Science Innovation Showcase

Compilation of Abstracts for 2022 IAFNS Science Innovation Showcase

Organized Alphabetically by First Author's Last Name

Title: Fried Sweetpotato Textures: Effects of Storage Root Chemistries

Author(s) and affiliation(s): Matthew Allan, USDA Agricultural Research Service

The popularity of sweetpotato fries and chips in the US has increased over the past 2 decades. The development of new sweetpotato varieties and processes for these products requires a better understanding of the effects of root chemistries on fry and chip textures. The USDA Agriculture Research Service Food Science and Market Quality and Handling Research Unit in Raleigh, NC has been researching these topics, and the recent findings will be presented. Fries: Textures of sweetpotato fries made from 16 diverse genotypes were associated with dry matter, starch, alcohol insoluble solids, and sugar contents; yet distinguishing textures were not fully explained by composition alone. Starches were isolated from these roots and starch viscoelastic properties, molecular structures, thermal properties, and granule sizes were characterized to investigate associations with fry textures. Sweetpotato fry “denseness”, a texture unexplained by composition, was correlated with starch peak viscosity, and it was postulated the local viscosity inside cells were influencing this texture. Sweetpotato fry texture predictions using composition plus starch attributes were most improved by starch thermal properties, and the strongest causal relationships with fry textures were starch gelatinization temperatures and its interaction with amylase activity. Starch structures were less predictive and granules sizes were not predictive of fry textures in this study. Thus, sweetpotato composition and starch properties both affect sweetpotato fry textures. Chips: Sweetpotato chip breaking forces and fat contents are correlated with dry matter; however, dry matter does not fully explain chip breaking forces and fat contents. To investigate the effects of sweetpotato cell wall polymers on chip textures and fat contents, sweetpotato slices were treated before frying with a cellulase, hemicellulase, pectin lyase, pectin methyl esterase, protease, or blend of cell wall hydrolyzing enzymes. Chips treated with the protease and enzyme blend had significantly lower breaking forces than the control, and the pectin methyl esterase treated chips were significantly harder than the control. Chips treated with the cell wall hydrolyzing blend also had less oil content than the control. This demonstrated that sweetpotato cell wall polymers affect chip texture and fat content and are important to consider for selection of varieties for sweetpotato chip manufacturing.

Statement on how this science or technology supports or advances public health:

This science is investigating fried sweetpotato texture in hopes of increasing consumption of this healthful vegetable as well as oil content reduction in fried sweetpotato products.

Title: Rationale, design and baseline characteristics for the strategies to oppose sugars with non-nutritive sweeteners or water (STOP Sugars NOW) trial

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Excess intake of sugars via sugar-sweetened beverages (SSBs) increases weight and cardiometabolic risk. Health authorities recommend the replacement of SSBs with water, but not non-nutritive sweetened beverages (NSBs) due to concerns that they do not have the intended benefits and may induce glucose intolerance through changes in the gut microbiome.

We undertook the STOP Sugars NOW trial, a pragmatic "head-to-head" crossover randomized controlled trial of the effect of NSBs (the "intended substitution") versus water (the "standard of care") as a replacement strategy for SSBs on glucose tolerance and gut microbiome diversity.

We recruited participants with overweight or obesity participants who regularly consume ≥1 SSBs/day. Each participant underwent a ≥2-week run-in period followed by three 4-week treatment phases in random order (usual SSBs, equivalent NSBs, or water) with each phase separated by another ≥4-week washout phase. The two primary outcomes are change in glucose tolerance (75g oral glucose tolerance test [75g-OGTT] derived iAUC) and gut microbiome beta-diversity. Secondary outcomes include change in waist circumference, body weight, fasting plasma glucose, 75g-OGTT derived 2-hour plasma glucose and Matsuda whole body insulin sensitivity index. Adherence outcomes include objective biomarkers of added sugars (13C/12C isotopic ratio in serum fatty acids and urinary fructose and sucrose) and non-nutritive sweeteners (urinary sucralose and acesulfame-potassium) as well as beverage logs. Analyses will be done according to the intention to treat (ITT) principle.

Recruitment for the trial began on June 1, 2018, and the last randomized participant completed the trial on October 15, 2020. We screened 1,086 participants, of whom 80 were randomized and 66 completed the trial (83% retention) with 3 withdrawn by the investigators owing to the COVID-19 pandemic. The participants had a middle-aged mean age 41.8(± SD 13.0y), majority were female (51%) with a BMI of 33.7±6.8kg/m^2. The average baseline SSBs intake was 1.87 SSBs/day. SSBs were replaced with 8 matched NSB brands, sweetened with either the blend aspartame and acesulfame-potassium (95%) or sucralose (5%).

