Researchers Further Validate Ice Slurry’s Antimicrobial Capability for Poultry Chilling

Poultry processors in North America typically use water immersion chilling systems to lower the temperature of carcasses to a degree that inhibits pathogen growth. They also add an antimicrobial agent to the water as an extra safeguard. These necessary precautions use considerable amounts of water, energy, and antimicrobials.

Researchers at the Georgia Tech Research Institute (GTRI) are investigating the feasibility of using ice slurry (a mixture of tiny ice crystals and liquid water) as an alternative chilling medium both for its increased cooling capacity and antimicrobial properties. They hypothesize that the ice slurry’s grain acts as a scrub on the external surface of the carcass, dislodging or eroding skin-attached pathogens and releasing them directly into the chiller’s water. This direct abrasion could possibly reduce bacterial loads and lower the amount of antimicrobials needed.

Initially, the team conducted tests using a 250-gallon scaled auger chiller and *Salmonella*-spiked whole bird carcasses. The chiller included the antimicrobial, peracetic acid (PAA), with either chilled water or ice slurry. Results showed up to twice the reduction in CFU/mL of pathogen presence when ice slurry was used as the chilling medium instead of chilled water. In addition, the ice slurry’s greater cooling capacity enabled the carcasses’ core temperatures to drop faster than when using just the chilled water.

Recently, the team switched testing protocols to use chicken parts, specifically wings, inoculated with *Salmonella* and again chilled by either water or ice slurry. To expedite testing, they also designed and built 30-gallon micro-chillers.

“The micro-chiller allows us to conduct more tests per day compared to the larger chiller, which means we can get more replicates and better statistical analysis,” explains Dr. Daniel Sabo, a GTRI research scientist and the project’s lead chemist.

“Before, with the larger chiller, it would take two days a week to get one comparative replicate. With the micro-chillers, we can now get up to two comparative replicates in a single day because the two micro-chillers can run concurrently,” adds Stephanie Richter, who is leading the biological testing protocols for the project, and recently earned a Master of Science in Biology from the Georgia Tech School of Biological Sciences.

For the micro-chiller tests, each chiller medium contained the same initial volume of PAA based on a total volume of 60 L (liquid and ice fraction) and similar salinity readings. A baseline was established continued on page 5
Spring Reflections…Poultry’s Commitment to Worker and Workplace Safety

Spring is always a beautiful time of year. Isn’t it fascinating that, in what seems like overnight, the natural landscape goes from a dormant gray to being full of life with vibrant colors of greens and pastels? The blooming flowers, the sprouting leaves, and the emergence of natural beauty is a great visual reminder of starting fresh. It provides us with a natural opportunity to take stock of current practices, to reaffirm existing activities, or to adjust and evaluate existing processes based on emerging trends and new challenges. This internal re-evaluation process can extend to many aspects of poultry operations, but it is no less critical than in the area of worker safety.

First, we should all extend a huge “thank you” to the safety professionals in our facilities who work so diligently to ensure that our team members are able to go home to their families each night. These safety and health professionals are often tasked with assuring regulatory compliance in an ever-changing landscape, managing emergency response activities, supporting operations functions, all while providing training and support for all of the people in the facilities. And many times this must be accomplished while communicating in multiple foreign languages. So if you haven’t done so recently, I’d encourage you to head over to your worker safety professional and let them know how much they are appreciated as an integral part of your operations!

While the general principles of worker safety seem well established, there are often significant differences in facilities, equipment, and personnel that can cause unique challenges. One recent trend that I have observed that could help to alleviate some of these unique challenging cases is the inclusion of a “safety engineer” on new construction or new equipment and processes design teams. This person’s primary responsibility is to work with the facility management/operations team and the vendor/contractor to ensure that whatever new addition, whether a physical expansion of the production floor or the addition of a new piece of equipment, meets the worker safety objectives and expectations of the company. Having this person involved in the design and discussions from the very beginning can help to prevent major safety-related issues that if uncovered much later can become very costly to address. We are also hearing from many of the equipment suppliers that they are eager to work with the processing companies to provide solutions that address worker safety on new equipment.

