**W5122 Multistate Research Activity 2021 Accomplishments Report**

*Note: This report is submitted each year of an activity’s duration and is due 60 calendar days following the annual meeting. The SAES-422 is submitted electronically by AAs into NIMSS. Annual Reports for MRF projects are available to NIFA through NIMSS*.

**Project/Activity Number:** W4122

**Project/Activity Title:** Beneficial and Adverse Effects of Natural, Bioactive Dietary Chemicals on Human Health and Food Safety

**Period Covered:** October 2021-September 2022

**Date of This Report:** January 26, 2023

**Annual Meeting Date(s):** October 13-14, 2022

**Participants:**

* Jacques Izard (jizard@unl.edu) - University of Nebraska-Lincoln
* Nancy Turner (ndturner@msu.edu) - Michigan State University
* Mohit Verma (msverma@purdue.edu) - Purdue University
* Maria Marco (mmarco@ucdavis.edu) – University of California-Davis
* Tiffany Weir (tiffany.weir@colostate.edu) - Colorado State University
* Efren Delgado (edelgad@nmsu.edu) - New Mexico State University
* Bill Helferich (helferic@illinois.edu) - University of Illinois
* Chi Chen (chichen@umn.edu) - University of Minnesota
* Susan Tilton (susan.tilton@oregonstate.edu) - Oregon State University
* Kaustav Majumder (kaustav.majumder@unl.edu) – University of Nebraska-Lincoln
* Adam Chicco (adam.chicco@colostate.edu) - Colorado State University

**Brief summary of minutes of the annual meeting:**

Thursday October 13, 2022

9:00-9:05 AM- Opening remarks: Dr. Adam Chicco (W4122 2022 Chair) provided information on the format of the meeting followed by an introduction and sharing the experiences from attendees. The project W4122 is now renewed for next 5 years (10/01/2022 to 09/30/2027) and the new number is W5122.

9:05-9:30 AM- Update from NIFA/USDA Leadership- Dr. J. Mark Carter, National Program Leader, Institute of Food Safety and Nutrition- Dr. Carter provided an update on current NIFA and USDA initiatives, including Addressing Climate Change via Climate-smart Agriculture and Forestry, Advancing Racial Justice, Diversity, Equity, Inclusion, & Accessibility, Creating More and Better Markets Opportunities, Tackling Food and Nutrition Insecurity and Food Safety challenges.

Research Updates and Discussion: (15 min Presentation + 15 min discussion)

* 9:30-10:00 AM- Jacques Izard (University of Nebraska-Lincoln)
* 10:00-10:30 AM- Nancy Turner (Michigan State University)
* 10:45-11:15 AM- Mohit Verma (Purdue University)
* 11:15-11:45 AM- Maria Marco (University of California-Davis)
* 11:45-12:15 PM- Tiffany Weir (Colorado State University)
* 1:45-2:15 PM- Efren Delgado (New Mexico State University)
* 2:15-2:45 PM- Bill Helferich (University of Illinois)
* 2:45-3:15 PM- Chi Chen (University of Minnesota)
* 3:30-4:00 PM- Susan Tilton (Oregon State University)
* 4:00-4:30 PM- Kaustav Majumder (University of Nebraska-Lincoln)
* 4:30-5:00 PM- Adam Chicco (Colorado State University)

Thursday October 13, 2022

6:00-6:30 PM- Business meeting- led by Dr. Adam Chicco

Discussion of new and emerging collaborative projects and initiatives

• Dr. Weir is serving as a guest editor for two microbiome Frontiers journals special topic review series (Frontiers in Nutrition and Frontiers in Microbiome), to which at least 2 members plan to contribute. Other interested members should contact Tiffany for more information.

• Various other potential and ongoing research collaborations and shared interests were discussed based on research reports presented during the meeting, which we hope will promote continued productivity and interactions within our group and our institutions. For example, Dr. Chicco is visiting the University of Nebraska in November to present a research seminar and learn more about the research facilities at the University (hosted by Dr. Majumder), where he will also meet with Drs. Izard and Kumar Natarajan). Dr. Weir is planning a collaborative project with this group using the gnotobiotic animal facility at the University of Nebraska, to which Dr. Chicco may contribute his expertise in metabolism and cardiac ischemic tolerance (past area of collaboration with Dr. Weir).

Assignment of W5122 group leadership roles for 2023

The following 2023 W5122 multistate group officers were elected to support efforts into next year:

• Chair: Pratibha Nerurkar, University of Hawaii (2022 Vice-Chair); responsible for assembling the annual report of group activities for the 2022-23 year following the annual meeting in October 2023.

• Vice Chair: Mohit Verma, Purdue University; responsible for assisting the chair in assembly of the 2023 annual report (i.e., learning the process) in advance of serving as group chair in 2024.

• Secretary: Susan Tilton, Oregon State University; responsible for recording the meeting minutes and distributing to group members following the meeting)

Vote on location for next year’s meeting

The 2023 W5122 Annual meeting will be held at the **Calistoga Hot Springs Resort in Calistoga, CA.**

**Activities/Accomplishments:**

**Objective 1: Examine the effects of phytochemicals and other dietary components on gut microbiota and intestinal function.**

**W4122 researcher in Michigan (Turner)** examined the effect of quercetin and chlorogenic acid, in the presence of the fermentable fiber pectin in suppressing the expression of pro-inflammatory molecules, altering the luminal environment, and altering the colonocyte proliferation to provide protection against recurring bouts in a DSS-induced Rat model of ulcerative colitis. Although quercetin and chlorogenic acid did not protect against overt morphological indicators of DSS-induced injury and inflammation or fecal SCFA concentrations, compared to the control diet, their influence on the expression of injury repair molecules, pro-inflammatory cytokines, SCFA transport proteins, and NF-κB inhibitory molecules suggests beneficial influences on major pathways involved in DSS-induced injury/inflammation. Therefore, in healthy individuals or during periods of remission, quercetin and chlorogenic acid may promote a healthier colon, and may suppress some of the signaling involved in inflammation promotion during active disease.

