POSTER COMPETITION
APRIL 20, 2017

CCUR TECHNOLOGY TRANSFER THEATRE
IOWA STATE UNIVERSITY

www.ccur.iastate.edu/postercompetition
GREETINGS

Thank you for joining us to celebrate student success at the second annual Center for Crops Utilization Research and BioCentury Research Farm Research Symposium and Student Success Celebration. Today we are highlighting the efforts of many undergraduate and graduate students engaged in food, feed, and biorenewables research at Iowa State University. We also are celebrating the outstanding efforts of our undergraduate student employee workers in CCUR and BCRF who provide support to many of our service projects.

We value your participation in this event and the sharing of your knowledge and encouragement to the next generation of scientists, engineers, and global leaders. The time you spend with these students will be like planting seeds in a garden. Over time these thoughts and ideas will transform into amazing successes.

Best regards,

Kevin Keener, Ph.D., P.E.
Director, CCUR and BCRF

1:00 WELCOME
Kevin Keener, CCUR and BCRF Director

1:05 CYBIZ LAB: CCUR MARKETING STRATEGY AND RECOMMENDATIONS
Travis Manderfield, marketing
Will Graham, mechanical engineering and business administration
Emily Martin, agricultural and biosystems engineering
Nick Collison, industrial engineering and business administration

1:20 POSTER VIEWING AND RECEPTION
Refreshments will be available

2:45 AWARDS CEREMONY
Undergraduate and graduate student research poster award recognition
CCUR and BCRF student employee recognition
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High Voltage Atmospheric Cold Plasma Treatment of Wastewater

Jens Dancer, Martin Gross, Victoria Villanueva, and Kevin M. Keener
Contact: Jens Dancer, jcdancer@iastate.edu

Wastewater treatment facilities throughout Iowa and the United State use various methods to treat their water before releasing it into the environment. Some of these methods include chlorine and ultra violet light systems to bring the level of harmful bacteria in the water to an acceptable concentration before release. These current methods are costly and either consume large amounts of energy or consume chemicals to disinfect water. Recently developments in plasma technologies have shown that plasma generated gas can be used to kill bacteria and pathogens. A majority of the previous research on plasma thus far has been on the decontamination of various food products. This research represents one of the first instances where plasma has been used in wastewater disinfection. My research is focused on exploring the viability of using the plasma technology to treat wastewater in a more energy efficient and economical way. If shown to be a viable option, this method could result in a new lower cost approach to disinfect wastewater in Iowa and across the nation.
From a microbial standpoint, pre-sliced fruits are of concern as preparation and exposed surfaces put the product at risk of contamination and microbial growth due to contaminated rind surfaces. Between 1990 and 2005, there were 17 cantaloupe-related foodborne outbreaks. Although bacterial growth on cantaloupe has led to outbreaks, the main concern of this study is the microbial shelf life of sliced cantaloupe, based on a bacterial spoilage level of 10^7 CFU/g. The purpose of this study was to both enumerate and observe microbial ecology on pre-sliced cantaloupe at its “typical” refrigeration temperature, defined as 4°C. Replicate packages of pre-sliced cantaloupe were sampled on days 0, 4, 7, 11, 14, and 18, from differing lot numbers. Ten grams of cantaloupe were stomached in a sterile bag with buffered peptone water and appropriately diluted for the corresponding plates. Tryptic Soy Agar track plates were then used for mesophilic enumeration (37°C for 24 hours) and psychrophilic enumeration (4°C for 7 days). For yeast enumeration (25°C for 48 hours), 3M Rapid Yeast and Mold Petrifilms were utilized. Differential staining was used to determine the morphology of bacteria cells. The bacteria were gram-positive rods and cocci. Microbial spoilage level of 10^7 CFU/g was obtained on day 11, providing the data to determine an estimated shelf life (11 days). Yeast growth occurred on all days, but growth declined with the appearance of mold on day 11. Further investigation of the inhibitory qualities of the presence of mold on yeast growth is suggested.
New Algae Treatment Technology Addresses Stricter Wastewater Regulations for Rural Iowa

Max Gangestad, J. Gimondo, Martin Gross, Zhiyou Wen, and Darren Jarboe
Contact: Max Gangestad, mtgang@iastate.edu

