GUELPH FOOD ENGINEERING CONFERENCE'23

April 10, 2023

BOOK OF ABSTRACTS

Hensall FOODS

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UNIVERSITY of GUELPH ENGINEERING

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GUELPH FOOD ENGINEERING CONFERENCE

THE BOOK OF ABSTRACTS

School of Engineering
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Ph. D. Students

1. Biocomposite films from talc filled blends of plasticized post-industrial waste starch and biodegradable polymer for packaging applications

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The present work exemplifies the utilization of plasticized post-industrial waste wheat starch (30wt.%) into poly (butylene adipate-co-terephthalate) (70wt.%) to fabricate starch thermoplastic blend and composite films using the melt extrusion followed by cast film extrusion technique. The thermoplastic starch-based composites films were developed by adding 25wt.% talc masterbatch and effect of chain extender at two different processing temperatures of 160 °C and 180 °C were analyzed. The thermal, mechanical, rheological and morphological properties of the developed films were analyzed. The thermal stability of starch thermoplastic-based composites increased upon the addition of talc and chain extender. The DSC results exhibited an increase in melting temperature (16%) and crystallization temperatures (32%) of starch thermoplastic-based composites after addition of talc and chain extender. The inclusion of combination of talc and chain extender further improved the tensile strength and modulus of bio composite film by 5% and 517%, respectively, compared to thermoplastic starch film. In contrast, the %elongation at break of the composite film was reduced by 96% after adding 25% talc. However, the results obtained from FTIR and SEM analysis have showed that the addition of chain extender resulted in formation of chain entanglement in talc based thermoplastic starch composite films. This improved the dispersion of talc in matrix and further increased the interaction between PBAT and Plasticized starch. Thus, this work shows that a fine tuning of this biobased and biodegradable material can be performed in order to achieve industrial requirements for single-use applications.

2. Machine direction oreintation of biobased poly(butylene succinate-co-adipate): effect of stretching on morphological, mechanical and barrier properties

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The contamination of chicken products with microorganisms, such as E. *coli*, Salmonella, and Campylobacter sp., is a major concern in the food industry. Plasma-activated water (PAW) has emerged as a potential alternative to conventional decontamination methods as it can effectively eliminate microorganisms without affecting the meat quality. In this study, we evaluated the efficacy of PAW for decontaminating E. *coli* from the chicken surfaces. PAW was generated using a DBD-HVACP system operated at 90kV with a power output of 170W. Two Petri dishes each containing 12 mL of deionized water were exposed to direct plasma treatment with atmospheric air as working gas at 80% relative humidity for 20 mins + 10 mins with a 5-minute break in between to cool the electrodes. Chemical analysis of the generated PAW showed a pH of 1.47 ± 0.02, oxygen reduction potential of 572 ± 13 mV, and electrical conductivity of 3.13 ± 0.08 mS. The nitrate and peroxide concentrations were 1000 ppm. Boneless, skinless chicken breast purchased from local store were cut into 2 cm X 2 cm X 1 cm pieces and the background microflora was removed. The chicken pieces were then inoculated with 10^7 CFU/mL of E.*Coli* ATCC 25922. The samples immersed in the PAW for 5 minutes and 10 minutes showed a 1.78 ± 0.03 log and a 4.17 ± 0.08 log reduction, respectively. There was no discernible visual quality changes after treatment. These findings suggest that PAW has the potential to be an effective decontamination method for chicken meat.

3. 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.

4. Degrading aflatoxin m1 from milk: a novel approach using high voltage atmospheric cold plasma (hvacp)

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Aflatoxins are one of the highly toxic secondary metabolites with high decomposition temperatures, ranging from 237 ℃ to 306 ℃. Therefore, non-thermal treatments are preferred to ensure safe food while preserving food quality. High voltage atmospheric cold plasma (HVACP) is a novel non-thermal technology with the potential to reduce contaminants (e.g. mycotoxins) owing to reactive species such as ozone. Therefore, the aim of this study was to investigate the efficacy of HVACP to degrade Aflatoxin M1 (AFM1) in skim milk. A dielectric barrier discharge HVACP was performed at 90 kV using modified air (MA65: 65% O2, 30% CO2, 5% N2) fill gas for 1,3, and 5 minutes in a direct and indirect mode with no post-treatment or 4.0 h post-storage at room temperature. The optimum condition of toxin degradation was chosen for quality assessment including color, pH, viscosity, peroxide value (PV), Thiobarbituric acid reactive substance (TBARS) assay, and Fourier-transform infrared spectroscopy (FTIR). A one-minute HVACP treatment degrades 41.9% AFM1 in skim milk. However, greater reductions were seen after a short treatment and then post-treatment storage. Quality changes were less significant with shorter post-treatment time and indirect mode of exposure. These results suggest that a few minutes of HVACP treatment is sufficient to generate significant reactive plasma species in the milk while maintaining the quality property. Overall, HVACP is an effective solution for the decontamination of milk from AFM1.

5. Surface disinfection of wheat kernels using a gas phase hydroxyl-radical process: effect on germination characteristics, microbial load, and functional properties

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Microbes encountered on the surface of wheat kernels can negatively affect the safety, stability and functionality of the grain when used as an ingredient. Upon wheat germination, the growth of the microbes associated with the kernel is supported by the released nutrients along with the high temperature and humidity within the germination-chamber, thereby, leading to quality and safety issues. The objective of the study was to evaluate the efficacy of a gas phase hydroxyl-radical process for disinfection of wheat kernels and compare it with the treatment based on hypochlorite (3.5 % v/v). The hydroxyl-radical treatment is based on the UV-C degradation of hydrogen peroxide and ozone to generate a cloud of anti-microbial hydroxyl-radicals. The bleach treatment supported 5 Log reduction of the microflora on unsprouted kernels. In comparison, the hydroxyl-radical treatment was found to decrease the surface microflora on unsprouted kernels by 90% with no negative effect on germination power or development of the seedling. The gluten aggregation behavior and xylanase activity of the wholemeal also remained unchanged after the hydroxyl-radical treatment. This finding suggests that hydroxyl-radical treatment of wheat kernels has promise; but will require optimization in terms of UV-C dose, operating temperature, concentration of H2O2 and ozone to enhance the decontamination efficacy without negatively affecting the product functionality.