**W4122 researcher in Nebraska (Izard)** aims to evaluate the new biology of the small intestine via multiple approaches. It is already known that the small intestine and the colon do not absorb bioactive polyphenol compounds similarly. However, there needs to be more knowledge on improving nutrition via the small intestine. Izard’s team investigated food-specific IgG presence in ostomates (ileostomates lacking a colon and colostomates having a partial colon) relative to participants affected by other digestive diseases. Jejunostomates and ileostomates had a significant risk of presenting circulating food-specific-IgG in contrast to colostomates (odd ratios (OR) 12.70 (p=0.002), 6.19 (p=0.011), and 2.69 (p=0.22), respectively). Crohn’s disease, eosinophilic esophagitis and food malabsorption groups also showed significantly elevated risks (OR 4.67 (p=0.048), 6.68 (p=0.016) and 16.70 (p=0.003), respectively), but not the ulcerative colitis group (OR 2.05 (p=0.36)). Individuals with profoundly or significantly reduced, and mild to moderately reduced, levels of total IgG were protected from the formation of food-specific IgG (OR 0.09 (p=<0.001) and 0.33 (p=0.005), respectively). Males were at higher risk than females. The study that led to the acquisition of stool samples from 60 individuals, in the context of digestive resections opened the door to understanding the human digestive small intestine; we started investigating the metabolome. This metabolome includes small molecules known as phytochemicals, bioactives, and by-products of bacterial and human metabolism. This complex dataset under investigation will uncover new potentials in the digestive mid-gut.

**W4122 researcher in Indiana (Verma),** in collaboration with Materials Science Engineers, has developed a sampling capsule that can collect intestinal contents from various parts of the gastrointestinal tract. The capsule can be configured to dissolve at different pH levels and, thus, collect samples from the small or large intestine. The team has demonstrated that the capsule survives the stomach's acidic environment and can sample proteins and bacteria. The capsule also functions well when sampling from an ex-vivo intestinal region. The development of this capsule can help support future characterization of the microbiome across the gastrointestinal tract in healthy people and people suffering from intestinal diseases. It can also help track the effects of various dietary components on the microbiome.

**W4122 researcher in Colorado (Weir)** has continued to examine both the effects of diet and direct microbiota modification (ie. probiotics) on intestinal and vascular health in both pre-clinical animal models and human clinical trials. The research done in this lab 1) established the safety (in humans) of several novel dietary supplements for gut health, including a cocktail of E. coli-targeting bacteriophages and a spore-based probiotic, *Bacillus subtilis*. 2) showed that these products alone and in combination do not cause significant disruption to the structure and function of native gut microbial communities. 3) established that consumption of these products by healthy adults may reduce various symptoms of mild gastrointestinal distress. 4) showed that the *Bacillus subtilis* may improve blood lipids, vascular function, and circulating immune cell profiles in generally healthy adults. Furthermore, the team has demonstrated through an animal study that *Bacillus subtilis* partially reverses vascular dysfunction in obese mice.

**W4122 researcher in California (Marco)** emphasizes the diversity and functionality of lactic acid bacteria (LAB), with a specific focus on the LAB species *Lactiplantibacillus* (*Lactobacillus*) *plantarum.* These bacteria are found in fermented foods and the human microbiome. They are essential to making fermented foods and contribute to health-benefiting effects observed with fermented food intake. The team has identified a novel, hybrid metabolic pathway expressed by *L. plantarum, combining respiration and fermentation elements*. This pathway uses extracellular electron transfer to accelerate *L. plantarum* growth, environmental acidification, and production of flavor compounds. The study shows that this metabolism is performed by other food, and gut-relevant, and is active during food fermentation. This activity can be controlled using electrofermentation approaches, thus showing promise for fine-tuning of food fermentations and potentially increasing live-microbe food intake. Further research studied *L. plantarum* intraspecies co-existence in food fermentations and identified that fermented foods like teff injera could harbor different clonal populations of *L. plantarum.* These findings demonstrate the complexity of microbial populations in food fermentations.

**Objective 2: Identify cellular mechanisms and molecular targets of beneficial or adverse dietary components that influence human health.**

**W4122 researcher in Connecticut (Ock)** examined the relationship between citrus intake and melanoma risk in the NIH-AARP Diet and Health Study subjects. Among 388,467 adults, 3,894 melanoma cases were identified during a median follow-up of 15.5 years. After adjustment for relevant potential confounders, total citrus consumption was not significantly associated with melanoma risk in this cohort. Among those with higher estimated exposure to ultraviolet radiation, and among those aged 60+ years at baseline, there were significant trends toward increased melanoma risk associated with whole citrus fruit consumption (P trends = 0.01 and 0.02, respectively), but the hazard ratios of the top consumers (2+ cups per week) vs. non-consumers were nonsignificant. Further research is needed to explore associations of citrus with melanoma risk among older adults and those with high sun exposure.

**W4122 researcher in Nebraska (Majumder)** tested the hypothesis that dietary bioactive peptide (γ-glutamyl peptide: γ-EV) can inhibit inflammation in both vascular tissues to protect against atherosclerosis and associated chronic disorders like type-2 diabetes. Study with atherosclerotic-prone Apolipoprotein E knockout (ApoE-/-) mice showed that intervention of γ-EV both in low dose (50mg/kgBW) and in high dose (150mg/kgBW) can reduce vascular biomarkers like (ICAM-1, VCAM-1, and LOX-1). Additionally, an intervention with γ-EV attenuated the development of Angiotensin-II-induced arterial hypertension in C57BL/6 mice and markedly decreased blood glucose in obese diabetic db/db mice.

