

A tall, light-colored brick tower with a clock face and a pointed roof, surrounded by green trees and a lawn. The tower is the central focus of the image, with its shadow cast onto the grass. The sky is clear and blue.

2018 CYCLONE SCHOLAR SUMMER RESEARCH EXPERIENCE

July 27, 2018 | CCUR Theatre

IOWA STATE UNIVERSITY



PROGRAM

9:00am	Welcome and Opening Remarks
9:20am	Isaiah Byrd
9:35 am	Bridget Clark
9:50 am	Kathleen Crank
10:05 am	Savina Fischer
10:20 am	Helen Glazunov
10:35 am	April Hill
10:50am	Lauren Holderfield
11:05 am	Hannah Klemmer
11:20 am	Irena Oh
11:35 am	Catherine Simon
11:50 am	Closing Remarks
12:00 pm	Luncheon

Edible Oleogels: Bioaccessibility of Retinyl Palmitate

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Oleogels have the potential to entrap and protect labile molecules while providing a suitable matrix for the delivery of lipid bioactive components. Previously, it was demonstrated that 10% Policosanol oleogels (PCOs) can entrap and protect retinyl palmitate (RP) from photodegradation. The goal of this study was to determine the ability of PCOs to gradually release RP during *in-vitro* digestion. PCOs were prepared at 10% w/w concentration containing 1% w/w RP. RP in liquid oil (RP-LO) was used as a control to account for the effects of structural difference on the release of RP. A three part (saliva, gastric, duodenal) *in-vitro* digestive system was developed to evaluate bioaccessibility of RP in the different matrices. Samples were collected at various times (0, 30, 60, 120, 180 min) upon the duodenal stage to analyze the rate and amount of RP released. Normal phase high performance liquid chromatography (NP HPLC) was used to quantify RP in the digested fractions. Compared to RP-LO, the RP-PCO had a slower and gradual RP release over three hours of digestion. The maximum release of RP from the liquid oil was observed after 30 minutes digestion whereas the maximum RP bioaccessibility in PCOs was upon 60min digestion. The obtained results show that PCOs are a suitable strategy to allow controlled and enhanced bioaccessibility of RP in food systems.

The Effect of Superoxide Dismutase Levels and the Progression of Alzheimer's Disease

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Alzheimer's disease (AD) is a neurodegenerative disease that drastically affects memory and other various mental functions. It is the most common form of dementia and the 6th leading cause of death in the United States. Previous literature has suggested a relationship between AD and oxidative stress, and questioned how antioxidant levels in the body could influence this. Superoxide dismutase (SOD) is an antioxidant enzyme that reduces the harmful effects of oxidation within cells. The present study looked at SOD levels in the cerebrospinal fluid (CSF) of 287 human participant samples from the Alzheimer's Diseases Neuroimaging Initiative (ADNI) database. ADNI provides researchers with clinical, imaging, biochemical, and genetic biomarker data to conduct further research on the early detection and prevention of AD. SOD main effects were compared with other AD biomarkers and cognitive results using SPSS linear mixed modeling. SOD was also compared to regional gray matter (GM) and fluorodeoxyglucose (FDG) metabolism. Higher SOD was associated with improved scores for The Clinical Dementia Rating sum of boxes (CDR-sob), the AD Assessment Schedule - Cognition (ADAS-cog) and the Mini-Mental Status Exam (MMSE). However, increased SOD levels were related to increased tau and p-tau, which are markers of atrophy. SOD levels predicted both positive and negative associations that were region dependent for GM volume and FDG uptake. Regions associated with more GM involved areas of the frontal lobe and temporal lobe, including the hippocampus and cingulum. Additionally, increased FDG uptake was correlated with the cingulum and inferior temporal. Negative regional associations were found in the supplementary motor area, precuneus, and the surprisingly, the cingulum as well. These results support the hypothesis that SOD levels are a valuable biomarker in the early detection of cognitive impairment and AD. Furthermore, it confirms and supports previous literature results that SOD levels may be dose and location dependent.