The results will provide high-level evidence to inform guidelines for SSB replacement and the viability of using NSBs as a sugar reduction strategy.

Statement on how this science or technology supports or advances public health:

The results from this trial will provide high-level evidence to inform guidelines for SSB replacement and the viability of using NSBs as a sugar reduction strategy.

Title: Why should the food processing industry establish a public private partnership for the discovery of new food packaging materials?

Author(s) and affiliation(s): Jack Cooper, Animal Digestible Food Packaging Initiative, MD, USA

Because a significant amount of plastic food packaging is “improperly discarded;” that is, it finds its way to land and waterways where it is left to naturally degrade into macro, micro and nano size plastic particles.

And because Improperly Discarded Plastic Food Packaging (IDPFP) is a food industry science, public affairs and legislative/regulatory issue:

- Wildlife, including marine food sources, are exposed to IDPFP in their natural environment
- Adverse biological effects of macro size plastic particles have been demonstrated
- Adverse biological effect studies of micro and nano size plastic particles are underway; for some species, adverse biological effects have been demonstrated; currently, there are no known adverse human health effects from exposure to IDPFP from micro and nano size particles.
- Governments around the world are developing legislative and regulatory mandates to prevent the environmental release of IDPFP, including the concept of Extended Producer Responsibility (EPR) where producers are required to accept financial or physical responsibility for the treatment or disposal of discarded consumer products.
- Consumers are increasingly applying Environmental, Social, and Governance (ESG) factors to the companies from which they purchase consumer products and investors are applying ESG factors in their decision-making process.
- Lawsuits against companies for alleged false environmental claims.
- Recycling difficulties.
- Constant social and mainstream media attention.

Title: Novel single-fiber probe to evaluate internal myoglobin forms of the *psoas major* muscle

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When purchasing steaks, consumers use a variety of characteristics such as marbling, price, and color when making purchasing decisions in the grocery store. In terms of color, consumers prefer to purchase steaks which appear bright-cherry red without brown surface discoloration. Myoglobin is the primary protein that gives beef its characteristic bright-cherry red appearance in the form of oxymyoglobin. Oxidation of myoglobin leads to the formation of metmyoglobin or surface discoloration. Recently, surface discoloration has been estimated to cost the beef industry approximately $3 billion annually, resulting in a waste of 13.4 million kg of beef. Therefore, limiting and understanding the development of surface discoloration can help to limit food waste and economic loss for the beef industry. Our understanding of surface discoloration is subsurface oxidation of myoglobin leading to internal development of metmyoglobin which rises to the surface during retail display. To better understand the internal oxidation of myoglobin during retail, a single-fiber probe (SfP) was used to characterize internal color changes and understand the internal oxidation of myoglobin as surface discoloration occurs in the *psoas major* muscle. The SfP system was a 400-µm fiber in a 15-gauge needle. To evaluate internal myoglobin changes, the SfP system was inserted into the muscle in five locations varying in depth by 1 mm. With MATLAB, a mathematical model was developed to calculate the percent metmyoglobin and oxymyoglobin. At 1 mm depth, oxymyoglobin decreased during retail display whereas deeper (2 – 5 mm) depths had little decrease in oxymyoglobin. The percent metmyoglobin rapidly increased from d 0 to d 1 of retail display at 1-mm depth. Furthermore, from 2 – 5 mm, metmyoglobin increased throughout retail display. It is understood the interior portions of steaks are predominantly deoxymyoglobin which was supported by the high percent of deoxymyoglobin on d 0 at 3 – 5 mm internally. During retail display, the deoxymyoglobin content decreased at 1 – 5-mm depths using the SfP. Therefore, a loss of deoxymyoglobin during retail display occurs with an increase in metmyoglobin while oxymyoglobin remains constant. These results support the oxidation of deoxymyoglobin forming metmyoglobin internally. As surface discoloration has a large role in food waste, better understanding the formation of metmyoglobin as well as continuing to develop technology to evaluate color throughout processing is key to limiting food waste and economic loss.

Statement on how this science or technology supports or advances public health:

Through the use of the SfP technology, our understanding of discoloration and the occurrence of discoloration is improved. Therefore, we can begin to prevent discoloration and extend shelf stability to limit food waste.