**W4122 researcher in Colorado (Weir)** has been carrying out experiments in cell cultures, animal genetic knockouts and preforming microbiota transplantation studies to better understand the cellular impacts of microbiota manipulation on vascular outcomes. Although, a clear relationship between the gut microbiota and vascular function has been established, however, the mechanistic underpinnings of this relationship remain unclear. Thus, this present work will be able to bridge that existing gap. The team have established that 1) TLR-4 signaling pathways are partially (but not wholly) responsible for mediating signaling between the gut microbiota-vascular endothelium. 2) Obesity-associated human microbiome is a critical regular in the development of vascular dysfunction. The present studies will examine 1) gut-mediated immune signaling on vascular function and 2) identify microbial components that elicit responses in the gut that have a downstream influence on vascular endothelial cells by using co-culturing systems in-vitro.

**W4122 researcher in Colorado (Chicco)** investigated the impacts of dietary fatty acid intake during pregnancy on fetal development and metabolism using a novel ovine model of maternal-fetal metabolic programming. Studies demonstrated that elevated consumption of saturated fatty acids (~25% kcal intake) promoted skeletal muscle insulin resistance and enhanced uptake and oxidation of fatty acids in mid-term fetuses, consistent with findings from murine and non-human primate models. Studies also established that supplementing 2% algae-derived DHA to the diet of pregnant ewes crosses the maternal rumen and placenta to enrich fetal tissue DHA levels. This was associated with complex shifts in the expression of fatty acid transporters on the placenta and fetal tissues that may impact nutrient metabolism during development and early neonatal life. Taken together, these studies are the first to validate use of an ovine model for investigating the impact of maternal dietary fatty acid supplementation on fetal metabolism and development.

**Objective 3: Explore the interaction between dietary components and the host metabolome and epigenome.**

**W4122 researchers in Minnesota (Chen)** examined the influences of feeding thermally oxidized oil on amino acid metabolism. Feeding thermally oxidized lipids to pigs has been shown to compromise growth, reduce energy digestibility, and disrupt lipid profile. Oxidized corn oil (OCO)-elicited changes in the amino acid homeostasis of nursery pigs were examined by metabolomics-based biochemical analysis. The results showed that serum and hepatic free amino acids and metabolites, including tryptophan, threonine, alanine, glutamate, and glutathione, as well as associated metabolic pathways, were selectively altered by OCO, and more importantly, many of these metabolic events possess protective functions. Specifically, OCO activated the tryptophan-nicotinamide adenosine dinucleotides (NAD+) synthesis by the transcriptional upregulation of the kynurenine pathway in tryptophan catabolism and the promotion of adenine nucleotide biosynthesis. Furthermore, OCO induced oxidative stress, causing the decreases of glutathione (GSH)/oxidized glutathione (GSSG) ratio, carnosine, and ascorbic acid, and simultaneously promoted antioxidant responses as shown by the increases of hepatic GSH and GSSG and the transcriptional upregulation of GSH metabolism-related enzymes. Moreover, OCO reduced the catabolism of threonine to α-ketobutyrate in the liver by inhibiting the threonine dehydratase (TDH) route. Overall, these protective metabolic events indicate that, below a certain threshold of exposure, nursery pigs can overcome the oxidative stress and metabolic challenges posed by the consumption of oxidized lipids by adjusting antioxidant response and nutrient and energy metabolism, partially through the transcriptional regulation of amino acid metabolism.

**W4122 researcher in Hawaii (Nerukar)** has been carrying the work on Coffee.Coffee is the most widely consumed beverage worldwide. Recent studies indicate that drinking moderate amounts of coffee (up to 4 cups/day) may improve mortality rates as well as metabolic abnormalities in humans. Our studies indicated that Hawaii-grown coffee helps to reduce plasma inflammatory markers among healthy individuals.

**Objective 4: Determine how food processing influences chemical composition to affect human health.**

**W4122 researchers in New Mexico (Delgado)** shows the effects of maltodextrins and gum arabic as microencapsulation agents on the stability of sugarcane bagasse extracts and the potential use of the extracts as antimicrobial agents. The bioactive compounds in sugarcane bagasse (SCB) were extracted using 90% methanol and an orbital shaker at a fixed temperature of 50 °C, thereby obtaining a yield of the total phenolic content of 5.91 mg GAE/g. The bioactive compounds identified in the by-product were flavonoids, alkaloids, and lignan (-) Podophyllotoxin. The total phenolic content (TPC), antioxidant activity, and shelf-life stability of fresh and microencapsulated TPC were analyzed. This experiment’s optimal microencapsulation can be obtained with a ratio of 0.6% maltodextrin (MD)/9.423% gum arabic (GA). Sugarcane bagasse showed high antioxidant activities, which remained stable after 30 days of storage and antimicrobial properties against *E. coli*, *B. cereus*, *S. aureus*, and the modified yeast SGS1. The TPC of the microencapsulated SCB extracts was not affected (p > 0.05) by time or storage temperature due to the combination of MD and GA as encapsulating agents. The antioxidant and antimicrobial capacities of sugarcane bagasse extracts showed their potential use as a source of bioactive compounds for further use as a food additive or nutraceutical.

**W4122 researcher in Hawaii (Nerukar)** provided evidence that the beneficial effects of fermentation on food chemical composition and positive influence on human health. We have identified the role or fermenting bacteria in preparations of traditional Hawaiian medicine noni (*Morinda citrifolia*) and its effects on obesity and glucose metabolism in mice fed a high-fat diet.