6. Effect of hot water treatment and storage temperature on the shelf-life of pitaya (dragon fruit)

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Pitaya is a tropical, non-climacteric fruit, belonging to the Cactaceae family. It has a short shelf-life, about 4 to 8 days under ambient conditions, which senescence is characterized by darkening of the bracts, intense softening, difficulty in separating the pulp from the peel and elevated water loss. As it is a newly cultivated crop with high market value, studies focused on extending its postharvest quality are necessary. Hot water treatments (HWT) have proved effective in reducing physiological disorders and postharvest decay. In this sense, we aimed to evaluate the effect of HWT at 49 °C (3 min) compared to untreated fruits (20 °C) under storage temperatures of 7 and 10 °C on the quality of pitaya over 33 days of storage. Fruits were removed from cold storage at 10-days intervals, transferred to shelf-life conditions at 23 °C for three days and then analyzed for weight loss, respiratory rate, total soluble solids, pH, titratable acidity, electrolyte leakage and color. Treated fruits maintained better visual appearance throughout the storage period. HWT associated with a storage temperature of 10 °C was efficient in reducing weight loss and respiratory rate after 30 days of storage. Untreated fruits stored at 10 °C showed the highest weight loss and elevated respiratory rate at the end of storage. Pitaya senescence was mainly marked by weight loss and the darkening and wrinkling of the bracts after 30 days of storage. Storage at 10 ºC combined with HWT was the best condition to maintain the postharvest quality of pitaya.

7. Understanding the contribution of structural features in foods, and their effect on component instability using 3D printing

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3D food printing can be used for rational design and prototyping of food scaffolds, allowing for the systematic study of the role structural components play on spoilage (lipid oxidation and protein rigidity) through storage. A zein-lipid ink (5:2:10 w/w zein/lipid/solvent) was printed using a 3D bioprinter (100µm resolution) with different printing conditions (i.e., time between deposition of successive layers), obtaining "fused" or "interrupted" structures (i.e., with continuous vs. shorter threads) and stored for 4 weeks (21ºC, 25% RH, in the dark). Structural features were assessed using atomic force microscopy (AFM), and location/crystallization of the lipids by polarized light microscopy (PLM). Lipid oxidation, protein structure, scaffold rigidity and formation of disulfide bonds were monitored using optical tools (Raman (micro)spectroscopy, FTIRS) and luminescence spectroscopy of an intrinsic fluorophore (tyrosine) and an oxidation-sensitive probe (BODIPY-C11)) at 4-day intervals. AFM unveiled structural features (e.g., pores). BODIPY-C11 emission intensity in the interrupted and fused structures increased by 2.3±0.3, & 3.6±0.4 fold, respectively, during storage. Lipid compartmentalization in pores of interrupted structures likely explains the lower extent of oxidation, confirmed by PLM. Tyrosine emission intensity increased by 2.0±0.1 & 1.8±0.1 fold, (interrupted, fused, respectively), corresponded to increased ordered secondary structures (interrupted). Raman (micro)spectroscopy mapped the progressive lipid oxidation and disulfide bond formation via changes in spectral bands at 1400 and 520 cm-1, respectively. The rational design of food matrices using 3D printing provides insights into how structure modulates matrix properties and advances the feasibility of developing and prototyping future food matrices that delay spoilage.

8. Morphological design in binary blends of two biodegradable polyesters and its effect on mechanical performance

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In this research, a moderate level of compatibilization in binary blends of two home-compostable biopolyesters, namely bio-based poly (butylene succinate co adipate) (BioPBSA) and poly (butylene adipate co terephthalate) (PBAT), was achieved by a blend design approach, and a wide range of morphologies was obtained based on the blend composition through extrusion processing method. A clear transition was observed from droplet-matrix morphology in the blend with the lowest content of PBAT dispersed phase to a co-continuous one in the blend with an equal concentration of two biopolyesters. Improved interaction between two biopolymers was evidenced by the rheological analysis as two blends containing 30 and 40 wt% of PBAT showed higher complex viscosity and storage modulus compared to the individual biopolymers. This was correlated to a higher melt elasticity and compatibilization effect in these two blends. The incorporation of PBAT in BioPBSA helped enhance the deformability and impact strength of the blends. The elongation at break value increased from 276% in neat BioPBSA to 331 and 347% in the blends containing 30 and 40 wt% of PBAT, respectively. The impact strength was improved from 425 J/m in neat BioPBSA to non-break mode in all three blends due to a significant change in morphological behavior. Moreover, results from thermogravimetric analysis confirmed that all the blends showed almost the same thermal stability as compared to neat biopolyesters. The blending of BioPBSA with different content of PBAT was shown to have a minor effect on the melting and crystallization temperatures of BioPBSA.

9. Trends and hotspots in nanocatalysed bioprocessing of food waste streams: A bibliometric analysis

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Management of organic waste streams generated by agri-food industry is of significant concern worldwide and critically important for ensuring environmental sustainability. These waste streams contain functional molecules and nutrients such as nitrogen, phosphorus, carbon, and several bioactive compounds. Their improper disposal can have adverse impacts on the environment by contamination of land and water ecosystems. One potential approach to mitigate this problem is through their transformation to value-added products such as biofuels, fertilizers, hydrogen, or small molecules by using chemical and biochemical processes. However, applicability of such valorization processes to diverse waste streams, and low process yields and productivities are challenges to their adoption. Such problems can be overcome by the use of nanotechnology which has proved to be successful in other fields. This study's focus is to evaluate the current research trends and potential gaps involving the application of innovative nanotechnologies towards sustainability through nutrient recovery and fermentation and generating value-added products. A bibliometric analysis was performed using peer reviewed publications over the past decade (2013 to 2022) on nanoparticles and their applications towards these two fields by evaluating annual publication volumes, research areas and keyword co-occurrences. The findings highlight a growing interest in nanotechnology for these processes, however most research is focused on agricultural waste with limited reports on agri-food processing waste. Furthermore, more efforts have been directed towards implementation of nanotechnology (e.g., microfluidics) than its optimization for process development. These indicate major research gaps that need to be filled to promote bioprocessing for a bio-based economy.

10. Development of low-sugar dehydrated mango products with stevia powder

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This study investigated the proximate composition, moisture sorption isotherm, and drying behavior of mango pulp (cv. Ashwina) to develop low-sugar dried products using stevia powder. Water sorption isotherm of mango pulp was analyzed at different water activity levels (0.11 to 0.93), revealing equilibrium moisture content of 19.10% and 20.90% at water activity levels of 0.60 and 0.65, respectively, with a calculated monolayer moisture content of 8.19% using the BET equation. Six formulations were made with varying levels of stevia and skim milk powder (SMP) with mango pulp for this study. The developed products had higher nutrient content than that of fresh pulp except for vitamin C and fat content. The protein content of a sample containing 95% mango pulp and 5% SMP was about two times higher than the fresh sample, whereas the sample containing 100% pulp contained almost a similar amount of protein as that of fresh pulp.

The pulp was dried at different thickness (3 mm, 5 mm, 7 mm) at 65 ºC. Then the pulp was dried at different temperatures (55ºC, 60ºC and 65ºC) at 5 mm thickness in a cabinet air drier.

The drying rate decreased with the increase in thickness, and the drying time decreased with an increase in temperature. The activation energy (Ea) was calculated as 2.843 Kcal/g-mole for 5mm thick pulp. Among the six developed products, the control product (100% Pulp) contained less initial solid exhibited the fastest drying rate (0.252/h), while the product with higher initial solid (90% Pulp+10% SMP) was found to be resistant to drying, (0.192/h).