Title: Development of antimicrobial nanofiber food packaging film loaded with northern Alabama grown hemp (*Cannabis sativa*) extract

Author(s) and affiliation(s): Aaron Dudley, Lamin Kassama, Armitra Jackson-Davis, Ernest Cebert, Xian Kuang, Alabama A&M University, Huntsville, AL, USA

The use of Hemp (*Cannabis sativa sp*.) as an ingredient for food application is a current research interest because of its documented antimicrobial activity. Hemp's application in food system is being explored to enhance food safety, and active packaging with natural antimicrobial agents is of immense interest to impede microbial proliferation during storage. Active packaging in the form of Nanofibers have many advantages over conventional packaging materials because of their high surface area and nanoporous structure resulting in higher loading capacity, encapsulation efficiency, and effective controlled release of the antimicrobial agents. However, the bioactive and nanoencapsulated efficacy of the cultivars grown in Northern Alabama and their implications on food safety have not been studied. Therefore, the purpose of this study was to evaluate the in vitro antimicrobial effect of hemp cultivars and the nanoencapsulated hemp extract (nanofiber active film) against cocktails of *Salmonella enterica* spp (SE) and *Listeria monocytogenes* (LM).

In this study, hemp inflorescences grown from the Winfred Thomas Agricultural Research Station (Hazel Green, Alabama) were used. The whole (W) samples were ground and defatted (DF) by the Soxhlet extraction. Antibacterial activity of the hemp extracts and nanofiber against cocktails of enteric pathogens *Listeria monocytogenes* (LM- H7969 serotype 4b, H7962 serotype 4b, and Scott A NADC 2045 Serotype 4b, Iowa State University Food Microbiology Lab, USA) and *Salmonella enterica* (SE-FSIS32105652-serovar *Typhimurium*, FSIS32105654-serovar *Enteritids*, FSIS32105656-serovar *Infantis*) were evaluated using a BioScreen C MBR (Oy Growth Curves Ab Ltd, Finland), MIC/MBC (minimum inhibitory and bactericidal concentrations) and time kill assays. All treatments were analyzed in triplicate and an ANOVA was conducted and the statistical significance-based $P \leq 0.05$.

Bactericidal concentrations of both whole and defatted extracts had a significantly lower ($p \leq 0.05$) optical density compared to all other treatments against both SE and LM. The cell count of both SE and LM drastically decreased from 9.45 Log CFU/mL and 9.7 Log CFU/mL to 4.1 Log CFU/mL and 6.15 Log CFU/mL at 37°C against Hemp extracts, respectively. The number of SE and LM in the control groups reached 10.5 Log CFU/mL and 10.72 Log CFU/mL respectively at 37°C, while the number of SE and LM in Hemp nanofibers decreased to 9.8 Log CFU/mL and 8.87 Log CFU/mL after 24h, respectively.

Hemp nanofiber's antibacterial effectiveness against *Salmonella enterica* and *Listeria monocytogenes* directs research to food model evaluation. Hemp loaded nanofiber will contribute immensely to food preservation and safety in the food supply chain.

Title: The effect of substituting soy milk for cow's milk on lipid markers: A systematic review and meta-analysis of randomized controlled trials

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Soy protein holds a health claim for its lipid-lowering effect and cardiovascular benefits. Plant-based milks have increased in popularity. Whether the cholesterol-lowering effect holds for soy milk (as a single soy food matrix) in its intended substitution for cow's milk is unclear.

To quantify the effect of soy milk in substitution for cow's milk on established lipid markers, we conducted a systematic review and meta-analysis of randomized controlled trials (RCTs). MEDLINE, Embase, and The Cochrane Central Register of Controlled Trials were searched (through March 2021). We included RCTs of >3 weeks assessing the effect of soy milk in substitution fora cow's milk control on established lipid targets: low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and non-HDL-C in adults. Two independent reviewers extracted data and assessed risk of bias. Data were pooled using random-effects models and expressed as a mean (MD) difference with 95% confidence intervals (95% CI). GRADE was used to assess certainty of evidence.

We identified 2674 RCTs. Eligibility criteria were met by 6 RCTs in 201adults with normocholesterolemia (3 RCTs), hypercholesterolemia (2 RCTs), or diabetes (1 RCT). Median doses of soy and cow's milk protein were 21.5g (6.9-58.56) and 24.5g (16.7-58.87) per day, respectively. The substitution of soy milk for cow's milk reduced LDL-C (-0.20 mmol/L [-0.33, -0.08mmol/L]) and non-HDL-C (-0.24 mmol/L [-0.41, -0.07mmol/L]) and increased HDL-C (0.6 mmol/L[0.01, 0.11mmol/L]). There was no significant effect on TG. The certainty of evidence was moderate across all outcomes owing to downgrades for imprecision. There is good indication that the substitution of soy milk for cow's milk improves LDL-C, non-HDL-C, and HDL-C in adults. These findings support the cholesterol-lowering health claim for soy protein as soy milk in substitution for cow's milk.