**W4122 researchers in Minnesota (Chen)** examined the chemical properties of soybean meals. Feeds containing oxidized lipids and proteins can contribute lead to oxidative stress, impaired protein and fat digestibility, and compromised intestinal function in food producing animals. However, the status of lipid and protein oxidation among sources of soybean meal (SBM), which is most widely used feed ingredients in animal feeds, has been largely unexplored. In this study, lipid and protein oxidation status of 48 samples of SBM samples from different preparation procedures (solvent extraction, extrusion, expeller) and geographic locations were analyzed by p-anisidine value (lipid oxidation indicator) assay and 2,4-dinitrophenylhydrazine (DNPH)-based protein carbonyl content (protein oxidation indicator) assay, respectively. In addition, water activity, as a parameter that could contribute to lipid and protein oxidation, was also measured. The results showed that p-anisidine values ranged from non-detectable to 2.29 and protein carbonyl contents ranged from 0.58 to 35.12 mmol /kg protein in these samples. Pearson correlation analysis revealed a significant positive correlation (r=0.56, p<0.001) between p-anisidine values and carbonyl contents. Mechanically processed extrusion and expeller SBM samples had higher p-anisidine values (p <0.0001) and protein carbonyl levels (p <0.0001) than samples of solvent-extracted SBM samples. Overall, the water activity of 48 SBMs averaged less than 0.60, which is considered safe for preventing bacteria and mold growth during long-term storage. Moreover, the water activity of solvent-extracted SBMs (ranging from 0.55 to 0.68) was greater (p<0.0001) than that of mechanically processed SBMs (ranging from 0.28 to 0.45). Taken together, mechanically processed extrusion and expeller SBM samples have significantly higher oxidation level compared with solvent-extracted SBMs, in which lipid oxidation is positively correlated with protein oxidation of SBMs, and extraction methods may affect the oxidation status and water activity of SBMs.

**W4122 researcher in Colorado (Weir)** are exploring how altering feedstock of crickets can impact their iron bioavailability and micronutrient content as well as how solid-state fermentation of mealworms impacts protein digestibility, iron availability and consumer acceptance of whole mealworm-based foods. The recent study determined that the iron content in crickets is tightly regulated, despite differences in this micronutrient in the feedstock. Furthermore, rearing crickets on spent mushroom compost (post-fruiting) compared to pre-fruiting mushroom blocks may increase bioavailable iron in the consumed crickets, which could provide a convenient circular food production system for low resource contexts. The team also determined that mealworm larvae are a suitable substrate for solid-state fermentation by Rhizopus molds and studies are underway to compare their food safety, nutritional, and consumer acceptability profiles relative to non-fermented mealworm and traditional soybean-based fermentations (tempeh).

**Impact statements:**

**W4122 researcher in Michigan (Turner)** has demonstrated that although quercetin and chlorogenic acid are beneficial in combination with a fermentable fiber during inflammatory bowel disease remission, they influence several aspects of inflammatory processes not able to prevent injury from occurring during periods of activity.

**W4122 researcher in Nebraska (Izard)** provided the first analysis of food-specific IgG present across digestive diseases or surgical resections, a missing component to understand a complex phenomenon often underestimated its impact on the quality of life of the population. Via this approach, we uncovered a difference between the ileum (small intestine) and the colon that affects food-specific IgG risk, food absorption, and immune regulation.

**W4122 researcher in Indiana (Verma)** has developed a new way of probing the microbiome in a non-invasive manner. This sampling capsule will help characterize the microbiome more thoroughly and extend gut microbiome studies beyond analyses of fecal samples.

**W4122 researchers in Minnesota (Chen)** observed novel metabolic functions of oxidized lipids and the impacts of processing on the oxidation status of soybean in our research. These results could be used to understand the metabolic consequences of consuming oxidized food and feed.

**W4122 researcher in Colorado (Weir)** research program will directly impact the public and establish the efficacy of gut-modulating dietary supplements such as the bacteriophage cocktail and probiotics. The findings will assist dietitians, clinicians, and consumers identify the appropriate microbiota-targeted dietary supplements for a given condition.

**W4122 researcher in California (Marco)** research program will improve microbe-based therapies and dietary measures to optimize human health. This research results in the characterization of specific bacteria taxa and bacterial metabolites consumed in foods and beverages that improve human health via modulation of the intestinal epithelium. The knowledge will be used to reduce the prevalence of obesity and type 2 diabetes through dietary measures.

**W4122 researcher in Connecticut (Ock)** indicated that neither total citrus nor any citrus product consumption was associated with melanoma risk among the entire tested cohort.

**W4122 researcher in Nebraska (Majumder)** provided further evidence that the dietary γ-glutamyl peptide intervention could be a beneficial strategy to mitigate the risk of developing chronic cardio-metabolic disorders.

**W4122 researcher in Colorado (Chicco)** characterized an ovine model of fetal metabolic programming by maternal diet, corroborating evidence from a non-human primate model that high-fat feeding promotes fetal muscle insulin resistance during pregnancy, perhaps predisposing the offspring to metabolic syndrome in early life. Furthermore, established that algae-derived DHA supplementation to pregnant ewes crosses the maternal rumen and placenta to enrich fetal tissues. This was associated with changes in fetal muscle and liver nutrient metabolism that might reduce risk of obesity and diabetes in offspring.

**W4122 researcher in Hawaii (Nerukar)** have demonstrated that drinking 2 to 3 cups of coffee/day has health benefits among obese individuals. Results from these studies are expected to increase public awareness about the health benefits of coffee.

**W4122 researchers in New Mexico (Delgado)** established the first step in encapsulating phenolic compounds from SCB as a promising source of antioxidant agents and ultimately a novel resource for functional foods.