The Iowa DNR are enforcing new stricter wastewater treatment limits for communities throughout Iowa. The communities that these new permits affect the most are rural communities because of the high costs associated with meeting the new limits. Our research, which is funded by ISU CIRAS and a private company Gross-Wen Technologies, is investigating a new algae based wastewater treatment technology. This technology is known as the revolving algal biofilm (RAB) treatment system and was invented by ISU researchers in 2012. Our current tests using a pilot scale RAB treatment system in Dallas Center, IA is a critical step before full-scale commercialization of the technology. In this pilot-scale research we have installed our pilot RAB reactor at the Dallas Center lagoon treatment system. Before the wastewater enters the lagoon, it first passes through the RAB system. Following RAB treatment, it enters the lagoon. We take measurements before and after the RAB to identify nitrogen and phosphorus removal. In the first three months of the pilot, we have seen, on average, a 90% reduction in ammonia, 50% reduction in total nitrogen, and 30% reduction in phosphorus. The algae biomass that is produced during treatment can be made into biofuels, bioplastics, and fertilizers.
Degradation of Methylene Blue Sugar Solutions in High Voltage Atmospheric Cold Plasma Treatment

Brady Suby, William J. Colonna, S.K. Pankaj, and Kevin M. Keener
Contact: Brady Suby, basuby@iastate.edu

High Voltage Atmospheric Cold Plasma (HVACP) is a novel and promising non-thermal technology which can be used to treat food products for extension in shelf-life and inactivation of pathogenic microorganisms without affecting the quality of the product. Sugar is commonly and widely used in food products, and there is no study has done to understand how sugar would affect the effectiveness of plasma treatment. This is study is designed to understand the effect of different types of sugar on degradation of methylene blue, which has shown to be degraded substantially within 2 minutes by plasma treatment, after HVACP treatment, in which methylene blue is used as an indicator of the effectiveness of HVACP treatment. In this study D-glucose, lactose, fructose, and sucrose were treated in a 100-ppm methylene blue solution to be a 5% sugar concentration. The samples were then treated under direct mode of exposure in dry air at 60 kV for 1 to 5 minutes in triplicate and stored at 4°C for 24 hour prior to absorbance measurement at 610 nm. The results have showed that after five minutes of treatment, the selective reaction of the plasma with the saccharides resulted in less than 60% degradation of the sample, while the methyl blue alone degraded nearly 100%. This study plans to further analyze amino acids and proteins in the future to create a baseline datum for dye absorption in protein-rich subject foods.
Evaluation of the Respiration Rates of Stored Product Insects at Three Constant Temperatures With and Without the Presence of Food

Chukiat Chotikasatian, Watcharapol Chayaprasert, Siwalak Pathaveerat, and Dirk E. Maier
Contact: Chukiat Chotikasatian, chochu@iastate.edu

In recent years, carbon dioxide (CO₂) concentration monitoring has been widely used for spoilage detection and quality management in stored grain. The level of CO₂ accumulation during the grain storage period depends on several factors. One key factor is the respiration rate of insects in the stored grain. The goal of this study was to establishing baseline respiration rates of adult maize weevil (MW) (Sitophilus zeamais), red flour beetles (RFB) (Tribolium castaneum) and lesser grain borers (LGB) (Rhyzopertha dominica). Changes in CO₂ concentrations due to insect respiration were monitored in a closed system using non-dispersive infrared CO₂ loggers. For each experimental replicate, a known number of adult insects were placed along with a CO₂ data logger in a glass desiccator for 15 h, and the respiration rate was calculated from the slope of the CO₂ concentration curve. Three different numbers of insects (i.e., 50, 100 and 200 insects) were tested at three constant surrounding temperatures (i.e., 25, 30 and 36°C). In addition, respiration rates were measured both when a food source (i.e., 125 g of brown jasmine rice) was and was not provided for the insects. When averaging across the insect numbers, without the presence of food the respiration rates of MW, LGB and RFB were 2.66–5.50, 1.01–2.15 and 1.07–2.72 µlCO₂/insect-h, respectively. Similarly, when food was present, the respiration rates increased to 9.57–14.13, 1.96–3.93 and 4.59–11.76 µlCO₂/insect-h, respectively. With no food source, for all insect species the respiration rates increased significantly as the temperature increased from 25 to36°C. With a food source, the respiration rates of MW and RFB were highest at their optimal growth temperature of
The goals of this study were to:

1. Establish baseline respiration rates of adult maize weevil (MW) (Sitophilus zeamais), red flour beetles (RFB) (Tribolium castaneum) and lesser grain borers (LGB) (Rhyzopertha dominica).
2. Evaluate the effects of temperature levels and the presence of a food source on the respiration rates.