Biotinidase as a possible biomarker of metabolic dysfunction and Alzheimer's Disease

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Biotinidase (BTD) is an enzyme in the biotin cycle that is critical for releasing free biotin from biotinylated peptides. Currently the effects of BTD on cognitive function in people with dementia is widely unknown. This study's purpose was to determine if the BTD peptide SHLIIAQVAK could be a biomarker for metabolic dysfunction in the brain by analyzing concentrations of this peptide in the CSF of Alzheimer's disease (AD), mild cognitively impaired (MCI) and cognitively normal (CN) patients in the Alzheimer's Disease Neuroimaging Initiative (ADNI) database. BTD levels were analyzed with grey matter (GM) volume and fluorodeoxyglucose (FDG) scans to measure neuronal degradation and metabolism. Through voxel-wise analysis, high levels of BTD in CSF was shown to be significantly correlated with more GM volume and less FDG metabolism in areas associated with learning and memory. In addition, high levels of BTD were positively associated with the Clinical Dementia Rating Sum of Boxes (CDR-sob) and Logical Memory Delay (LDEL) while having a negative association with composite memory scores (ADNI-MEM) and executive function tasks. For cognitively normative patients, higher levels of BTD were significantly associated with higher forgetting scores in the Rey Auditory Verbal Learning Test (RAVLT) test while patients with MCI and AD had lower forgetting scores in the RAVLT test with higher amounts of BTD in CSF. These results indicate that among these subjects, higher BTD predicted deficits in working memory on global assessments. Due to the role of free biotin as a coenzyme in many carboxylases in the TCA cycle, BTD was analyzed as a potential biomarker of metabolism. There was a positive association between BTD and both mitochondrial aspartate aminotransferase and two glutamate receptors peptides. Future research should focus on the binding affinity of BTD for biotin through aging and the effects of high doses of biotin to clarify if these results are due to an increase of free biotin in the CSF, unknown effects of the enzyme BTD, or because BTD is a biomarker of metabolism.

MicroRNA Gene Expression in Whole Egg

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Obesity affects nearly one-third of the global population and contributes to the increased prevalence of type 2 diabetes. Our lab previously demonstrated a whole egg-based diet, when fed to Zucker-Diabetic-Fatty (ZDF) rats, reduces weight gain despite increased food intake compared to casein-based diets. Therefore, we hypothesize that the microRNA content of whole egg may underlie the decreased weight gain in ZDF rats. The objective of this project was to characterize the microRNA content in the dietary components: whole egg, casein, cornstarch, corn oil and combined diets. Five RNA extraction methods were performed on the casein and whole-egg diets and their individual components. RNA extraction/isolation was conducted using one of the following methods on 6 samples of each ingredient: 1) Trizol (Invitrogen), 2) Trizol + Directzol (Zymogen), 3) Trizol followed by a second extraction using a fatty acid RNA extraction kit (Norgen), 4) mirPremier (Sigma-Aldrich), 5) ISOLATE II RNA (Bioline). RNA concentrations and 260/280 ratios were determined via the nanodrop 2000 (Thermo Scientific) and RNA integrity was assessed using a bio-analyzer 2100 (Agilent). The greatest total RNA recovery (ng/μL) and 260/280 absorbance ratios (mean ± SD) were achieved using Trizol on casein diets (460.9 ± 528.1; 1.56 ± 0.12) and whole egg diets (394.3 ± 292.8; 1.55 ± 0.16), whole egg (73.4 ± 20.3; 1.15 ± 0.23), corn oil (67.5 ± 20.0; 1.41 ± 0.04), and cornstarch (247.12 ± 110.34; 1.64 ± 0.13). RNA recovery using Trizol achieved the greatest quantity and purity when compared against these other methods.

Antibacterial Effectiveness of High Voltage Atmospheric Cold Plasma (HVACP) Against *Salmonella enterica* on Artificially Inoculated Raw Shelled Pistachios