**Plans for 2023:**

W4122 project is completed in 09/30/2022 and now renewed with a new project number W5122: Beneficial and Adverse Effects of Natural Chemicals on Human Health and Food Safety with a duration of 10/01/2022 to 09/30/2027.

**W5122 researcher in Michigan (Turner)** will complete the data analyses from a previous project aimed at determining the impact of prunes on colon carcinogenesis. Results from that experiment are expected to be summarized in two manuscripts.

**W5122 researcher in Nebraska (Izard)** will further analyze the potential impact on bioactive metabolism and absorption.

**W5122 researcher in Indiana (Verma)** plans on demonstrating *in vivo* capabilities of the sampling capsule.

**W5122 researchers in Minnesota (Chen)** will examine more metabolic events associated with the exposure of oxidized lipids, bile acids, and phytochemicals.

**W5122 researcher in Colorado (Weir)** aims to explore how popular diet trends, like intermittent fasting, influence the gut microbiota as it relates to vascular function and immunity.

**W5122 researcher in California (Marco)**plans to continue shedding light on the production of fermented foods that would ultimately be informative for understanding resource sharing and complementarity within environmental niches that result in intraspecific co-existence.

**W5122 researcher in Connecticut (Ock)** will examine the relationship between citrus intake and non-melanoma skin cancer (NMSC) risk in a population of postmenopausal US women.

**W5122 researcher in Nebraska (Majumder)** will develop new food processing methods to increase the abundance of γ-glutamyl peptides in foods and then test their efficacy in exhibiting biological activities. Furthermore, aims to evaluate the effect of γ-glutamyl peptide in modulating the function and composition of gastrointestinal microbiota as a large portion of the ingested peptide can reach the colon.

**W5122 researchers in Colorado (Chicco)** will utilize their new ovine model of fetal metabolic programing by maternal diet to evaluate the mechanisms that govern placental lipid transport to the fetus. Complimentary studies in mice will examine the specific role of the FADS2 gene linked to cardiometabolic risk in humans on nutrient metabolism in neonates and offspring into early adulthood. They also plan to publish findings from their ovine model studies in two manuscripts, and further develop ongoing collaboration with new W5122 members to elucidate the interactions between dietary nutrient metabolism and intrauterine grown restriction (IUGR) in a murine model.

**W5122 researcher in Hawaii (Nerukar)** will continue to explore the health-beneficial compounds of Coffee and further evaluate how food processing specifically fermented traditional Hawaiian foods and its effects on obesity and glucose metabolism.

**W5122 researchers in New Mexico (Delgado)** plans to express and produce oleosin in yeast cells to use them in aquaculture feed.

**Grants awards (new and ongoing):**

W4122 members and their labs were awarded approximately **over $5.9M in new grants in the 2021-22 period** to study effects of bioactive nutrients on cancer, diabetes, fetal programming by maternal diet, gut health, and cardiovascular risk). Major awards from this reporting period are listed below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **W4122 member** | **Year** | **Project Title** | **Funding Agency** | **US Dollars (approx.)** |
| Nancy Turner (Michigan State University) | 2020-2025 | Food processing, technology, and safety workforce development: Dual certificate and associate degree program.  | USDA-AFRI | $499,999.08 |
| 2021-2023 | Colon cancer protection derived from prunes.  | California Prune Board | $31,000 |
| 2022-2023 | Dried beans contribute to colon health through microbiota-mediated mechanisms. | Northarvest Bean Association | $19,999 |
| Mohit Verma (Purdue University) | 2022-2023 | Sentient Environment for Enhancing Resilience (SEER) for Sustainable Animal Agriculture | Purdue University College of Agriculture | $100,000 |
| 2022-2023 | Point-of-care detection of African swine fever virus: a paper-based device for molecular diagnostics | United States Department of Agriculture Animal and Plant Health Inspection Service | $1,000,000 |
| 2022-2023 | Use case demonstration of a paper-based LAMP platform for plant pathogen detection | Foundation for Food and Agriculture Research | $64,850 |
| Maria Marco (University of California-Davis) | 2021-2022 | Fermented dairy effects on markers of intestinal health: a literature review | National Dairy Council |  |
| 2022-2026 | PIG-PARADIGM: Preventing Infection in the Gut of developing Piglets-and thus Antimicrobial Resistance - by disentAngling the interface of DIet, the host and the Gastrointestinal Microbiome. | Novo Nordisk Foundation |  |
| 2021-2024 | Developing community frameworks for improving food security inGreenland through fermented foods | National Science Foundation |  |
| 2021-2023 | The yogurt matrix during digestion: benefits of milk composition and structure | California Dairy Research Foundation |  |
| Chun K Ock (University of Connecticut) | 2019-2022 | Beneficial and Adverse Effects of Natural Chemicals on Human Health and Food Safety: Citrus Intake and Skin Cancer Risk | Hatch Capacity Grant, University of Connecticut USDA (Multistate) | $90,000 |
| Kaustav Majumder (University of Nebraska-Lincoln) | 2022-2027 | Evaluating the Efficacy of Dry Bean-Based Dietary-Glutamyl Peptides for Improvement of Metabolic Syndrome | USDA Hatch Multistate Enhanced Program, Nebraska Agricultural Experiment Station (NEAES) | $217,472 |
| Adam Chicco (Colorado State University) | 2021-2023 | Feeding the starving heart in Barth Syndrome | Barth Syndrome Foundation | $82,000 |
| 2021-2023 | Tissue-specific role of FADS2 in dietary regulation of cardiometabolic risk | Colorado Agricultural Experimental Station (USDA) | $50,000 |
| 2020-2023 | Effects of Chronic High LET Radiation on the Human Heart | Translational Research Institute for Space Health (TRISH/NASA) | $864,878 |
| 2022-2025 | Evolutionarily conserved variations in menaquinone structure: Functional implications | National Science Foundation  | $528,000 |
| 2019-2024 | Cortical-Medullary Circuitry Preventing the Cardiovascular Consequences of Chronic Stress | NIH/NHLBI | $690,578 |
| Pratibha V Nerurkar (University of Hawaii) | 2022-2023 | Valorization of agricultural waste and identifying novel proteins | Capacity building, USDA, CTAHR | $40,029 |
| 2021-2026 | Empowering Women and Underrepresented Undergraduates with Advanced Technology Research Training in Agriculture and Food Sciences | AFRI-NIFA | $440,367 |
| 2018-2024 | Specialty Crops: From Farm to Human Health | USDA- ARS | $80,000 |
| Efren Delgado (New Mexico State University) | 2021-2024 | Developing an Alliance for Training and Apprenticeship in Climate-Smart Agriculture (DATA-Ag)  | USDA-AFRI-AWT Program through UT at Arlington.  | $124,852  |
| 2021 -2024  | Training of Next Generation Workforce for Smart Food Science and Agricultural Technology in the Digital Era (WorkFoS-Ag)  | USDA-AFRI  | $500,000 |
| 2021 - 2023  | Transcriptome analysis of Phytophthora blight (Phytophthora capsici) interaction and identifying genes involved in the infection process for early detection of infected plants  | NM Chile Association  | $91,850  |
| 2018-2022  | ALFA-loT ALliance For Smart Agriculture in the Internet of Things Era | USDA- Hispanic Serving Institutions (HSI)  | $295,000  |
| 2021-2026  | Bioprocessing of Agroindustrial By-products  | Hatch-Proposal- US Department of Agriculture  | $27,500  |