Statement on how this science or technology supports or advances public health:

This research has shown that soy milk is beneficial, when compared to cow's milk, as a lipid-lowering agent in adults of various health statuses. Cardiometabolic disease is a major health burden globally. New methods of prevention and treatment through diet could impact public health initiatives and clinical guidelines targeting this problem.

Title: Estimated dietary intake of essential and non-essential elements through four highly consumed vegetables

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Vegetables are important for human health because of their vitamins, essential elements, phytochemical compounds, and dietary fiber content. However, in a food safety point of view, vegetables can also be source of exposure to toxic substances such as heavy metals, or pesticides.

A multielemental analysis was carried out on four vegetables, carrot (*Daucus carota*), onion (*Allium cepa*), potato (*Solanum tuberosum*), and Swiss chard (*Beta vulgaris* var. cicla) from nine central markets distributed across the horticultural areas of the province of Buenos Aires, Argentina. The selected four vegetables have a high presence in the diet of the Argentine population.

Aluminum, barium, cadmium, cobalt, copper, chromium, iron, lead, manganese, molybdenum, nickel, strontium, and zinc were analyzed by microwave induced plasma – atomic emission spectrometry (MIP OES) (triplicate analysis). Seven of the thirteen elements analyzed (aluminum, barium, cadmium, chromium, lead, nickel, and strontium) are considered non-essential elements for human beings. Results for cadmium, cobalt, chromium, lead, molybdenum, and nickel were non-detectable in all four vegetables. Mean concentrations in carrots, onions, potatoes and Swiss chards, for aluminum were 2.84, 1.82, 4.08 and 25.18 $mg.kg^{-1}$, respectively; for barium were 0.88, 0.07, 0.06 and 1.58 $mg.kg^{-1}$, respectively; for copper were 0.39, 0.37, 0.84, 0.61 $mg.kg^{-1}$, respectively; for iron were 3.52, 2.61, 5.55, 18.07 $mg.kg^{-1}$, respectively; for manganese were 1.43, 0.78, 1.56, 9.81 $mg.kg^{-1}$, respectively; for strontium were 1.81, 1.38, 0.04, 1.72 $mg.kg^{-1}$, respectively; and for zinc were 0.74, 0.48, 2.22, 1.04 $mg.kg^{-1}$, respectively. Contribution of these four vegetables to the Recommended Dietary Allowance (RDA) was calculated for the essential elements, copper: 0.1 $mg.day^{-1}$ (RDA: 0.9 $mg.day^{-1}$), iron: 1.15 $mg.day^{-1}$ (RDA: 8 to 18 $mg.day^{-1}$), manganese: 0.49 $mg.day^{-1}$ (RDA: 1.8-2.3 $mg.day^{-1}$), and zinc: 0.21 $mg.day^{-1}$ (RDA: 8-18 $mg.day^{-1}$). Estimated dietary intakes (EDIs) were calculated for non-essential elements as indicators of exposure to potential toxic metals through food. Food intakes were obtained from the Dietary Guidelines for the Argentine population (2016). EDI for aluminum was 0.018 $mg.kg^{-1}.day^{-1}$, and the estimated weekly intake was 0.124 $mg.kg^{-1}$ (Provisional Tolerable Weekly Intake: 2 $mg.kg^{-1}$). EDI for barium was 0.001 $mg.kg^{-1}.day^{-1}$ (Reference dose: 0.07 $mg.kg^{-1}.day^{-1}$). EDI for strontium was 0.002 $mg.kg^{-1}.day^{-1}$ (Tolerable Daily Intake: 0.13 $mg.kg^{-1}.day^{-1}$).

The results showed no significant health risk to the consumer associated with the consumption of these vegetables and the exposure to toxic elements. In a next step, other elements such as arsenic and selenium will be included in the analysis.

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Statement on how this science or technology supports or advances public health:

Technology at the service of food safety

Food safety is a public health priority

Title: Novel AI discovery of new bioactives elevates the need for recommended intakes at a population level

Author(s) and affiliation(s): Swati Kalgaonkar, Serene Buckley, Jan-Willem van Klinken, Brightseed, San Francisco, CA, USA

Dietary bioactive compounds have been defined by the U.S. National Institute of Health (NIH) and the NIH Office of Dietary Supplements 2018, as "compounds that are constituents in foods and dietary supplements, other than those needed to meet basic human nutritional needs, which are responsible for changes in health status."