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Recent food trends have shown an increase in consumer demand for raw, minimally processed food products, for their perceived higher nutrient content and fresh-like characteristics. Several multistate-outbreaks of salmonellosis from the consumption of raw or minimally processed tree nuts including almonds, pistachios, pine nuts, pecans and macadamia nuts have raised concerns over the microbial safety of these nutritious products. Pistachios are of particular concern because of their biological structure; poor hull protection and a highly creviced surface enhance microbial growth and survival, increasing their susceptibility to contamination. In the present study we examined the effects of treating raw shelled pistachios artificially inoculated with a 5-strain mixture of *Salmonella enterica*, with varying increments of High Voltage Atmospheric Cold Plasma (HVACP). Samples (10-gram) of pistachios were inoculated with a 5-strain mixture of *S. enterica* (10^7 CFU/g) then treated with HVACP at 44kV, for times ranging from 0 minutes (control) to 20 minutes, in increments of 5 minutes. Treated samples were kept at ambient temperature (22 ± 1 °C) for 24 hours before they were analyzed for *S. enterica* survivors. Survivors were enumerated using selective agar [Xylose Lysine Tergitol 4 (XLT-4)], as well as Thin Agar Layer method, layering Tryptic Soy Agar with Yeast Extract (TSAYE) over XLT-4, to account for injured cells. Initial numbers of viable *S. enterica* on pistachios decreased with increased exposure to HVACP. HVACP treatment for 20 minutes resulted in a 2.4log reduction of the pathogen. All HVACP treatments caused substantial sub-lethal injury (43.3%-49.2%). Based on these results HVACP has good potential for use as a non-thermal kill step to destroy *S. enterica* on pistachios and enhance the microbial safety of this product.

Attitudes of Black Men on Recipes to be used in Diabetes Education

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Diabetes disproportionately affects Black individuals in the United States. Effective diabetes education often includes a cooking component. Food is an integral part of Black culture, so cultural considerations must be made during program development. This study assessed participant satisfaction on eight soul food recipes for use with a diabetes program. Black men and their support persons were recruited via email listservs, word of mouth, and Facebook. During the taste testing, participants completed a sociodemographic questionnaire and a sensory evaluation for each recipe. The sensory evaluation assessed appearance, aroma, texture, and overall impressions of the recipe using a 5-point Likert scale. Surveys were analyzed using descriptive statistics. Eight educated Black men and one woman (support person) attended. Most did not have a diabetes diagnosis (88.9%) but had a family history of diabetes (n=8 out of 9) (88%) and were single (44.4%). Participants were ages 21 years to 77 years. Of those who answered (n=7 out of 9) most (57.1%) were “Likely” to attend a diabetes education program for Black men. Barbecue pork (n=6) (66% “Liked very much”) and shrimp jambalaya (n=7 out of 9) (86% “Liked very much”) were the favorite recipes. Participants felt the most negatively about the corn bread (n=8) (13% “Dislike slightly”, 13% “Neutral”, 75% Like Slightly). All recipes scored mostly “Liked very much” or “Liked slightly” for overall impression. Flavor and texture were attributes mentioned most frequently in regards to satisfaction. The findings suggest these recipes would be acceptable for use in a diabetes education program for Black men.

Health Status Markers of Division I Female Collegiate Gymnastics

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Energy is important for everyday tasks especially when it comes to athletes. In recent studies it has been discovered that collegiate female athletes in aesthetic sports are at high risk of overtraining. The purpose of this study was to examine health status markers including: biochemical parameters of blood lipids, inflammatory markers, and body composition, relative to dietary intake in female collegiate gymnastics. The study data collected was prior to pre-season training. Collegiate female gymnasts (n=13; ages 19-22 years) were recruited and voluntarily participated. Body composition was collected by Bod Pod® for each subject and subjects completed a 5-day food record to capture dietary intake. Biochemical indices were collected from fasting blood draws processed by commercial laboratory (Quest) and ELISA kits. Descriptive statistics were run using SPSS. At baseline, there was no significant difference observed between the data and data from similar elite female collegiate athletes. Using Recommended Dietary Allowances (RDA) and Dietary Guidelines as a reference to the data. Kilocalories (1907.46 kcal \pm 550.58) at baseline were as expected compared to similar populations. The estimated protein requirement of an elite female athlete is 68.20-79.5 g/day or (1.2-1.4g/kg BW). However, the data showed higher protein (79.64 g \pm 30.90) intake than what is suggested. Due to the results of the study, more research will need to be discovered in order to find difference among health status in elite female collegiate gymnastic athletes.