**Publications:**

There were **43 new publications by W4122 members in 2021-2022** period, addressing the effects of bioactive nutrients on health and chronic disease risk, basic insights into nutrient metabolism, and the development of new methodology and technologies for studying these processes in humans and model systems.

Nancy Turner (Michigan State University)

(1) Turner, N. D.; Chapkin, R. S. Biography of Joanne R Lupton (1944–2020). *J. Nutr.* **2022**, *152* (4), 914–916.

(2) Maslin, L. A.; Weeks, B. R.; Carroll, R. J.; Byrne, D. H.; Turner, N. D. Chlorogenic Acid and Quercetin in a Diet with Fermentable Fiber Influence Multiple Processes Involved in DSS-Induced Ulcerative Colitis but Do Not Reduce Injury. *Nutrients* **2022**, *14* (18), 3706.

Jacques Izard (University of Nebraska-Lincoln)

(3) Carson, W. K.; Baumert, J. L.; Clarke, J. L.; Izard, J. Small bowel stomas are associated with higher risk of circulating food-specific-IgG than patients with organic gastrointestinal conditions and colostomies. *BMJ Open Gastroenterol.* **2022**, *9* (1), e000906.

(4) Nguyen, L. H.; Cao, Y.; Hur, J.; Mehta, R. S.; Sikavi, D. R.; Wang, Y.; Ma, W.; Wu, K.; Song, M.; Giovannucci, E. L.; et al. The Sulfur Microbial Diet Is Associated With Increased Risk of Early-Onset Colorectal Cancer Precursors. *Gastroenterology* **2021**, *161* (5), 1423-1432.e4.

Mohit Verma (Purdue University)

(5) Wang, J.; Ranjbaran, M.; Ault, A.; Verma, M. S. A loop-mediated isothermal amplification assay to detect Bacteroidales and assess risk of fecal contamination. *Food Microbiol.* **2023**, *110*, 104173.

(6) Boodaghidizaji, M.; Milind Athalye, S.; Thakur, S.; Esmaili, E.; Verma, M. S.; Ardekani, A. M. Characterizing viral samples using machine learning for Raman and absorption spectroscopy. *Microbiologyopen* **2022**, *11* (6), e1336.

(7) Nejati, S.; Wang, J.; Sedaghat, S.; Balog, N. K.; Long, A. M.; Rivera, U. H.; Kasi, V.; Park, K.; Johnson, J. S.; Verma, M. S.; et al. Smart capsule for targeted proximal colon microbiome sampling. *Acta Biomater.* **2022**, *154*, 83–96.

(8) Ranjbaran, M.; Verma, M. S. Microfluidics at the interface of bacteria and fresh produce. *Trends Food Sci. Technol.* **2022**, *128*, 102–117.

(9) Centeno-Martinez, R. E.; Glidden, N.; Mohan, S.; Davidson, J. L.; Fernández-Juricic, E.; Boerman, J. P.; Schoonmaker, J.; Pillai, D.; Koziol, J.; Ault, A.; et al. Identification of bovine respiratory disease through the nasal microbiome. *Anim. Microbiome* **2022**, *4* (1), 15.

(10) Nejati, S.; Wang, J.; Heredia-Rivera, U.; Sedaghat, S.; Woodhouse, I.; Johnson, J. S.; Verma, M.; Rahimi, R. Small intestinal sampling capsule for inflammatory bowel disease type detection and management. *Lab Chip* **2021**, *22* (1), 57–70.

(11) Wang, J.; Dextre, A.; Pascual-Garrigos, A.; Davidson, J. L.; Maruthamuthu, M. K.; McChesney, D.; Seville, J.; Verma, M. S. Fabrication of a paper-based colorimetric molecular test for SARS-CoV-2. *MethodsX* **2021**, *8*, 101586.

Chi Chen (University of Minnesota)

(12) Hung, Y.-T.; Song, Y.; Hu, Q.; Faris, R. J.; Guo, J.; Ma, Y.; Saqui-Salces, M.; Urriola, P. E.; Shurson, G. C.; Chen, C. Identification of Independent and Shared Metabolic Responses to High-Fiber and Antibiotic Treatments in Fecal Metabolome of Grow-Finish Pigs. *Metabolites* **2022**, *12* (8).

