process waters as feedstock.Shake flask experiments were performed at 30°C and 150 rpm agitation without any pre-treatment of the feedstock and/or supplementation with pure and expensive nutrients. The study further explored the impact of various pH at 5, 7, and 9 on the microbial synthesis of rhamnolipids. This led to an optimized rhamnolipids concentration of approximately 2.25 g/L at pH 7. Fourier Transform Infrared Spectroscopy (FTIR) analysis confirmed the presence of Rha-Rha-C12-C14 congeners, indicative of rhamnolipids' beneficial emulsification properties. Such properties make them valuable soil supplements to improve the nutrient recycling. Overall, this work highlights the value-addition of agri-food resources to high-valued products for improved soil health and crop yield, thereby closing the nutrient loop and promoting circular economy.

6. Valorization of food industry waste for the fabrication of sustainable nanocomposites for food packaging

Sivaranjani Palanisamy Ravikumar, Fatemeh Nayeri, Malvika Sharma, Rahul Islam Barbhuiya, Charles Wroblewski, Gopu Raveendran Nair, Prasad Daggubati, Ashutosh Singh

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Food packaging waste accounts for almost 50% of plastics derived from fossil fuels with a major portion ending up in the landfills raising serious concerns with respect to the environment, sustainability and, the future of food safety. This study aimed to utilize food industry waste to develop biodegradable packaging for applications in the food industry. The food industry waste namely the pea starch and food wrapping papers were valorised to fabricate starch/nanocellulose based biodegradable nanocomposites. The films were fabricated through solution casting method and the composition of the constituents with optimization being performed focusing on tensile strength, water vapour barrier properties, and hydrophobicity. Physical properties such as the thickness, colour and light transmittance of the optimized nanocomposite were examined. Further, the structural properties of the nanocomposite films were characterized through X-Ray Diffraction and Fourier Transform Infrared Spectroscopy. Thermal properties were examined using Differential Scanning Calorimetry and the surface morphology through Scanning Electron Microscopy. Finally, the biodegradability of the films was assessed.

7. The Application of Big Data and Neural Networks for Determining Deoxynivalenol Contamination in Corn Corps in Ontario

Erich Fischer, Annamalai Manickavasagan

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The province of Ontario accounts for just over half of Canada's total corn for grain area, and two thirds of the counties total production. Each year disease causes significant yield losses to Ontario's corn crop. The fungi Fusarium graminearum is of special concern due to its high prevalence, and the production of the secondary metabolite Deoxynivalenol (DON). DON belongs to the trichothecenes family of mycotoxins and acts as a strong inhibitor of protein synthesis. Livestock such as swine are extremely sensitive DON. When present in animal feed, DON can cause reduced feed intake, reproductive effects and immuno-suppression. Field surveys completed by OMAFRA between 2011 and 2022 found that 35 percent of corn fields in southern Ontario had DON concentrations at or exceeding the CFIAs legislated maximum tolerated levels. In addition to field monitoring, predictive models can act as an early warning system, providing farmers with crucial insight into DON contamination. Predictive models have been developed for regions such as Italy and the United States; however, at the time of writing, a working model has not been developed for Ontario. The objective of this study is to develop a predictive model that uses big data and machine learning to predict DON contamination risk in corn at the time of harvest in Ontario. The model leverages geospatial data hosted on Google Earth Engine as primary model inputs, and a TensorFlow neural network for large-scale machine learning. Training data was obtained from a collection of 10 years of in field DON concentration samples provided by OMAFRA. The model output is a 2km resolution map showing the risk of DON contamination across Ontario for the years 2013 through 2022. Assessment of actual and predicted DON contamination shows the model is able to generalize to previously unseen data and capture many of the key features present in any given year. The developed model shows superior performance to models proposed in previous academic works. This research provides a novel approach for predicting mycotoxin contamination at scale and provides a basis for further research into ex situ predictive modeling.

8. Experimental analysis of a full-scale batch grain dryer operating with low temperature air to determine energy intensity and energy consumption

Katelyn Anne Irene Sysiuk, William David Lubitz, Greg Dineen

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New approaches to energy supply for low temperature grain drying have the potential to reduce energy costs, improve grain quality and yield climate benefits. Current options for drying grain using alternative energy sources are few, necessitating the development of new dryers optimized for this type of drying. This research project is studying a full-scale prototype of an electrically-powered air source heat pump, horizontal flow, low temperature batch dryer. Initial drying experiments have been completed in the prototype dryer with corn. The first round of experimental drying utilized electric heaters and a fan to slightly increase the air temperature from ambient conditions for drying. The initial tests quantified the energy intensity and energy consumption of corn drying in the prototype dryer. Further analysis of the efficiency of the dryer will be included in future research and used to inform refinement of the prototype dryer design. This ongoing research using full-scale field studies and laboratory experiments has already provided insights into the potential benefits of low temperature drying at a larger scale. Benefits of this new design may include reduced greenhouse gas emissions, and lower and less variable energy costs than conventional high temperature drying with fossil fuels.

Poster Presentations

Undergraduate Students

1. Application of Cold Plasma Technology to Extend the Shelf-life of Fresh Strawberries

Simontika Chowdhury, Kevin Keener

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Introduction: Post-harvest spoilage of fresh strawberries by Botrytis cinerea mold is a significant economic and social issue costing over $5 billion in North America and leading to wasting over 50% of fresh strawberries. Currently, fresh strawberries have a short shelf-life of only five days before getting infected by the spoilage organism. Hence, this study utilizes the novel non-thermal technology- High Voltage Atmospheric Cold Plasma (HVACP) to destroy B. Cinerea spores on the surface of fresh strawberries and extend their shelf life.