In most prior respiratory studies, insect respiration rates were measured in the presence of a food source; in other experiments, no food source was provided for the insects. Because the respiration rate of insects in the storage system may be used to quantify the insect population, any difference in the presence of food could result in inaccurate population estimations.

In recent years, carbon dioxide (CO2) concentration monitoring has been used for spoilage detection and quality control in the food industry. In the perspective of grain quality management, this study provided important baseline data and experimental protocol for developing decision support tools based on quantitative insect population.

### Experimental Plan

Respiration rates of MWs, RFBs and LGBs were measured with and without the presence of food. Each experiment was executed separately.

#### Table 1. Summary of the split-plot experimental design which was implemented for each insect species with and without the presence of food separately.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temp. (°C)</th>
<th>Number of Insects</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>25</td>
<td>50, 100 and 200</td>
</tr>
<tr>
<td>Without</td>
<td>30</td>
<td>50, 100 and 200</td>
</tr>
<tr>
<td>Food</td>
<td>36</td>
<td>50, 100 and 200</td>
</tr>
<tr>
<td>MW</td>
<td>25</td>
<td>50, 100 and 200</td>
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<td>36</td>
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</tr>
</tbody>
</table>

CO2 Concentration (µl CO2/lair) = (slope) × elapsed time (h)

Where CO2 Concentration is the rate of change of CO2 concentration

(5) According to the Tukey HSD test (P = 0.05) (Table 2), the baseline respiration rates (average ±SD) of the 100-insect group, n=5 (µl CO2/insect-h) of the three insect species measured with and without a food source.

### What Did We Find?

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>MW</th>
<th>RFB</th>
<th>MW</th>
<th>RFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>2.57 ±0.50</td>
<td>3.62 ±0.47</td>
<td>5.47 ±0.50</td>
<td>3.72 ±0.49</td>
</tr>
<tr>
<td>30</td>
<td>1.04 ±0.19</td>
<td>1.59 ±0.22</td>
<td>2.21 ±0.27</td>
<td>1.99 ±0.19</td>
</tr>
<tr>
<td>36</td>
<td>0.42 ±0.02</td>
<td>1.88 ±0.27</td>
<td>2.71 ±0.31</td>
<td>1.88 ±0.20</td>
</tr>
</tbody>
</table>

MW = <i>M. suaveolens</i> (i.e., MW) and <i>R. dominica</i> (LGB) and lesser grain borers (LGB) (Rhyzopertha dominica).

### What Does It Mean?

(1) With no food source, for all insect species the respiration rates increased significantly as the temperature increased from 25 to 36°C.

(2) With a food source, the respiration rates of MW and RFB were higher at their optimal growth temperature of 30°C.

(3) The respiration rates of LGB were lower than MW and RFB possibly because LGB moves less than other insect species.

(4) Regardless of surrounding temperatures, all three insect species respired at higher rates (approximately 3x for MW, 2x for LGB and 5x for RFB) when a food source was provided.

(5) According to the Tukey HSD test (P = 0.05) (Table 2), the respiration rate of the 50-insect group was significantly different from those of the 100- and 200-insect groups, implying that a sample size of at least 100 insects is recommended for a single insect respiration measurement performed using the technique in the present study.

#### Table 2. Respiration rates (average ±SD, n=5) (µl CO2/insect-h) of the three insect species measured with and without a food source.

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
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<th>LGB</th>
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### Conclusion

The goals of this study were to:

1. Establish baseline respiration rates of adult maize weevil (MW) (Sitophilus zeamais), red flour beetles (RFB) (Tribolium castaneum) and lesser grain borers (LGB) (Rhyzopertha dominica).
2. Evaluate the effects of temperature levels and the presence of a food source on the respiration rates of three insect species measured with and without a food source.
Recovering Valuable Products from a Low-value Aqueous Waste Stream

Patrick H. Hall, John P. Stanford, Marjorie R. Rover, Ryan G. Smith, and Robert C. Brown
Contact: Patrick H. Hall, phall@iastate.edu

Productive use of all streams of fractionated bio-oil will be important to the development of a 50 ton per day biorefinery based on fast pyrolysis of biomass. Fractionation technology separates bio-oil into heavy ends, intermediates, and an aqueous phase containing water-soluble, light oxygenates (30 wt%) and carboxylic acids (10 wt%). However, the presence of water (60 wt%) makes upgrading and simple distillation of this fraction very difficult due to water's high heat capacity and azeotropic properties.