(13) Heidari, F.; Øverland, M.; Hansen, J. Ø.; Mydland, L. T.; Urriola, P. E.; Chen, C.; Shurson, G. C.; Hu, B. Solid-state fermentation of Pleurotus ostreatus to improve the nutritional profile of mechanically-fractionated canola meal. *Biochem. Eng. J.* **2022**, *187*, 108591.

(14) Guo, Y.; Weber, W. J.; Yao, D.; Caixeta, L.; Zimmerman, N. P.; Thompson, J.; Block, E.; Rehberger, T. G.; Crooker, B. A.; Chen, C. Forming 4-Methylcatechol as the Dominant Bioavailable Metabolite of Intraruminal Rutin Inhibits p-Cresol Production in Dairy Cows. *Metabolites* **2021**, *12* (1).

(15) Strom, N.; Ma, Y.; Bi, Z.; Andersen, D.; Trabue, S.; Chen, C.; Hu, B. Eubacterium coprostanoligenes and Methanoculleus identified as potential producers of metabolites that contribute to swine manure foaming. *J. Appl. Microbiol.* **2022**, *132* (4), 2906–2924.

(16) Liu, J.; Huang, L.; An, J.; Ma, Y.; Cheng, Y.; Zhang, R.; Peng, P.; Wang, Y.; Addy, M.; Chen, P.; et al. Application of high-pressure homogenization to improve physicochemical and antioxidant properties of almond hulls. *J. Food Process Eng.* **2023**, *46* (2), e14235.

Tiffany Weir (Colorado State University)

(17) Stull VJ, Wilson J, W. T. Making a meal out of bugs. *Food Sci. Technol.* **2022**, *36* (2), 24–28.

(18) Lutsiv, T.; McGinley, J. N.; Neil-McDonald, E. S.; Weir, T. L.; Foster, M. T.; Thompson, H. J. Relandscaping the Gut Microbiota with a Whole Food: Dose–Response Effects to Common Bean. *Foods* **2022**, *11* (8), 1153.

(19) Lutsiv, T.; Weir, T. L.; McGinley, J. N.; Neil, E. S.; Wei, Y.; Thompson, H. J. Compositional Changes of the High-Fat Diet-Induced Gut Microbiota upon Consumption of Common Pulses. *Nutrients* **2021**, *13* (11), 3992.

Maria Marco (University of California-Davis)

(20) Bendiks, Z. A.; Guice, J.; Coulon, D.; Raggio, A. M.; Page, R. C.; Carvajal-Aldaz, D. G.; Luo, M.; Welsh, D. A.; Marx, B. D.; Taylor, C. M.; et al. Resistant starch type 2 and whole grain maize flours enrich different intestinal bacteria and metatranscriptomes. *J. Funct. Foods* **2022**, *90*, 104982.

(21) Tejedor-Sanz, S.; Stevens, E. T.; Li, S.; Finnegan, P.; Nelson, J.; Knoesen, A.; Light, S. H.; Ajo-Franklin, C. M.; Marco, M. L. Extracellular electron transfer increases fermentation in lactic acid bacteria via a hybrid metabolism. *Elife* **2022**, *11*, e70684.

(22) Marco, M. L.; Hutkins, R.; Hill, C.; Fulgoni, V. L.; Cifelli, C. J.; Gahche, J.; Slavin, J. L.; Merenstein, D.; Tancredi, D. J.; Sanders, M. E. A Classification System for Defining and Estimating Dietary Intake of Live Microbes in US Adults and Children. *J. Nutr.* **2022**, *152* (7), 1729–1736.

(23) Ramos, T.; Louvau, H.; Kim, H.; Marco, M.; DiCaprio, E. Leveraging the COVID-19 fermentation trend to enhance nutrition and food safety Extension efforts. *J. Ext.* **2022**, *60* (4).

Chun Ock (University of Connecticut)

(24) Melough, M. M.; Sakaki, J.; Liao, L. M.; Sinha, R.; Cho, E.; Chun, O. K. Association between Citrus Consumption and Melanoma Risk in the NIH-AARP Diet and Health Study. *Nutr. Cancer* **2021**, *73* (9), 1613–1620.

Kaustav Majumder (University of Nebraska-Lincoln)

(25) Guha, S.; Majumder, K. Comprehensive Review of γ-Glutamyl Peptides (γ-GPs) and Their Effect on Inflammation Concerning Cardiovascular Health. *J. Agric. Food Chem.* **2022**, *70* (26), 7851–7870.

(26) Zhao, H.; Han, A.; Nduwamungu, J. J.; Nishijima, N.; Oda, Y.; Handa, A.; Zhang, Y.; Majumder, K.; Xu, C. Improving textural properties of gluten‐free veggie sausage with egg white proteins. *Food Bioeng.* **2022**, *1* (3–4), 319–330.

Adam J. Chicco (Colorado State University)

(27) Chatfield, K. C.; Sparagna, G. C.; Specht, K. S.; Whitcomb, L. A.; Omar, A. K.; Miyamoto, S. D.; Wolfe, L. M.; Chicco, A. J. Long-chain fatty acid oxidation and respiratory complex I deficiencies distinguish Barth Syndrome from idiopathic pediatric cardiomyopathy. *J. Inherit. Metab. Dis.* **2022**, *45* (1), 111–124.

(28) Chiñas Merlin, A.; Gonzalez, K.; Mockler, S.; Perez, Y.; Jia, U.-T. A.; Chicco, A. J.; Ullevig, S. L.; Chung, E. Switching to a Standard Chow Diet at Weaning Improves the Effects of Maternal and Postnatal High-Fat and High-Sucrose Diet on Cardiometabolic Health in Adult Male Mouse Offspring. *Metabolites* **2022**, *12* (6).