Pathogenic *Escherichia coli* Colonization of a Colonic Cell Line and Inhibition in Vaccinated Mouse Serum Samples

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Escherichia coli is a bacterium primarily found in human and animal intestines. Most strains are harmless, but some are infectious to humans and can cause disease in intestinal or extraintestinal sites. Shiga toxin-producing *E. coli* (STEC) is a pathogenic group that adheres to the colon in humans and is commonly associated with foodborne illness outbreaks. Extraintestinal pathogenic *E. coli* (ExPEC) is a major cause of bacteremia, commonly antibiotic resistant, and thus a vaccine is urgently needed. During my summer research training in Dr. Mellata's lab, I was involved in existing projects on STEC and ExPEC. My contribution was to: 1) understand the extent of colonization of various STEC strains on human colonic cells; and 2) evaluate the effectiveness of vaccines against ExPEC *in vitro*. In study one, Caco-2 cells were infected with STEC strains for two hours, washed with buffered saline, trypsinized, and treated with Triton-X-100. Bacterial levels were quantified by serial dilution and plating on MacConkey agar. In study two, serum samples collected from unvaccinated mice or immunized with *E. coli* proteins OmpA and TraT with alum as an adjuvant or encapsulated in nanoparticles were used in *in vitro* assays. Bacterial inhibition was tested using two ExPEC strains (CFT073, JJ1886) and non-pathogenic *E. coli* MG1655 mixed 1:1 in serum, incubated for six hours, plated on MacConkey agar, and bacterial concentrations were recorded. Preliminary studies indicate that STEC strains adhered at a similar level to colonic cells. Results from study two, from two independent trials, indicated that our vaccines had protective potential against *E. coli* strains. Future research will further explore *E. coli* infection mechanisms and develop therapeutics.

Evaluation of a Commercial Enzymatic Drain Cleaner for Food Matrix Disruption

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The physical complexity of foods can hinder our ability to detect human pathogens such as *Salmonella* which can be internalized within food structures. Recent attempts by others at addressing this issue have relied on digestion of food matrices using high-purity enzymes. However, the cost of this approach may limit industry's ability to implement it on a practical scale. As a potential alternative, we investigated the use of an inexpensive commercial enzymatic drain cleaner for pre-analytical digestion of ground turkey, butter lettuce, and baby spinach. In addition to viable bacterial spores, the product used contains a mixture of protease, cellulase, amylase and lipase enzymes intended to digest protein, cellulose, starch and fat residues. To prepare the product for digestion trials, we suspended it in warm water (41° C) at 1x, 3x, and 6x the recommended usage level, then filtered it (0.22 µm) to remove spores. We then added 1:10 dilutions of test foods and incubated them at 37°C for 2 or 4 h. We also evaluated further mechanical disruption of enzyme-treated foods using either a Stomacher or a Pulsifier. Increasing concentrations of drain product and longer incubation times led to decreased structural integrity of all test foods, with concomitant increases in pigmentation of the enzyme solution. Extended (overnight) incubation yielded further visual degradation of the meat, but these results were less pronounced for leafy greens. The efficacy of additional mechanical disruption was dependent on food type and instrument used. Overall, our results suggest that use of this approach could provide industry with an inexpensive and scalable means for pre-analytical treatment of meat substrates in support of food pathogen surveillance.

The Effect of Resistant Starch on Sugar Cookies

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Resistant starch is a type of starch that is not digested in the small intestine, but is fermented to short-chain fatty acids in the large intestine. These starches can improve health because the short-chain fatty acids benefit colon health. Incorporating resistant starch into foods can provide these health benefits. However, it is important the foods with added resistant starch have acceptable quality attributes. The objective of this experiment is to determine the effect of resistant starch on the quality characteristics of a sugar cookie. HiMaize 260, banana flour, and a blend of HiMaize 260 and banana flour (1:1) replaced the flour at 50%, 75%, and 100% substitution. Gluten was added to the resistant starch treatments to compensate for the lack of gluten in resistant starch. The experiment was replicated three times and compared to a control. Spread (diameter/height), texture, and color of the cookies were measured to evaluate quality attributes. The cookies made with banana flour were darker and had less spread than the control. The force to compress the banana flour cookies was large because the cookies were very dense. As the amount of starch increased in the cookie batter the color became darker and the cookie became denser. The HiMaize flour had a similar color and shape to the control cookies, but the texture of the cookies was grainy and fell apart easily. As the amount of HiMaize increased the cookies became chalkier and were more likely to break. The mixture of the banana flour and the HiMaize was ideal because the color was somewhat darker than the control however it still had a texture that was not too dense or chalky. The two starches complimented each other. However the more starch that is added, the more the cookie is different from the control. Therefore a 50% resistant starch substitution is ideal because it will provide the benefits of the resistant starch without adversely affecting the quality attributes.