The primary goal of this research is to recover acetic acid and other organic species from the aqueous phase, which increases the number of chemical products from the bio-oil and reduces waste water treatment costs associated with the pyrolysis biorefinery. We have determined that long chain fatty acids are suitable candidates for cleaning this waste water stream. Among possible solvents for the liquid-liquid extraction, heptanoic acid was selected because of its low water solubility; high boiling point compared to the acetic acid to be distilled from it; and stability during storage. Heptanoic acid extraction of SF5 has shown favorable results with almost complete removal of acetic acid.

This technique was also successful when used to recover acetic acid from an acetosolv product stream. Surprisingly, many other light oxygenates were extracted in our aqueous stream as well as the acetosolv product stream. These extractions yielded concentrated organic solutions, possible starting materials for catalytic cracking reactors, which were distilled from the heptanoic acid.
The Impacts of Biomass Properties on Pyrolysis Yields, Economic and Environmental Performance of Pyrolysis-Bioenergy-Biochar Platform to Carbon Negative Energy

Wenqin Li, Qi Dang, Robert C. Brown, David Laird, and Mark M. Wright

Contact: wenqin li, wenqin@iastate.edu

This study evaluated the economic and environmental impacts of a pyrolysis-biochar-bioenergy platform to produce carbon negative energy. Specifically, we analyzed the impact of biomass properties on the pyrolysis product yields, the economic and environmental performance for the pyrolysis-biochar-bioenergy platform. A feedstock sensitive fast pyrolysis regression-based chemical process model was developed. We applied this regression model to 346 types of feedstocks, which were grouped into five types: woody, straw (stalk/cob/ear), grass/plant, organic residue/product and husk/shell/pit. The results show that biomass ash content of 0.3 wt. % to 7.7 wt. % increases biochar yield between 0.13 and 0.16 kg/kg of biomass, and decreases biofuel yields from 87.3 to 40.7 gallons per ton. Higher O/C ratio (0.88 to 1.12) of biomass decreases biochar yield and increase biofuel yields within the same ash content level. The impact of ash and O/C ratio of biomass on GHG emissions are not consistent for all five types of biomass. Higher ash content decreased GHG emissions for woody, straw (stalk/cob/ear), grass/plant, organic residue/product, but increased emissions for husk/shell/pit. Higher O/C ratio increases GHG emissions for biomass with relatively lower ash content, while the impact is not clear for high ash containing biomass.
Over the past year, the Center for Crops Utilization Research (CCUR) undertook a project with CyBiz Lab (College of Business), a group of Iowa State students that serve as consultants to help businesses meet specific goals. The objective of the project between CCUR and CyBiz was to expand current outreach, brainstorm creative ways to develop beneficial workshops for industry, improve efficiency for projects, and improve understanding of current industry. The CyBiz team achieved these goals by comparing CCUR's current workshops and websites to other related top ranking university workshops in a benchmark analysis. CyBiz performed a variety of marketing research and surveys of past and potential customers to strategize ways to improve customer relations between CCUR and industry. A set of recommendations were extracted using the survey results and the competitive benchmark analysis. These recommendations include but are not limited to: hosting industry-specific tours and workshops on a quarterly basis, creating a client database, altering scheduling methods, sending follow-up surveys to clients, reaching out to potential clients around the world directly, and hiring a new staff member to serve as an account manager to execute these recommendations.
Assessment and Mitigation of Aflatoxin and Fumonisin Contamination in Animal Feeds in Rwanda

Kizito Nishimwe, Erin Bowers, Jean de Dieu Ayabagabo, Richard Habimana, Samuel Mutiga, and Dirk Maier
Contact: Kizito Nishimwe, nishimwe@iastate.edu