The sensory evaluation showed that the control (100% pulp) is mostly accepted by the panelists followed by product with 5% SMP, while the rest of the samples containing stevia powder (0.25 to 0.50%) were equally accepted as “like slightly” as per hedonic rating test. In conclusion, stevia can be used as a sugar substitute in low concentrations in the development of low-sugar dried mango products with enhanced nutrient content, although it has a slight bitter aftertaste.

11. Implications of maximum residue limits on trade in food commodities

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Maximum residue limit (MRL) is the maximum levels of pesticide residue that can be present in food products. In recent years, the issue of MRL has become increasingly important in international agri-food trade. These limits are set by regulatory authorities to ensure that the consumption of these products does not pose a health risk to consumers. In Canada MRL is regulated by the Pest Control Products Act of (Health Canada's Pest Management Regulatory Agency). Since different countries often have different MRL for the same pesticide, it creates barriers to trade. In the past years, there has been several rejections of food commodities from the importing countries due to excessive pesticide residues. In the Canadian context, managing the impacts of differing pesticide MRLs on trade in agricultural products is a complex issue that requires careful consideration of various factors. Some of the key factors that need to be considered include regulatory frameworks, international trade agreements, and consumer preferences. To manage the impacts of differing pesticide MRLs on trade in agricultural products, the Canadian government has taken several measures. These include working with trading partners, enhancing testing, the MRL database, and monitoring and providing information and support. By doing so, Canada can continue to export its high-quality agricultural products to markets around the world while ensuring the safety of consumers. Therefore, this work highlights the global pesticide MRLs, the Canadian MRL database, monitoring techniques at various farm and processing levels, and its impact on international trade.

12. Applying fluorescence fingerprints for the detection of adulteration in maple syrup

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Maple syrup is often adulterated by dilution or substitution with other syrups. Fluorescence fingerprints (excitation-emission matrices or EEMs) rely on the presence of fluorophores in samples, and can provide valuable information to detect adulteration. This study evaluates the use of EEMs to detect maple syrup adulteration. EEMs of pure amber and dark maple syrups, and admixtures with common adulterants (beet, corn, and rice syrups at 1-50%), were obtained using a Fluoromax-4 spectrophotometer (λex=250-500 nm, and λem=270-700 nm, slits=3 nm). The ratio of intensities of the two most prevalent EEM features was calculated. A feed-forward artificial neural network (ANN) built on Tensorflow & Keras was developed based on emissions at two selected excitation wavelengths (train/test/validation split = 50/30/20 %). The EEMs were also analyzed, in their totality, as images using a convolutional neural network (CNN) approach (train/test/validation/test split = 80/10/10 %). EEMs of the samples allowed for the identification of valuable discriminatory information. The ratio of the emission intensities at (I425/I350) at λex= 290 nm provided easy discrimination of adulterated samples (70-86% correct identifications depending on the adulterant). Applying computational algorithms improved detection. ANN, using the emission spectra at λex = 290 nm and 350 nm, correctly identified adulteration type and level (>82 % for all samples and >90% for C3 plants). The CNN approach, utilizing the full EEMs image, accurately classified 80-100% of adulterated dark syrups. This study aids in providing a quick monitoring tool for maple syrup adulteration based on its chemical composition, improving food safety and quality.

13. Effect of hydrogen mix drying (HMD) on the quality of tomato slices

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Drying is the most conventional method of food preservation, but the combination of heat and prevalence of oxygen has the ability to promote the chemical and enzymatic reactions in foods. The degradation of colour and nutritional aspects during drying is an inevitable phenomenon. Chemical reagents like sulphites have been proven effective in industrial drying to retain colour and nutritional content of dried food products.Tomato slices pre-treated with potassium meta bisulphite exhibited greater levels of lycopene, carotenoids and had been dried in the shortest time with better rehydration. Final residues of sulphites present in the end products had been found to have a deleterious effect on the health of the consumers. An alternative to sulphiting would be the use of hydrogen gas in the drying atmosphere which has a reducing property, retains colour and nutrition without any end residues. In this study, a comparative drying of tomato slices has been performed with three different gaseous environments: 100% air drying, 100% nitrogen drying and hydrogen mix drying (HMD: 91% nitrogen, 5% carbon dioxide and 4% hydrogen) at 60º C. For 100% nitrogen drying and HMD, a gas flush was given to the plenum chamber every 10 min to avoid depletion of gas concentration and moisture condensation within the system. The drying time of the tomato slices of thickness (10 ± 5 mm) was 8 h for both 100% nitrogen drying and HMD from an initial moisture content of 1233.33% (dry basis) to 15 – 20 % (dry basis). HMD had the best colour retention with minimum darkening of 10.1% (ΔE value of 10.1) and lycopene retention of 94.28%. Total phenolics content of HMD and 100% air-dried samples did not have a significant difference ($p<0.01$). Rehydration ratio was the maximum for HMD tomato slices. HMD could be used in industrial drying to preserve colour and nutritional notes in dried food products without any compromise in health factors.

14. Performance improvement of tray drying system with solar desiccant wheel for food drying

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Tray drying is a widely used method for drying food products, but it often consumes a substantial amount of fossil fuel or electricity, leading to high operational costs and adverse environmental impacts. To address these problems, a tray drying system that utilizes renewable energy sources and a desiccant wheel to remove moisture from the drying air is proposed. The system includes a solar air heater and a desiccant wheel that work together to provide a continuous supply of warm, dry air for food drying. Simulations of the proposed system were conducted using TRNSYS software, and it was found that although solar energy alone cannot provide the total required energy for the drying process, it can provide most of the energy needed. The results indicate that the proposed system can significantly reduce fossil fuel or electricity consumption and emissions associated with food drying. Additionally, the quality of the dried food products can be improved by reducing the humidity of the input air. Desiccant wheels can help remove moisture from the drying air before it is heated, resulting in a more efficient drying process and shorter drying times. This system is particularly suitable for use in hot and humid cities like Toronto and Vancouver where high humidity levels can make traditional drying methods difficult. The proposed system offers a sustainable and cost-effective alternative to conventional tray drying systems, particularly during summer months when solar energy is readily available. Furthermore, the proposed system has the potential to promote environmentally-friendly practices in the food processing industry.