Science has long known that bioactives are critical to human health; published literature as far back as ancient traditional medicine, recognizes the presence of more than 5000 known bioactives in plants and foods. However, due to the historical challenges in isolating and characterizing bioactive compounds and identifying their underlying molecular mechanisms, scientists have only been able to identify less than 1% of plant bioactives.

Rapid advances in discovery and validation of bioactives can enable lasting systems reform for the benefit of public health. Artificial Intelligence (AI) has accelerated bioactive discovery and biological validation from years to months – and is rapidly revealing new connections between nature and humanity.

Bioactives such as catechin (found in strawberries), epicatechin (found in dark chocolate), epigallocatechin gallate (found in green tea) have been shown to impart more than just antioxidant properties[4,5]. These compounds are associated with benefits for heart health, gut health, liver health, skin health, and healthy blood glucose regulation. Not many metabolites have the privilege of crossing the blood brain barrier (BBB), but many bioactive metabolites have been shown to do so and impart neuroprotective benefits[6], underscoring how essential they are to our healthy function.

Unlike recommended intakes for vitamins and minerals and dietary fiber, U.S. Dietary Guidelines does not provide recommended intakes for bioactives. As a result, it is almost impossible for the general population to understand whether their intake is adequate and if alternate sources should be considered. Although the importance of DHA, EPA, and omega 3's is recognized by the U.S. DGA, the significance of other bioactives is yet to be highlighted.

Making health benefits of bioactives available to the population at large is critical and federal agencies have an opportunity to act as a world leader in setting the right standards for inclusion of bioactives in their recommendations.

Statement on how this science or technology supports or advances public health:

AI discovery of novel plant bioactives is rapidly revealing new connections between nature and humanity, thereby significantly reducing the time from discovery to health benefit and providing a way to scale up the growing demands of a growing population.

Title: Prediction of protein and amino acid contents in Canola (*Brassica napus* L.) meal with near-infrared reflectance spectroscopy

Author(s) and affiliation(s): Junya Liu, University of Manitoba, Winnipeg, Canada

Canola (*Brassica napus* L.) meal is a by-product of the *B. napus* oil crushing process and is well-positioned as a plant-based protein additive in animal feed rations. Crude protein and amino acid concentration assessment would provide valuable information regarding *B. napus* meal further utilization. However, the traditional wet-chemistry analysis method for crude protein and amino acid determination is complicated, environmental unfriendly, time and labour consuming, thus positioning the need for alternative approaches.

The current study focused on developing and validating near-infrared reflectance spectroscopy (NIRS) calibration models for predicting protein and amino acid contents in *B. napus* meal. This research investigated the effects of different types of spectrometers, including the diode array analyzer PerkinElmer DA7250 and the Fourier transform NIRS analyzer PerkinElmer FT9700 on the predictive performance of the NIRS calibration models.

In total, 480 *B. napus* whole seed samples were selected from the 2015 and 2020 cropping year populations to produce *B. napus* meal samples and then analyze crude protein and amino acids concentrations with reference chemical methods; among those, 420 samples were randomly picked and assigned for constructing calibration models, while the rest of 60 samples were used for the external validation study. The partial least square regression technique was used for model calibration and verification, performed on the Unscrambler X10.3 software with the spectra obtained from PerkinElmer DA7250 and PerkinElmer FT9700 analyzer.

The calibration models of crude protein and most amino acids except for tryptophan, histidine and sulphur amino acids showed an acceptable coefficient of determinations (R^2c = 0.677 - 0.885), low standard error of calibration (SEC = 0.012-0.090) while the NIR models for tryptophan, histidine and sulphur amino acids were less accurate which might require more work in the future study. Besides, PerkinElmer DA 7250 was discovered with a similar predictive performance to PerkinElmer FT 9700 with no significant differences.

This study indicates that NIRS could predict crude protein and amino acid contents simultaneously with acceptable precision, there is a nonnegligible potential to integrate the NIRS technology to both feed research and industry level for further *B. napus* meal capitalization.