(29) Wang, E.; Whitcomb, L. A.; Chicco, A. J.; Wilson, J. W. Transient absorption spectroscopy and imaging of redox in muscle mitochondria. *Biomed. Opt. Express* **2022**, *13* (4), 2103.

(30) Wang, E.; Specht, K. S.; Chicco, A. J.; Wilson, J. W. High-Repetition-Rate Transient Absorption Spectroscopy of Respiratory Supercomplexes. *J. Phys. Chem. B* **2022**, *126* (7), 1404–1412.

(31) Catandi, G. D.; LiPuma, L.; Obeidat, Y. M.; Maclellan, L. J.; Broeckling, C. D.; Chen, T.; Chicco, A. J.; Carnevale, E. M. Oocyte metabolic function, lipid composition, and developmental potential are altered by diet in older mares. *Reproduction* **2022**, *163* (4), 183–198.

(32) Zhai, C.; Li Puma, L. C.; Chicco, A. J.; Omar, A.; Delmore, R. J.; Geornaras, I.; Speidel, S. E.; Holt, T. N.; Thomas, M. G.; Mark Enns, R.; et al. Pulmonary arterial pressure in fattened Angus steers at moderate altitude influences early postmortem mitochondria functionality and meat color during retail display. *J. Anim. Sci.* **2022**, *100* (2).

(33) Nguyen-Truong, M.; Liu, W.; Doherty, C.; LeBar, K.; Labus, K.; Puttlitz, C.; Easley, J.; Monnet, E.; Chicco, A.; Wang, Z. The Interventricular Septum Is Biomechanically Distinct from the Ventricular Free Walls. *Bioengineering* **2021**, *8* (12), 216.

Pratibha Nerurkar (University of Hawaii)

(34) Nerurkar, P. V; Gandhi, K.; Chen, J. J. Correlations between Coffee Consumption and Metabolic Phenotypes, Plasma Folate, and Vitamin B12: NHANES 2003 to 2006. *Nutrients* **2021**, *13* (4).

Efren Delgado (New Mexico State University)

(35) Sapkota, G.; Delgado, E.; VanLeeuwen, D.; Holguin, F. O.; Flores, N.; Heyduck, R.; Yao, S. Dynamics of Nutrients in Jujube (Ziziphus jujuba Mill.) at Different Maturity Stages, Cultivars, and Locations in the Southwest United States. *HortScience* **2023**, *58* (2), 155–163.

(36) Nájera-Domínguez, C.; Gutiérrez-Méndez, N.; Carballo-Carballo, D. E.; Peralta-Pérez, M. R.; Sánchez-Ramírez, B.; Nevarez-Moorillón, G. V.; Quintero-Ramos, A.; García-Triana, A.; Delgado, E. Milk-Gelling Properties of Proteases Extracted from the Fruits of Solanum Elaeagnifolium Cavanilles. *Int. J. Food Sci.* **2022**, *2022*, 1–12.

(37) Quintero, J.; Torres, J. D.; Corrales-Garcia, L. L.; Ciro, G.; Delgado, E.; Rojas, J. Effect of the Concentration, pH, and Ca2+ Ions on the Rheological Properties of Concentrate Proteins from Quinoa, Lentil, and Black Bean. *Foods* **2022**, *11* (19), 3116.

(38) Jorge Iñaki, G.-B.; Gerardo Antonio, P.-C.; Efrén, D.; Hiram, M.-R.; Daniela, G.-I.; Damián, R.-J. Black soldier fly: Prospection of the inclusion of insect-based ingredients in extruded foods. *Food Chem. Adv.* **2022**, *1*, 100075.

(39) Judith, R.-B. D.; Pámanes-Carrasco, G. A.; Delgado, E.; Rodríguez-Rosales, M. D. J.; Medrano-Roldán, H.; Reyes-Jáquez, D. Extraction optimization and molecular dynamic simulation of cellulose nanocrystals obtained from bean forage. *Biocatal. Agric. Biotechnol.* **2022**, *43*, 102443.

(40) Velázquez-Martínez, V.; Valles-Rosales, D.; Rodríguez-Uribe, L.; Laguna-Camacho, J. R.; López-Calderón, H. D.; Delgado, E. Effect of Different Extraction Methods and Geographical Origins on the Total Phenolic Yield, Composition, and Antimicrobial Activity of Sugarcane Bagasse Extracts. *Front. Nutr.* **2022**, *9*.

(41) Velazquez-Martinez, V.; Quintero-Quiroz, J.; Rodriguez-Uribe, L.; Valles-Rosales, D. V.; Reyes-Jaquez, D.; Klasson, T.; Delgado, E. Effect of glandless cottonseed meal protein and maltodextrin as microencapsulating agents on spray-drying of sugarcane bagasse phenolic compounds. *J. Food Sci.* **2022**, *87* (2), 750–763.

(42) Mesta-Vicuña, G.; Quintero-Ramos, A.; Meléndez-Pizarro, C. O.; Galicia-García, T.; Sánchez-Madrigal, M. Á.; Delgado, E.; Ruiz-Gutiérrez, M. G. Physical, Chemical and Microbiological Properties during Storage of Red Prickly Pear Juice Processed by a Continuous Flow UV-C System. *Appl. Sci.* **2022**, *12* (7), 3488.

(43) Cram, A.; Espiritu, J.; Taboada, H.; Valles-Rosales, D. J.; Park, Y. H.; Delgado, E.; Su, J. Multi-objective biofuel feedstock optimization considering different land-cover scenarios and watershed impacts. *Clean Technol. Recycl.* **2022**, *2* (2), 103–118.