15. Hybrid dehulling technology for hard minor-millets

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Millets, also termed 'Nutri-cereals', have recently gained global importance after the year 2023 was declared as "International Year of Millets" by the United Nations. Millet crops are highly climate resistant and millet grains are rich in nutritional value. In general, they have medium to low glycemic index, and therefore, considered as diabetic friendly. They are classified into major, and minor millets. Sorghum, finger and pearl millets are considered as major millets whereas, kodo, foxtail, proso, barnyard, little and browntop millets are listed under minor millets. All minor millets possess both harder non-palatable outer shells termed as 'hull' and soft seed coat called 'bran' while, major millets contain only bran. dehulling is a mandatory unit operation for all minor millets to make them palatable and suitable for further processing. Conventional dehulling of cereals is achieved either by abrasion or impact principles. Dehulling of all minor millets by any of the abrasion and impact has shown good results in the previously reported studies except for two minor millets namely, kodo and browntop millets. In the current study, SEM analysis of kodo and browntop millets revealed multiple and thick hull layers. Therefore, a hybrid approach involving combined and simultaneous application of abrasion and impact principles to dehull the hard kodo and minor millets was studied. The abrasion system consisted of an abrasive stone of grit size #24. The rotating speed of stone was controlled by a variable frequency drive. The impact chamber consisted of an ABS plastic impeller rotating at 3000 rpm. Abrasion at 1800 rpm for 60 seconds followed by impact dehulling of kodo millet and abrasion at 1800 rpm for 30 seconds followed by impact dehulling of browntop millet increased the dehulling efficiency by 25 and 20%, respectively. Additionally, the percentage of brokens due to dehulling was also significantly reduced. Dehuller with this hybrid technology can also be utilized for polishing if the output from dehuller is re-conveyed into the abrasion chamber. Therefore, this approach has the potential for dual applications such as efficient dehulling of harder millets and polishing.

16. Microwave assisted hydrothermal pre-treatment of finger millets: An alternative industrially feasible technology

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Millets are also called as 'Nutri-cereals because of their rich nutritional profiles. They are classified into major and minor millets and the calcium-rich finger millet falls under the category of major millets. Decortication refers to the removal of grain's seed coat. It is one of the major primary processing operations of food grains. Like other cereals, finger millet also has an outer seed coat and is rigidly attached to the endosperm, making decortication complicated. Hydrothermal thermal pre-treatments are well proven to ease decortication, but conventional hydrothermal treatments require long-duration steeping, steaming, and drying involving more effluent and higher specific energy consumption. This study investigated an alternative microwave-assisted hydrothermal pre-treatment where, the finger millet grains were soaked in water and treated at different levels of microwave power densities ranging from 0.25 to 1.0 W/g. Further, the grains were dried in same microwave system at 1.0 W/g power density till the initial moisture content of grain before soaking was obtained. The pre-treated grains were later decorticated in an abrasive decorticator at 1800 rpm for 2 min. These decortication parameters were determined by a set of preliminary studies. Microwave-assisted water absorption in 1:1 (w/v) ratio at 0.5 W/g microwave power density was found to be optimum condition resulting in maximum water absorption after 6 minutes, followed by drying for 22 minutes enhanced the decortication efficiency by 13% and reduced the cooking time by 60 % with higher rehydration ratio. The processing time and specific energy consumption of the microwave assisted processing were 90 % lesser than the conventional hydro-thermal treatments. The microwave power density was maintained less than 1.0 W/g during the experimentation to make the process easily replicated at industries for bulk quantity applications. The microwave assisted hydrothermal pre-treatment has the potential to reduce effluent generation, and energy consumption, and therefore to replace or supplement conventional hydrothermal systems at industries.

17. Preparation, optimization, and characterization of niosome nanocarriers loaded with Azadirachta indica seed oil as a new approach to combat agricultural diseases

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Nanotechnology has aided in an agrotechnological revolution that promises to transform the effective agricultural system and ensure the world's food supply. However, potential toxicological concerns, unknown life cycles of nanomaterials, high cost, interactions with the biotic or abiotic environment and their possible amplified bioaccumulation effects are some of the barriers which needs to be overcomed. Niosomes are nanocarriers composed of non-ionic surfactants, which are inexpensive, has good encapsulation efficiency, more stable, relatively nontoxic, and biodegradable. In this study, Azadirachta indica seed oil-loaded niosomes were prepared by thin-film hydration method utilizing different molar ratios of surfactants (Tween 80) and stabilizers (Soy lecithin). The characteristics of niosomes were broadly explored by Zeta Potential, Dynamic Light Scattering, Transmission Electron Microscopy, Fourier Transform Infra-Red Spectroscopy, and others. Further, the prepared niosomes were statistically optimized using the Box-Behnken experimental design. The optimized condition displayed optimum particle size (<150 nm) and acceptable percentage entrapment efficiencies (> 70%). The prepared niosomes could have the potential to be used in agriculture for the targeted delivery of natural fungicides or pesticides to combat agricultural diseases, and further research will be conducted in this area.

18. Implementation of BIMBA framework to ensure food safety from Farm-to-Fork

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In the recent times, application of modern mechanised practices and technologies in every facet of agricultural food production vis-à-vis to crop production, harvesting, handling, processing, transportation, storage, and distribution has not only ensured food security but also affordability to the millions of people across the globe. The technology also enabled the expansion of markets for food products beyond the boundaries, e.g., food produced in tropical countries is now available in polar countries and vice versa. Since the harvested raw products undergo multiple stages of processing and often traverse multiple geographies on its journey to reach the platter of the end consumer, the risk of contamination has increased several-fold when compared to the food that was produced in the back yard. The governments agencies across the world have recognized the importance of having food safety processes and imposed regulatory measure such as food recalls through voluntary disclosure by the food processors or observed illness among populace after consumption of unsafe food or consumer complaints on contamination and so on. The primary challenges of many of the existing practices of ensuring food safety are the delay in the identification of unsafe food, decision making process for a recall, dissemination of recall decisions, tracing the source of contamination and eventual removal of recalled products from the store shelves.

Leveraging the huge technological advancements in the field of information technology (IT), BIMBA (Blockchain/IoT/Machine Learning (ML)/ Big data and Artificial Intelligence) has been designed and integrated to provide an overarching framework to address the current challenges in ensuring food safety. Using IoT, the real time data of identified parameters are collected and collated at the every stage (farm/processing/transportation/distribution/ stores/shelves) and processed to identify the potential contamination (microbial/mycotoxin/ pesticides/undeclared allergens) at each stage of food supply chain (Edge Computing) before aggregating at a cloud based Big Data storage after vetting the data through blockchain. The ML powered algorithms will be processing the aggregated data at defined intervals automatically for all potential recall scenarios and instantly disseminates the outcomes to the intended recipients for further action.

19. Deamidation-involved reactive extrusion: a potential approach to improve the performance of pulse flour as a plant protein ingredient

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Pulse flour is an excellent allergen-free source of plant protein. However, the presence of antinutrients and weak functional properties limit the application of pulse flour as a plant protein ingredient. Extrusion is a thermal method that uses heat, shear, and pressure to process food materials. It can destroy pulse flour antinutrients by degrading their structure, changing their chemical activity and/or forming insoluble complexes. Deamidation is a chemical method that uses acid/alkali to catalyze the hydrolysis of amide-containing amino acids of pulse protein, converting the amide group into a carboxyl group or carboxylate ion under acidic and alkaline pH, respectively. This change could increase the flexibility of pulse protein, resulting in improved functional properties of pulse flour. Reactive extrusion refers to a manufacturing method that combines chemical processes and extrusion, using the extruder as a continuous chemical reactor. Inspired by the concept of reactive extrusion, the idea of developing deamidation-involved reactive extrusion to modify the antinutritional and functional properties of pulse flour in one step is proposed. In the proposed method, an acid/alkali solution will be injected into the extruder barrel to induce deamidation. Meanwhile, the acid/alkali involved in deamidation can promote the effect of extrusion on removing antinutrients in pulse flour. The extensive heat involved in extrusion can also enhance the effect of deamidation on modifying the functional properties of pulse flour, achieving a win-win situation. Pulse flour processed through the deamidation-involved reactive extrusion is expected to become a versatile plant protein ingredient with promising performance.