Purpose: Assessing the efficacy of HVACP treatment to decontaminate B. cinerea spores from fresh strawberries, extending their shelf-life to 12 days, while maintaining their color and firmness.

Methods: 25g of fresh strawberries, inoculated with 6 log10 spores/g of B. cinerea, underwent HVACP treatment (80 kV, 5 minutes, air, 100% RH, 175W) and 24 hrs post-storage treatment. Microbial counts and quality assessments were conducted on days 0, 2, 5, 7, 10, and 12. Additionally, a visual mold spoilage scale was developed to evaluate the degree of mold growth. Measurements were conducted in triplicates and data were analyzed using one-way ANOVA and Tukey's post-hoc test ($p \leq 0.05$).

Results: Treated samples showed a 99.6% reduction in the mold population without compromising color, firmness, or pH over the 12-day study period. Untreated strawberries showed significant B. cinerea mold growth by day 7 while the HVACP treated strawberries showed no mold growth until day 12.

Significance: HVACP treatment effectively extends strawberry shelf-life up to 12 days by controlling B. cinerea spores, offering potential applications in fresh produce preservation, and enhancing post-harvest practices in agriculture.

2. Home-compostable blends of Bio-Poly (Butylene Succinate) and Bio-Poly(Butylene Succinate-Co-Adipate): Compatibilization and Performance Evaluation

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Over 90% of 400 million tons of plastics produced in 2022 were petroleum-based, and the associated waste contributed to environmental pollution of natural resources such as soil and water. The rising plastic problem caused Canada to ban harmful single-use plastic from checkout bags, cutlery, stir sticks, straws, and containers. The emerging stream of biopolymers in food packaging can replace the application of traditional non-degradable plastics. In this study, we used two home-compostable polymers, namely bio-based poly (butylene succinate co-adipate) (BioPBSA) and bio-based poly (butylene succinate) (BioPBS). These bioplastics were selected for blend formation to strike a balance between the stiffness of BioPBS and the ductility of BioPBSA. Moreover, compatibilization approaches such as the addition of peroxide and maleic anhydride-grafted-BioPBSA/BioPBS (MA-g-BioPBS/BioPBSA) were also performed to see their effect on the properties. Blending the two polymers increased the tensile strength of up to 15% of the blends compared to neat BioPBSA and BioPBS. This was possible due to the formation of strong intermolecular force between two polymer phases and/or the nature of a highly miscible mixture between BioPBSA and BioPBS. Introducing peroxide and MA-grafted compatibilizers into the blends improves the flexural properties and tensile modulus with a nominal reduction in tensile strength. Moreover, the blends' thermal stability did not change significantly after the addition of compatibilizers, inferring that the blends can be processed in the presence of compatibilizers without thermal degradation. The properties studied in the article provide a promising alternative to flexible packaging applications.

3. Turmeric: Processing, nutritional and medicinal values

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Turmeric is a rhizomatous herbaceous perennial plant belongs to the Zingiberaceae (ginger) family. The average annual production of turmeric in the world is 1.1 million tonnes, and about 80% is produced in India. When the leaves of the turmeric plant turn brown and begin to dry, usually within 7 to 9 months, the rhizomes are ready to be harvested. After harvesting, the mother rhizome is separated and stored to use as a seed for the next season. The finger rhizomes are cured for the production of ground turmeric. The general stages followed in the processing or curing of turmeric include; boiling and drying; re-boiling; separation from water; and sun drying. Boiling the rhizome removes the raw odour, gelatinizes starch, and generates a more even colour product. Boiling is usually done in large shallow iron pans with 0.05% to 0.1% alkaline water. After boiling, it must be immediately dried (usually sun drying) to prevent overcooking. The final moisture content of the rhizome should be between 8% and 10% and produce a metallic sound when tapped by the finger. Finally, they are polished to remove the rough exterior and then ground to a fine powder.

The active component of turmeric is curcumin, a polyphenol. The primary compound present in turmeric is a volatile oil comprised of tumerone, and coloring agents named curcuminoids. The curcuminoids include curcumin demethoxycurcumin, 5'-methoxycurcumin, and dihydrocurcumin, and are also antioxidants. The volatile oils present in turmeric are d-α-phellandrene, d-sabinene, cinol, borneol, zingiberene, and sesquiterpenes. Depending on turmeric species, different types of sesquiterpenes have been observed. This includes germacrone, termerone, β-bisabolene, α-curcumene, zingiberene, β-sesquiphellanderene, bisacurone, curcumenone, dehydrocurdione, procurcumadiol, bis-acumol, curcumenol, isoprocurcumenol, epiprocurcumenol, procurcumenol, zedoaronediol, and curlone. Turmeric is also rich in ω-3 fatty acid and α-linolenic acid. Tumeric has been proved to lessen markers of oxidative stress within the body. Curcumin has been observed to inhibit the activation of NF-κB and downregulate NF-κB-associated gene products. The anti-inflammatory properties

of turmeric can protect against inflammatory disease processes. This property can assist in the treatment of arthritis. Several studies have reported that curcumin inhibits the growth, development, and spread of cancer cells. The anti-inflammatory properties of turmeric might help in preventing atherosclerosis and lower blood pressure. Curcumin and lipophilic components of turmeric have been proven to have antibactericidal and antiviral activity. Although, turmeric has been abundantly used in traditional medicine, further research is required to validate their potential uses as treatment for specific diseases.

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