Title: Edible Pongamia oil as a novel culinary food ingredient

Author(s) and affiliation(s): Palma Ann Marone, James Astwood, Jake Olson and Naveen Sikka. Terviva Inc., Alameda, CA, USA

With world population recently passing 8 billion people, more efficient and sustainable farming practices are needed to produce safe, nutritious, affordable food world-wide. Terviva Inc. (Alameda, CA) is engaged in a comprehensive program to harvest the beans of the Southeast Asia native Pongamia tree to solve the environmental challenges and global food insecurity and shortage with high quality edible oil and protein. Combining attributes for addressing climate change, the fast growing, sub-tropical legume tree is uniquely suited to solve environmental challenges and enhance regenerative agriculture by fostering water-saving and nitrogen-carbon sequestration with ability to attract a wide variety of pollinators while naturally pest resistant. Revitalization of previously abandoned lands engages the local farming community for both wild harvest and traditional cultivation models as pressure to relieve deforestation is united with investment in the local economy.

Historically, the Pongamia tree is known in many cultures for its aesthetic, medical, and pesticidal purposes. Today, in a first-of-its-kind technology, Terviva has refined the oil, removing the unpalatable, bitter furanoflavonoids to formulate a mid-oleic fatty acid edible oil, protein and flour, suitable for inclusion in a variety of plant-based food applications.

For its potential use as food Edible Pongamia Oil (EPO) was safety-evaluated in an acute oral toxicity study, GLP 14- and 90- Day repeated dose isocaloric dietary toxicity studies and in genotoxicity studies performed to evaluate the toxicologic and mutagenic and clastogenic potential of the oil. A single oral acute study revealed no adverse effects and an LD50 > 5000 mg/kg. In a 14-day feeding study of dietary levels of 0, 5.0, 10.0, 15.0% EPO in Sprague-Dawley male and female rats, there were no adverse, clinical, body weight, food consumption, clinical pathology, or liver histology changes attributable to the administration of the oil. The animals tolerated up to 15.0% in the diet. In a subsequent 90-day dietary study with 28-day recovery at 0, 2.5, 5.0, 7.5 and 10.0% EPO in Sprague-Dawley male and female rats there were no mortalities or adverse changes in clinical, body weight, food consumption, functional or motor activity, clinical-, macro- or micro- pathology, thyroid hormone, estrus cycle or spermatogenesis in either the main study or recovery animals. The NOAEL was reported at 10% in the diet. No genotoxic potential was reported. EPO is considered safe and suitable under its intended conditions of use when the estimated consumption is up to and includes 7,703.32 mg EPO/day.

Title: Perfect Day's Collaborative approach to a kinder, greener future food system

Author(s) and affiliation(s): Perfect Day, Inc., Berkeley, CA, USA

Perfect Day has created the world's first nature-identical animal protein, without any animal inputs, using precision fermentation. Precision fermentation uses glucose (sugar) from plant sources and GRAS microflora that have been designed to produce beta-lactoglobulin. The microflora is cultivated to produce whey protein, the protein is purified to over 95% purity, and spray dried for shipment to customers. Analytical methods are used at every step, in line with regulatory requirements, to ensure that it is identical to the beta-lactoglobulin in traditional milk, and verify the quality, safety, and consistency of the product. Food science analytical and sensory methods similarly validate that the product behaves identically to bovine beta-lactoglobulin for use in non-animal dairy products and new product development.

This innovation is creating a new category of foods which offer a sustainable, nutritious, delicious way to feed our growing population. According to an ISO-conformant lifecycle assessment, this production process reduces greenhouse gas emissions up to 97% compared to traditional production methods. And because it's identical to the milk protein (whey) that we all love, it offers a way to leverage that planet-positive impact in a way that doesn't compromise on taste, texture, or nutrition.

In this session, Perfect Day's Chief Science Officer Tim Geistlinger will share how the company uses an established technology in a new way to create high-value ingredients, and how collaboration is at the core of scaling the impact of what the company has unlocked. The company is bringing others along on this journey by partnering with the largest CPGs and most mission-driven startups who want to use its animal-free protein as an ingredient as a tool in their own kinder, greener mission. It also offers the expertise its built going from an idea to global scale to others, via its enterprise biology business nth Bio, helping extend what's possible through precision fermentation in our food system—and even beyond.

Statement on how this science or technology supports or advances public health:

Perfect Day's technology has unlocked a no-compromise approach to building a sustainable, nutritious, delicious future food system. By collaborating with ingredient and technology partners, offering its own consumer products, and championing the work of others around the food system, Perfect Day is excited to share what's possible for generations to come.