20. Lipase-catalyzed glycerolysis, a viable solution to develop fat alternatives

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The increasing demand for plant-based meat products, particularly replacements for animal adipose tissue, has the food industry rushing to find healthier and more environmentally friendly alternatives. Currently, the focus is on tropical oils and fats, e.g., coconut oil that in addition to health and sustainability issues, lacks the functionality of an ideal animal fat alternative. Glycerolysis (GL) is a mild enzymatic technique to structure a variety of oils by converting native triglycerides (TAGs) into mono- (MAGs) and di- (DAGs) acylglycerides. Since MAGs and DAGs crystallize at higher temperatures than TAGs containing the same fatty acids, glycerolysis products (GPs) exhibit higher melting point, making them a good candidate for development of adipose tissue mimetics. This study aims to modify and scale up the GL process of different plant oils, e.g., palm olein, tigernut, peanut, cottonseed, and rice bran oils. GPs were then converted to oleogels, using ethyl cellulose (EC) with different molecular weights (20 cP, and 45 cP) at 5% w/w to emulate desirable rheological and textural attributes of adipose tissue. Product characteristics were comparable at laboratory and pilot plant scales, supporting the commercial viability of the process. Dramatic changes in the melting point, solid fat content (SFC) and microstructure were found after GL. Comparison of the thermal softening behavior and mechanical properties of the some of EC oleogels with those of whole pork, beef, and lamb adipose tissue showed their potential to mimic adipose tissue in the new generation plant-based meat analogs.

21. Glyphosate residue detection in individual grain of chickpea and yellow pea using surface-enhanced Raman spectroscopy

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In this study, the surface enhanced Raman spectroscopy (SERS) was used to determine the glyphosate residue level in pulses. Cys-AuNPs were used to collect Raman spectra for glyphosate-treated chickpea and yellow pea at concentrations of 0, 5, 10, 15, and 20 ppm, and chemometric techniques were used to analyse the amplified SERS signal. Principal component analysis (PCA), k-nearest neighbours (KNN) and partial least squares (PLS) regression were used to analyse the acquired datasets. The results showed that principal component analysis (PCA) in conjunction with second derivative yielded the highest classification accuracy in chickpea (86%) and yellow pea (89%). The partial least square regression (PLSR) model applied to the first derivative preprocessed training and testing dataset depicted highest correlation coefficient of determination for chickpea (R2 = 0.95) and lower root mean square error of prediction (RMSEP = 1.105), whereas second derivative pre-processed data with PLSR showed the highest results in yellow pea (R2 = 0.99, RMSEP = 1.709) as compared to the other prediction model. The SERS and chemometrics approaches have the potential to implement in supply chain for the fast detection of glyphosate residues in pulses.

22. Potential application of computer vision techniques for determining hard-to-cook (HTC) quality and cooking time of pulses

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This study reviews the potential applications of computer vision technologies in determining hard-to-cook (HTC) quality and cooking time of pulses. While pulses are a rich source of protein, some varieties can be challenging to cook, resulting in extended cooking times and lower nutritional value. Developing methods to predict cooking times and HTC phenomena is crucial for optimizing their nutritional value and improving cooking efficiency. Traditional methods for determining cooking times are time-consuming and challenging to automate, but non-destructive techniques like imaging can be implemented in real-time application.

Several studies have evaluated the potential of hyperspectral and Vis/NIR spectroscopy imaging techniques in detecting hard-to-cook defects and predicting cooking time for pulses. These studies have developed predictive models for detecting hard-to-cook (HTC) chickpeas and beans and predicting cooking time using hyperspectral, NIR spectroscopy, and other computer vision techniques.

Computer vision technologies have the potential to support the pulse industries by providing real-time detection of hard-to-cook defects and predicting cooking time for different varieties of pulses. Implementation of these techniques could significantly improve the nutritional value of pulses and optimize cooking efficiency, leading to substantial benefits for the food industry and consumers alike

23. Real-time detection of Fusarium infection in moving corn grains using video analysis

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Online detection and removal of individual Fusarium head blight (FHB) infected corn grains from the processing lines has been a challenging issue due to smaller kernel size and bulk grain handling. In this study, You Only Look Once (YOLO) version 5 object detection technique was utilized to detect FHB infection in individual corn grains moving on the processing lines. A heterogenous dataset containing images and video frames of healthy and FHB infected corn grains in different illuminations were used for this study. Four different variants of YOLOv5 – small(s), medium(m), large(l) and nano(n) were trained with the monolayer of touching and non touching corn grains and evaluated for their detection performance and speed of detection. The mean average precision calculated at IoU (Intersection over union) threshold of 0.5 (mAP@50) was 99, 98, 95 and 96% for YOLOv5-s, YOLOv5-m, YOLOv5-n, and YOLOv5-l models, respectively. The detection speed in videos was 3.9, 1.6, 9.8 and 0.8 FPS (frames per second) for YOLOv5-s, m, n, and l models, respectively. The best combination of mAP, detection speed and lower false negatives was achieved by YOLOv5-m model. YOLOv5-m has the potential for use in online detection of Fusarium infection in corn grains.

Master's Students

24. Decontamination of e. Coli from chicken surfaces through immersion in plasma-activated water

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The contamination of chicken products with microorganisms, such as E. coli, Salmonella, and Campylobacter sp., is a major concern in the food industry. Plasma-activated water (PAW) has emerged as a potential alternative to conventional decontamination methods as it can effectively eliminate microorganisms without affecting the meat quality. In this study, we evaluated the efficacy of PAW for decontaminating E. coli from the chicken surfaces. PAW was generated using a DBD-HVACP system operated at 90kV with a power output of 170W. Two Petri dishes each containing 12 mL of deionized water were exposed to direct plasma treatment with atmospheric air as working gas at 80% relative humidity for 20 mins + 10 mins with a 5-minute break in between to cool the electrodes. Chemical analysis of the generated PAW showed a pH of 1.47 ± 0.02, oxygen reduction potential of 572 ± 13 mV, and electrical conductivity of 3.13 ± 0.08 mS. The nitrate and peroxide concentrations were 1000 ppm. Boneless, skinless chicken breast purchased from local store were cut into 2 cm X 2 cm X 1 cm pieces and the background microflora was removed. The chicken pieces were then inoculated with 107 CFU/mL of E.Coli ATCC 25922. The samples immersed in the PAW for 5 minutes and 10 minutes showed a 1.78 ± 0.03 log and a 4.17 ± 0.08 log reduction, respectively. There was no discernible visual quality changes after treatment. These findings suggest that PAW has the potential to be an effective decontamination method for chicken meat.