Aflatoxins and fumonisins are fungal metabolites that contaminate crops and animal feeds under favorable growth conditions. They are of importance to public and animal health as they are associated with or are causative agents of certain cancers in humans. The Feed the Future Innovation Lab for Livestock Systems (LSIL) based at University of Florida launched several competitively-funded multi-disciplinary, integrated and applied research and capacity-building projects. Iowa State University secured a 1-year LSIL-funded research project with the aim of assessing and mitigating aflatoxin and fumosin contamination in animal feeds in Rwanda. Specifically, this project focuses on: 1. Quantify aflatoxin and fumonisin levels in animal feeds at different points in the animal feeds value chain. 2. Establish a surveillance and early detection system for aflatoxin and fumonisin presence and mitigation in animal feeds. 3. Raise awareness of aflatoxin and fumonisin contamination and prevention among stakeholders involved in the animal feeds value chain. 4. Provide input to the regulatory framework in regards to policies for the mitigation of aflatoxin and fumonisin contamination in animal feeds.
Validation of a Finite Element Fumigation Model

Ben Plumier, Dirk Maier, and Matt Schramm
Contact: Ben Plumier, bplumier@iastate.edu

The warm subtropical Australian climate poses a number of grain storage difficulties, one of the largest of which is insect growth. The warm air makes ambient aeration of stored wheat more difficult when compared to North American wheat growing regions. As a consequence, heavy reliance on phosphine as the fumigant of choice is contributing to the development of genetic resistance to this most commonly used fumigant. To address these issues, a finite element model has been adapted to monitor chemical concentrations and their movement. The model has been used to analyze fumigant concentration and movement resulting from common fumigation practices and has been validated with real world fumigation data conducted at Kansas State University. Additional sensitivity analysis has also been conducted to determine the effects of weather on fumigation. Results demonstrate reasonable agreement between the model and real world fumigations in terms of overall trend and concentration time product achieved. This model will allow grain handlers to better predict results of fumigations and adjust their fumigation practices to ensure complete and successful fumigations.
Traceability Practices Across the Grain Supply Chain

Richa Sharma, Charles Hurburgh, Shweta Chopra, and Maitri Thakur

Contact: Richa Sharma, richas@iastate.edu

Traceability aids in minimizing errors across the supply chain, preventing faults from being carried through to the final customer. Traceability also helps to identify and eliminate discrepancies found at any step in an internal or external supply network. This proactive approach has been supported by government regulations and international standards. This support is necessary to develop a standardized approach towards traceability. Traceability systems have specific measurable attributes: depth, breadth, and precision. The purpose of this research is to define a traceability framework for grain handling facilities, to enable carrying grain identification through handling and processing.
Effect of High Voltage Atmospheric Cold Plasma Process Variables on Inactivation of *Listeria innocua* on Queso Fresco Cheese

Zifan Wan, S.K. Pankaj, William J. Colonna, and Kevin M. Keener

Zifan Wan, zwan@iastate.edu

Queso Fresco cheese has a high risk in *Listeria monocytogenes* contamination due to its high moisture content, near neutral pH and moderate salt content which provides the optimal environment for the growth of spoilage and pathogenic bacteria during storage and distribution. Currently, there is no effective commercial treatment on inactivating *Listeria monocytogenes* on Queso Fresco cheese. High Voltage Atmospheric Cold Plasma (HVACP) is a novel non-thermal technology which can be used to treat packaged food products and achieve significant reductions in foodborne pathogens and spoilage organisms without affecting the quality. Changes in HVACP treatment conditions are able to affect the inactivation efficiency of microorganisms. This study is primarily focused on evaluation of different HVACP treatment conditions on inactivation of *Listeria innocua* (non-pathogenic surrogates for *Listeria monocytogenes*) on Queso Fresco cheese, in which gas composition, treatment time, voltage, mode of exposures, and package dimensions are varied. 10 gram *Listeria innocua* inoculated Queso Fresco cheeses, with approximately 6 log10 cfu/g, were treated under varied HVACP treatment conditions. Recovery was done on both Listeria selective agar and non-selective Tryptic soy agar. Optical emission spectra were collected for the three gases used in this study, which showed that nitrogen species like second positive system (SPS) N\(_2\)(C-B) and first negative system N\(_2\)+(B-X) were observed in dry air and MA50 (50% N\(_2\), 50% CO\(_2\)) plasma in near UV region (300–400nm), while two excited atomic oxygen (O I) species were observed in MA 65 (65% O\(_2\), 30% CO\(_2\), 5% N\(_2\)) plasma at 777 and 844 nm.