Title: Protein quality and protein content claims of lentils

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Lentil is a nutritious pulse and an important protein source in the plant-based market, especially in Canada. Its amino acid composition and protein digestibility impact the protein quality assessment. In recent decades, different recommended scoring patterns by FAO/WHO have been used to estimate protein quality. This study evaluated 1290 lentil samples grown in 2016-2017 in Saskatchewan for amino acid composition prediction using near-infrared spectroscopy (NIRS) equipment. The NIRS method is a rapid, non-destructive, and green technique. The amino acid scores (AAS) of the lentil samples were calculated using recommended amino acid scoring patterns by FAO/WHO: (a) pre-school children (2 to 5 years) (FAO/WHO, 1991); (b) infants (birth to 6 months), (c) young children (6 months to 3 years), and (d) older children, adolescents and adults (FAO/WHO, 2013). The frequency distribution of the samples' AAS was determined. The pH-drop method was used to determine the in vitro protein digestibility (IVPD) of a subset of 40 lentil samples. The lowest AAS and IVPD were used for calculating the in vitro–protein digestibility corrected amino acid score (IV–PDCAAS) and in vitro–digestible indispensable amino acid score (IV–DIAAS) to determine their impact on the protein quality and the ability to make protein content claims using North America standards.

Results show that tryptophan and sulfur amino acids (methionine and cysteine) are the limiting amino acids for lentils. However, using the FAO/WHO (2013) reference pattern for adults, the amino acid score for tryptophan is higher than 100% (therefore, not limiting), while sulfur amino acids are still limiting amino acids. The IVPD for the lentil samples was 82.6 ± 1.1%. The IV–PDCAAS varied from 53.1% to 61.0%. The IV–DIAAS results were 37.5 ± 1.0%, 54.2 ± 2.8%, and 64.0 ± 3.4%, using FAO/WHO (2013) scoring patterns for infants, young children, and adults, respectively. Considering IV–PDCAAS, all samples were considered a "good source of protein", while for IV–DIAAS, no samples made protein claims. Therefore, DIAAS adoption can impact the foods' potential to qualify for protein content claims and affect consumers' food choices.

Overall, choosing different age-category amino acid scoring patterns by FAO/WHO can directly impact the protein quality of lentils. Finally, lentils' high protein content and utilization capacity in new food formulations places this crop as a promising alternative for high-quality protein foods for future generations.

Statement on how this science or technology supports or advances public health:

Determining the lentils' protein and amino acid composition can benefit the lentil breeding program, improve its protein quality, help food industries create value-added products with new food formulations, and make correct nutrient content claims.

Title: Cultured Meat: Shifting to a Race-to-Mission

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Cellular agriculture is an emerging technology that let us obtain animal products using cell cultures, either microorganisms or animal cells, instead of whole animals. It has the potential to improve animal welfare, our food system's sustainability, and tailor products that could be healthier and safer. Focusing on cultured meat (CM), as of today, there are over 150 companies and more than $1.5 billion have been invested in 2022 thus far in this nascent technology. Despite this fast growth, excitement around prototypes and launch dates, and high expectations to solve some of the most pressing issues we are facing, CM is still far from fulfilling its potential. The CM sector has been a private-sector-heavy field, encouraging IP ownership, siloing of research and duplication of efforts while preventing collaboration and data sharing. Such “race-to-market” mindset slows the pace of innovation and could work against the primary mission of transforming our current food system. Therefore, we need to shift to a “race-to-mission” mindset and establish mission-based parameters, where transparency, data-sharing and collaboration are essential for developing and implementing the technology properly and at speed.

Title: Soybean meal tempeh as a novel source of alternative protein

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Tempeh is a traditional Indonesian food, a plant-based protein source made from fermented whole soybeans. Soybean meal is a by-product of soybean oil extraction, mainly used as animal feed. Although with a large annual production (48 million metric tons in 2022), soybean meal has not been effectively used for human consumption. In our research, we developed ways to use different pulse sources to produce tempeh, including the production of soybean meal tempeh. Utilizing soybean meal instead of soybean as raw material to produce tempeh is a sustainable way to harvest high quality alternative protein and add value to a waste product.