25. An intelligent system based on advanced machine learning and deep learning techniques for quality classification of coffee beans

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Maintaining the quality of coffee is crucial for the exporting nations due to its extensive trade on international markets. Today, parsing processes are unreliable, time-consuming, and subjective due to the usage of human control methods. Automatic systems are required to get rid of such undesirable circumstances. The usage of Non-destructive testing methods have become more significant in assessing the quality of food. The possibility for adopting Intelligent System for food applications has increased because to improvements in machine learning and deep learning techniques for quick analysis with higher classification accuracy. The Aim of this System is to grade coffee beans by using image processing and Supervised Machine learning approach with the use of transfer learning method by utilizing several pretrained Neural networks-based models which compares and depicts the efficient approach which can grade coffee beans quality with higher accuracy. Consequently, choosing the right image processing and classification algorithms lays the path for more accuracy in the higher-level decision-making process.

26. Poly (Butylene Adipate-co-Terephthalate)/talc-based blown film for sustainable packaging application: impact of stretching on the mechanical and thermal properties

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The accumulation of plastic in the environment is significantly influenced by the flexible packaging industry and finding a lasting solution to this problem is paramount. Although poly (butylene adipate-co-terephthalate) (PBAT) films are biodegradable, due to their semi-crystalline makeup, they have poor barrier and thermo-mechanical properties. In this research, biodegradable PBAT-composite films reinforced with talc particles (15 and 25%) were created via blown-film extrusion followed by unidirectional orientation to optimise their structural, mechanical, and barrier properties. According to DSC result, adding 15% and 25% talc increased percentage crystallinity by 10% and 52% over neat PBAT while recording an increase of 42% and 125% following stretching (SR 5.5 and 6.0) in comparison to neat PBAT films stretched at SR 2.0. Talc has the potential to influence crystal growth due to its nucleating ability. This had a major impact on PBAT's mechanical characteristics, transforming it from ductile to brittle fracture as stiffness rose. In comparison to the neat PBAT, the elastic modulus increased by ~68% and ~162% for the unstretched composite samples with 15 and 25% talc, respectively, and reached ~1939% and ~2486% at SRs of 5.5 and 6.0. Stretching (SR 5.5 and 6.0) reduced the WVP of PBAT/talc-based composite blown films by 61% and 62% in comparison to unstretched PBAT films, respectively. An increase in crystallinity and a decrease in free volume were the causes of the improvement in barrier property. The created stands as a biodegradable substitute for single-use plastics in food packaging applications.

27. Utilization of walnut shell waste for the fabrication of green composites using a biodegradable polymer blend: influence of a compatibilizer on the performance

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Conventional use, production and disposal of petroleum-based single-use plastic packaging has become an increasingly widespread issue resulting in harmful environmental impacts from improper waste management practices and accumulation of toxic materials. The fabrication of a sustainable and easily discarded packaging alternatives can be produced using non-toxic, biodegradable and home-compostable packaging materials with the addition of a natural filler (at a high biomass load). Home-compostable polymer, poly(butylene succinate-co-butylene adipate) (PBSA), exhibits respectable strength and impact properties while poly(butylene adipate-coterephthalate) (PBAT) displays a high % elongation at break (>300%). Utilizing a polymer blend consisting of PBSA and PBAT would present balanced mechanical properties when incorporating a natural filler for packaging applications. However, a challenge with the addition of a low-cost filler and the combination of two polymers is the weak interaction among components, leading to inferior mechanical and thermal properties. A solution to improve adhesion between polymers and the natural filler is the use of a compatibilizer. This research examines the effect of a compatibilizer between a home compostable PBSA/PBAT polymer blend and natural filler through the determination of its mechanical and thermal properties. The introduction of a compatibilizer with polymer composites improves interfacial adhesion making them suitable for rigid packaging applications.

28. A review of lipoxygenase enzyme reduction methods in pulse-based products for flavour improvement

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Pulses are among the most versatile and nutritious foods, containing high levels of vitamins, minerals and protein while being easy to grow and low in cost. The World Food Organization recognizes pulses as one of the most important and valuable food crops as they have served as a stable food source for a long time. Yet despite their many benefits, pulses have remained on the periphery of Western cuisine due to the aversion to their distinct beany taste resulting from lipoxygenase enzymes. Lipoxygenase (LOX) is an enzyme which catalyzes the oxidation reaction of polyunsaturated fatty acids into hydroperoxyl derivatives and acids. These products are typically bitter and ultimately responsible for the perception of taste. Hence, the objective of this study is to review current methods for removing LOX from pulse-based products, with the ultimate goal of identifying the most effective methods. The removal of lipoxygenase content at present can be accomplished in three ways: biotechnologically, chemically, or physically. Furthermore, novel techniques for minimizing lipoxygenase are being developed due to shorter process times which results in reduced heat damage, as well as improved flavor, texture, colour and vitamin retention in the final product.

29. Non-destructive testing techniques in plant-based milk: a bibliometric analysis

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Plant based milk or non-dairy milk is a fast-growing market. It is considered as an excellent substitute for dairy milk due to low calorie count and fat as compared to conventional dairy products. It can also be used as a lactose-free substitute by those who are lactose intolerant or have any associated allergies to dairy products. Since the consumer is impacted by the food and beverage sector, routine inspection of production and processing equipment is necessary to guarantee not only regulatory compliance but also confidence in product quality for consumer safety. Therefore, non-destructive testing plays an important role as product quality and safety are crucial in all industries. In this study, a bibliometric analysis was conducted to assess the scientific advancements made in the usage of non-destructive testing techniques for plant-based milk to determine the progress as well as the limitations over a span of two decades. More than 150 publications were considered from year 2000-2021 for this study from Scopus database. The publications were categorized according to titles, abstracts, and keywords. To determine the present research trend, the subject area, document kinds, nation of origin, and the number of publications were taken into consideration. When compared to other non-destructive approaches, the analysis of this study showed that the use of ultraviolet radiation was most prevalent in plant-based milk. This research area needs to be further investigated considering the rising popularity of plant-based milk consumption in developed countries, as shown by the findings of this study. Additionally, given the rising popularity of veganism and fitness enthusiasts, more research is required using various non-destructive testing techniques for non-dairy substitutes.

30. Transformation of agriculture greenhouse gas emissions into value-added commodities with cold plasma

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Approximately 10% of Canada's GHG emissions are from crop and livestock production. Agricultural activities emit carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Cold plasma is a novel technology that can transform these waste gases at room temperature with minimal energy into valuable chemicals. For example, cold plasma can transform GHG emissions, such as CO2, CH4, and N2O, into compounds that can be further processed into fuel, fertilizer, or bioplastic.