Another topic that has garnered significant interest is the management of antimicrobials in facilities and their potential impact on employees. The Georgia Tech Enterprise Innovation Institute recently completed a study supported by the USPOULTRY Foundation on this topic, and we are very excited to share with you some of the key takeaways from this effort in this edition of PoultryTech (see page 7).

A recurring comment we receive from participants at the National Safety Conference for the Poultry Industry is how much they benefit and appreciate the sharing of best practices with colleagues throughout the industry. This year, the conference will be held August 13-15 in Destin, Florida (see page 6 for registration details), and I would highly encourage you to make sure your safety professionals have the opportunity to attend this valuable event. It is one small way in which you can show them how much you value what they do.

So as you enjoy this beautiful spring, take a moment to review and renew your commitment to safety, and be sure to say “thank you” to those who help keep our facilities safe.

Doug Britton, Ph.D.
ATRP Program Manager
Robots have been widely used to automate various industrial and food processing operations. However, the application is still mostly limited to repetitive actions with limited perception involved. Assumptions about target objects involved in these applications — uniformity, rigidity, non-ambiguous appearance — do not hold in a poultry processing plant or most other agricultural domains. How could we give robots the ability to understand the environment better and manipulate objects that are more complex? Well, they may need better eyes, but more crucially a better visual cortex — the state-of-the-art computer vision algorithms that we will discuss in this article.

Recent rapid advances in visual recognition tasks are mainly due to the prolific research activity in the field of Deep Learning that effectively makes use of the abundance of data available today. Those algorithms are able to learn to recognize important features on the images and perform classification by looking at a dataset of input images and desired predictions. In our work at the Georgia Tech Research Institute’s Food Processing Technology Division, we use them to tackle a few applied problems, which in Computer Vision language could be summarized as the following problems of increasing complexity:

1. **Classification**: Is there a particular object in the scene?
2. **Detection**: Classification + Localization; produce bounding boxes around objects in the scene and classify them.
3. **Semantic segmentation**: Segment the pixels belonging to an object from the background and other objects.
4. **Pose Estimation/3D detection**: What is the orientation of the object in 3D space?

We have developed and successfully applied object detection techniques to a wide range of projects. The typical approach called Faster R-CNN implements the whole detection pipeline inside one neural network. It can be trained end-to-end, only requiring images as inputs with bounding boxes around objects that it should learn to detect. Internally, it has several convolutional layers that extract semantically increasingly meaningful features from an image (for a car image, think about starting with the corners and edges and going all the way to wheels and side mirrors). Based on these feature representations, the network proposes likely regions of interest containing objects and classifies them.

The described approach does not require anything but a standard color image. However, if a sensor capable of producing a depth map is used (such as Microsoft’s Kinect or Intel’s RealSense), we can use aligned color and depth images to extract real-world coordinates of the detected objects. Thus, using this approach alone, the robot can be taught relatively easily to detect a novel object in 3D space. It may be sufficient to manipulate the object in such a way that the point of contact does not matter. Often, however, the orientation of the object is still necessary, for example, to determine how best to grasp a bird or how to place it facing a particular direction on a cone.

Our latest work focuses on performing pose estimation. We use the features detected using Faster R-CNN and add a new branch that predicts the orientation in 3D space for each object proposal using the quaternion representation. One of the keys to successfully learning which parameters result in correct predictions is an appropriate cost function. This provides a way to compare a network’s predictions and the ground truth labels during the training process and nudge the parameters toward the right values that produce the desired outcomes.