In this study, we prepared two different tempehs from soybean and soybean meal, respectively, and compared the nutrient composition, texture, appearance, flavor, and sensory parameters between soybean tempeh (ST) and soybean meal tempeh (SMT). The result showed that protein, flavanol, and polyphenol content increased during fermentation. SMT had a similar amount of polyphenol and flavonoid content compared with ST. The polyphenol and flavonoid content of SMT increased around 25% and 30% during 36 hours of fermentation, respectively. The protein content of the SMT also increased during the fermentation. The texture of the SMT showed a higher hardness, chewiness, and gumminess and a lower springiness and resilience compared with that of ST. The sensory evaluation revealed that the taste of ST and SMT after deep-fried cooking was different. ST tasted like meat, while SMT was more like chicken nuggets. The flavor score and volatile compounds profile also showed a significant difference between the tempeh products. Different from the ST which had achieve a higher score from color, yeasty and floury section in sensory evaluation. The SMT had a higher score in fungal, nutty and sweet section. In volatile compounds profile, although similar in the abundance of 3-methyl-1-butanol, SMT had three times more alcohol content than ST at the end of fermentation. Among aldehydes, the abundance of acetaldehyde, (E)-2-Butenal, Hexanal, and Nonanal in SMT was higher than those in ST after fermentation. Overall, our results showed that optimized tempeh fermentation of soybean meal led to alternative protein product with a great nutritional value, edible quality, and acceptability. The development of SMT can increase the utilization of soybean by-products and provide a novel plant-based protein source.

Statement on how this science or technology supports or advances public health:

Utilizing soybean meal to produce tempeh is a sustainable way to harvest high quality and healthful alternative protein and add value to a waste product.

Title: Establish framework for defining suitable recycled resin and characterize potential chemicals of concern based on intended end-use

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Contamination in recycled polypropylene (PP) meant to be used for direct food contact materials (FCMs) can pose significant consumer health risks. Opportunities for polymer contamination can occur during the manufacturing, service life, and recycling stages. Further, the use of post-consumer polymers for FCM from single-stream waste collection can introduce non-approved additives from sorted materials with non-food applications such as industrial products. These contaminants are potentially hazardous substances and, if not removed during recycling, can migrate into packaged food. Consequently, there is a gap in qualitative data about the nature and presence of these substances in the recovered polymers from both food and non-food applications. Additives (e.g., colorants, plasticizers, lubricants, antioxidants) are incorporated during polymer manufacturing to control properties for specific applications. The objective of this research is to identify potential contaminants and additives in PCR food-grade and non-grade PP recovered from single-stream waste collection. PP samples have been collected from food-grade and non-food-grade sources at each unit operation following the recycling procedure described by the Association of Plastics Recyclers (APR). To evaluate the chemical safety from food and non-food grade sources, PCR PP samples were granulated and washed using a trommel, batch friction, dried, then pelletized followed by injection molding into ASTM type 4 dogbones. Samples at each stage were collected to compare the decontamination efficiency steps. GC-MSD and GC-qQq have been applied to identify non-intentionally added substances/unapproved additives for FCM qualitatively and quantify targeted compounds (phthalates, bisphenols) on many restricted substance lists. This outcome will help to develop a critical understanding of potential contaminants from different food-grade and non-grade sources of PCR PP materials.

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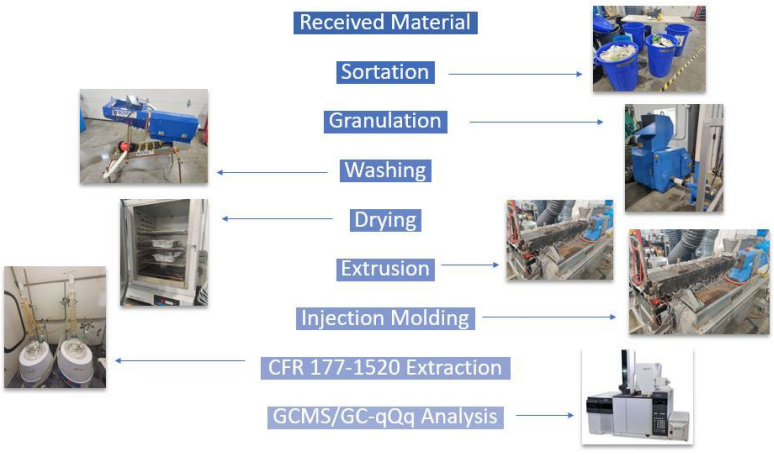

Figure: Flow chart for the experiment of Food-Garde PP and non-food-Grade PP sample for the detection of N/IAS and targeted compound.

Statement on how this science or technology supports or advances public health:

This research provides an understanding to increase the supply of safer recycled plastics in direct food contact applications by evaluating the presence of endocrine-modulating chemicals (phthalate, bisphenols) and other NIAS. With the increasing trend of plastic recycling, it is also essential to know the safety of the PCR plastic to be used as FCMs in securing public health by not exposing them to toxic chemicals through their food.