Highly energetic electrons generated using a high voltage gradient transfer their energy to the unionized heavy gas molecules by elastic collisions. The now energetic heavy gas particles can catalyze room-temperature chemical synthesis to produce fuel, fertilizer, and bioplastic. Experimental results found high voltage cold plasma operating at 80 kV with low energy consumption of 160 watts can generate 100,000 ppm (100 mL) of carbon monoxide (CO) from 1L of CO2 gas. CO gas has many industrial uses, from synthetic fuel production to organic chemistry. The introduction of CH4 and N20 into the plasma can generate hydrogen gas (H2), ammonia (NH3), and ethane (C2H6). Further investigation into factors influencing cold plasma-driven gas conversions, such as voltage, gas composition, discharge volume, gas pressure and electrode geometry, will aid in determining favourable conditions to maximize CO, NH3, H2, and C2H6 production at room temperature. Optimized parameters will allow transitioning from existing, high-energy, thermal, and chemical processes using petroleum-derived products to a non-thermal, sustainable, low-energy alternative approach that can capture greenhouse gases while simultaneously reducing energy and water use.

31. High voltage atmospheric cold plasma (HVACP) decontamination of liquid whole egg and egg components

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Global consumption of liquid egg products has been increasing gradually and is projected to expand even more in the following decade. In Canada about 30% of eggs are broken for processing. Contamination with Salmonella enterica serovar Enteritidis remains a major safety and quality concern associated with egg consumption. In 2019 Salmonella Enteritidis accounted for 51% of all reported human salmonellosis cases nationwide. High Voltage Atmospheric Cold Plasma (HVACP) is a novel non-thermal processing technology with great potential for microbial decontamination of heat-sensitive foods, such as eggs. The bactericidal effect of HVACP is attributed to the generation of free electrons, ozone, peroxides, reactive oxygen and nitrogen species. These reactive gas species (RGS) induce physical stress and degrade cell DNA and RNA. The objective of the current study is to evaluate the efficacy of HVACP technology in the inactivation of Salmonella Enteritidis in liquid whole egg and egg components (white and yolk). Effects of the principal HVACP parameters such as gas composition, humidity, treatment time and post-storage time were examined during direct exposure HVACP treatments of 10 mL of liquid whole egg, egg white and egg yolk inoculated with Escherichia coli as a surrogate for Salmonella species. Egg protein coagulation, changes in pH, conductivity and RGS are discussed. Moreover, results of the chemical treatments with the common plasma-generated antimicrobial species, hydrogen peroxide and nitrate, are presented, highlighting the complexity and buffering capacity of liquid egg matrix. In conclusion, we intend to demonstrate the application and limitations of HVACP treatments of liquid egg.

32. Modification of microwave oven and real-time temperature measurement of ready-to-cook microwavable foods

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Microwave ovens are indispensable appliances due to end-use convenience. But the major pitfall in microwave cooking is the non-uniform heating that can compromise the safety and quality of the cooked products. In this research, we investigated the effect of the packing arrangement of baby potatoes (3-5 cm diameter) in microwaveable packages of different geometries on temperature distribution. A consumer microwave oven (2450 MHz frequency, 1000 W rated output power) was modified and equipped with a fibre optic system to monitor the potatoes and package headspace temperatures during microwave cooking. To this end, an external motor was installed to control the rotation of the internal and external turntables that held the test package food and temperature monitoring system, respectively. Baby potatoes (~445 g) were arranged in different airtight polypropylene containers equipped with a steam valve: (1) cylindrical container (5.2 cm radius, 14.7 cm depth) in 3 layers; and (2) cuboid container (14.5 L x 14.5 W x 8.5 H cm) in 2 layers. The temperatures at the geometric centre of potatoes located near the periphery and centre of the containers, as well as the headspace temperature of the container were monitored throughout the entire cooking process. The potato on the container periphery reached 100-120oC around 2 min of cooking, and the container headspace reached 100oC in 3 min while the shadowed potato took 3-4 min to reach 100oC. The packaging geometry had a significant effect on the heating of the shadowed potato but not on the periphery potatoes and headspace air. This study will contribute to the understanding of package design effect to reduce the shadowing effects, thereby enhancing the heat distribution uniformity in ready-to-cook products.

33. Working at standard height versus an adjustable height during a precision, cooking-specific task- does it make a difference?

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We know that cooking is an essential part of life and it's not surprising that the restaurant industry in Canada brings in 79 billion dollars each year (1.5% gross domestic product) and employs 1.2 million people (3). Food service work is considered a physically demanding job and as such, involves a risk to workers for developing musculoskeletal disorders. Food service workers often work long hours, spend nearly 100% of working time in prolonged standing, often in awkward and relatively static postures, and engaging in repetitive movements, in a fast-paced environment, often without taking periodic breaks or a break in general (1). In addition, cooks engage in a high level of task variety, and are forced to work at a standard, non-adjustable height between 34-36 inches for most tasks. One of the principles of ergonomics states to "work at the proper height" which is dependent on the type of task (heavy, light, precision) being performed. Given that cooks will be of different body heights it is reasonable to wonder how working at a set table height may be affecting musculoskeletal health as well as workers perception of their workstation and physical discomfort. A recent (2021) study using direct biomechanical methods, and looking at bakers in Iran, has specifically suggested that less prolonged neck flexion, less constrained trunk posture, and working at appropriate heights is recommended to reduce risks and suggests furthering the research by investigating muscle activity levels and their relation to posture of neck and back, in bakers (2). In this study, we aim to investigate the potential differences in perceived discomfort at multiple anatomical sites, muscle activity levels, and posture of the back and neck during a prolonged standing, cooking-specific task at the set height versus an adjustable height, on separate visits.

34. A scalable machine learning approach for predicting the effect of climate change on suitable land for growing canola crops using big data

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Canada is a major producer of canola, accounting for 21.4 million seeded acres and exports worth 14.4 billion in 2022. Of all the canola grown in Canada, Saskatchewan, Alberta and Manitoba make up 99% of the total production. The government of Canada predicts that over the next century, these provinces will experience a 6.5C increase in mean surface air temperature, and a 10% increase in rainfall. Climatic changes pose a significant threat to Canadas canola production by altering the conditions needed to sustain healthy plant development. To date, most studies have focused on the impact of climate change on canola yield and production; however, there is a lack of understanding of the effect climate change will have on suitable land for growing canola. In this study, we propose a data pipeline capable of ingesting and processing high volumes of geospatial data to accurately predict the current and future state of suitable farmland for growing canola. The data pipeline is specifically designed to provide robust and efficient storage coupled with extremely fast and highly scalable data processing. This is achieved through the use of Google Cloud Storage (GCS) coupled with a Google Dataproc Apache Spark/Hadoop transient cluster. Dataproc leverages a cloud storage connector that allows Apache Spark jobs to run directly on data in GCS without the need to transfer data into Hadoop HDFS first. The Dataproc cluster is configured with one master and varying numbers of worker nodes as dictated by an autoscaling policy. The pipeline allows for extremely fast cluster deployment and parallel processing of data on the cloud. The pipeline was tested using, Saskatchewan, Alberta and Manitoba as a subject region. The team demonstrated the attributes of the pipeline by storing geospatial data in GCS, training a multi-layer perceptron and finally processing the subject region to produce a series of maps and tables that quantify the impact of climate change on suitable land for growing canola.

35. IoT-based framework to minimize undeclared allergens-based food safety risks in Canada

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The Canadian Food Inspection Agency's (CFIA) initiates about 175 recall incidents every year as a public health risk mitigation effort. According to CFIA stats, around 40% of these recalls are accounts of Allergens that are not declared on the food package. Hence rapid, accurate and real time qualitative detection of an undeclared allergen requires a protocol and framework. Based on preliminary research, Near Infrared Hyperspectral Imaging and Biosensor have shown promising approach to develop a simple handheld detection device for early detection of an allergen in a food system. The device data then can be input into a cloud server and can be trained using machine learning techniques to identify patterns based on location, time, or the industry. This research shall be focussed on developing such a non-destructive IOT based detection device and a framework to monitor the food industry in real-time at various levels in the supply chain. Moreover, this approach will support to predict a risk and call for a pre-emptive action to minimize actual recalls.

Bacherlor's Students

36. Bio-compostable beeswax coated banana leaf straw's physical and functional properties abstract

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The quest for an environmentally friendly substitute for plastic straws has led to the emergence of a promising alternative, beeswax coated banana leaf straws. Both materials display hydrophobic properties and are byproducts to natural foods: honey and bananas. Beeswax has shown evidence of food preservation as well as biodegradability which can benefit the shelf life of the straws. Banana leaves, have been used in food packaging for hundreds of years and display fantastic flexibility and strength.

To assess the performance of the banana leaf straws, the test results are compared to plastic straws and, paper straws. Hydrophobicity, strength, shelf life, and manufacturing tests were performed in order to compare the ability of all three alternatives. To test for hydrophobicity, the straws are soaked for 0, 5, 30, and 60 minutes and tested for %weight increase and contact angle. Strength testing followed identical soaking intervals, and were submitted to tensile and compression test parameters based on standard test methods (TAPPIT494 om-01, ASTM D882-12, ASTM D695-15, and ASTM D2412-11). To analyze shelf life of the straws, water activity was measured. Finally, a drying curve was developed to understand the manufacturing process of banana leaf straws.

Results from these tests indicate that banana leaf straws have superior strength and hydrophobicity compared to paper straws, functioning closer to a plastic straw. Additionally, banana leaf straws are byproducts, and biodegradable thus decreasing overall costs and environmental impact. Overall, banana leaves have shown promise as an alternative to plastic straws, with their functional and economical strengths. However, further research and testing are necessary to optimize these materials and make them more widely available as sustainable alternatives to plastic straws.

37. The Humble Potato: the world's first compostable snack bag (review of technology pioneered by Humble Chips)

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Humble Chips, a Guelph-based potato chip company, pioneered the world's first municipally compostable potato chip bag. This paper will delve into the technology behind it, as well as the economics of running an eco-conscious company with such high standards.

38. Continuous temperature monitoring system for beer products

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The current monitoring methods for beer pasteurizations are inefficient and are limited in their product loss prevention capabilities. Real-time continuous data monitoring, combined with set threshold temperature for desired pasteurization units, can ensure sufficient pasteurization with minimal effect on product integrity and quality.

In this study, we conducted several batch pasteurizations to collect quantitative data using a Wi-Fi enabled system on a chip, then developed a model for successful temperature progression to refine device accuracy and capability. Subsequent trials will be conducted to validate the device operation.

At present, the project is ongoing, and the results obtained thus far include a statistically valid 4th degree polynomial that represents the unit between maximum temperatures and pasteurization units when the beer is pasteurized with 80°C water.

The development of a modelling equation that has the potential to receive a desired pasteurization unit (1 PU equalling 1 minute of heating at 60ºC) from the operator and determine the optimal maximum temperature. The accuracy and functionality of this system will be tested and validated for different conditions. The end goal of this project is to create a system that effectively monitors the pasteurization of beer and uses programmed characteristics to track pasteurization units during the process and identify improper heating.

39. Optimizing the pre-treatment of kidney beans for the de-hulling process

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The current methods of dehulling kidney beans, including manual, mechanical, chemical, and abrasive methods can be time-consuming, result in the loss of edible product, or present residual chemicals on the final output. This represents a challenge for the food and agricultural industry, emphasizing the need to develop a cost-effective, efficient, and safe method of dehulling that maintains structural quality and nutritional value of the product. The aim of this project was to identify and implement a solution that optimizes the pre-treatment process of pulses, specifically kidney beans, within the food processing industry. This experimental design observes 24 trials in total, over which soaking time and water temperature are being examined. The trials are analyzed to determine the effects of time and temperature on water intake, dehulling efficiency, as well as the percentage of damaged product as a result of the food processing process. Each trial consists of placing distilled water and 612 kidney beans into a bucket with a sous vide to create a controlled water bath. Once the beans have soaked for the desired time, they are weighted and sorted into the desired categories. The parameters for these experiments include a temperature gradient from 20-70°C (in discrete 10°C increments) and soaking periods of 2-7 hours (in discrete 1-hour increments). Preliminary testing has presented that a moderate level of temperature and longer soaking time represents optimal settings for dehulling but produces more damaged product.

40. Ultimate zero-sugar ketchup for ketogenic population

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Ketchup is a popular kind of condiments that North American consumers use on food like French fries and Hot dogs. In 2021, every Canadian consume about 3.1 kg of ketchup per year (Statistics Canada, 2021). However, ketchup usually contains 22g of sugar per 100 mL which is unhealthy. There are some sugar-free ketchup options on the market, but they still contain up to 6 g of sugar per 100 mL (i.e., Heinz). In order to target the ketogenic population, this project aims to reduce the sugar content of ketchup to 1 g per 100mL or less by lactic acid fermentation. The purpose of fermentation is to utilize the natural sugar in tomato as an energy to produce lactic acid. First, distilled water was added to tomato paste to reach a desired viscosity and for better fermentation. Then, lactobacillus was added to the ketchup because it performs best at the condition of 30°C and pH 4-5. After 7 days of fermentation, sugar content was greatly reduced and turned into lactic acid. The ketchup used lactic acid from the fermentation to acidify the ketchup to pH 3.9. In the end, spice mix, sugar substitute and gums were added to adjust the taste and texture of the ketchup. The zero-sugar ketchup project innovatively uses lactic acid fermentation to reduce the sugar content in the ketchup to a lower limit. This ketchup will fill up the demand of ketogenic consumer and further improve the healthiness of the consumer.

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