If sufficient accuracy can be achieved, this approach will be able to detect an object of a specific class, segment it from the background, and tell its exact orientation, all from one image and in a fraction of a second. It has the prospect of improving a robot’s ability to perform such tasks as grasping, bin picking, cutting, and cone loading. Since, by nature, these algorithms are very flexible and can be adapted for almost any kind of data, we are always looking for more opportunities in the poultry domain where their application will be helpful.
Multi-Function Sensory System for Smart Poultry Farming

Milad Navaei, research engineer, discusses his work on designing an ammonia micro-sensor system that is targeted to measuring levels of ammonia in farm air with minimal interference from other sources.

Q: PoultryTech – What industrial challenge is the project addressing?

A: Navaei – At high concentrations, ammonia can be a highly toxic agent and is widely produced from the feces of chickens on a chicken farm. There are studies that show the presence of ammonia decreases the quality and quantity of egg and meat production, and may inhibit growth in cell lines. Research has shown that high levels of ammonia can create about 5-10% of runts in a flock. The economic impact of exposure to 50 ppm of ammonia is about a half-pound catch-time weight loss in a typical 7-week broiler growout period and an 8-point increase in feed conversion, which translates to thousands of dollars. Additionally, ammonia exposure may cause skin and digestive system irritation for humans working in these growout environments. Therefore, accurate detection and measurement of ammonia levels is an important issue with implications for food quality control and labor safety.

Q: PoultryTech – How is the proposed system different from current practice?

A: Navaei – The commercially available ammonia sensors on the market often have short battery life, baseline drift, selectivity problems, false alarms, and a need for recalibration. For a sensor to operate properly in this environment, it needs to be highly selective and have a very fast response and recovery time. It also has to be a low-power device and capable of real-time monitoring of ammonia levels. These disadvantages have limited the application and reliability of detection systems in production environments. A sophisticated and dependable sensing system with the capability of integration to the Internet of Things opens a new path for smart and efficient ventilation in the farms and improved energy consumption, which result in a healthier environment for animals and workers.

Q: PoultryTech – What are the initial testing results?

A: Navaei – An ultra-low power gas detector was used in some very preliminary tests to monitor ammonia levels in poultry farms. The sensor technology provides excellent life-time and reliability under corrosive gases, due to its nano silicon nitride layer protection. The system was able to detect 1-100 ppm levels of ammonia, and it has 5-year shelf life.

Q: PoultryTech – What are the potential benefits for the poultry industry?

A: Navaei – The benefits include enhancements in worker safety, higher yield, and the quality of the meat production.

Q: PoultryTech – What are the project’s next steps?

A: Navaei – The next step of the project is to evaluate the system’s performance under different interfering gases, such as H₂S (hydrogen sulfide) and high levels of humidity. In addition, a model will be developed to integrate the chicken house’s ventilation system with the ammonia system.

Q: PoultryTech – How does the system work?

A: Navaei – The system is comprised of several micro-electro-thermal sensors that are based on the interaction of joule heating in an electrically conductive microbridge and the heat transfer from the microbridge through the surrounding gas medium. When electrical power dissipation takes place in the sensor heater suspended in the gas sample, the thermal conductivity of the gas surrounding the heater defines the rate of heat loss. Therefore, steady state temperature of the heater is a function of the gas’s ambient thermophysical properties. As a result, the proposed system has a longer life in the poultry house with a significantly low number of false alarms.
Researchers Further Validate Ice Slurry’s Antimicrobial Capability for Poultry Chilling

continued from page 1

(wings that were inoculated but not chilled) to provide representative Salmonella concentrations before chilling interventions.

Using four different combinations of experimental factors (PAA concentration, salt concentration, and immersion time), researchers found that, on average, the ice slurry once again provided a greater reduction in pathogens than chilled water.

“Our experimental results continue to support the hypothesis that ice slurry has a thermomechanical advantage over chilled water with regard to antimicrobial efficacy,” notes Dr. Comas Haynes, GTRI principal research engineer and project director.

Also noteworthy, when adding the same volume of PAA to ice slurry and chilled water, the ice slurry contains a higher concentration of PAA within its liquid-phase compared with chilled water (see Figure 1).

Researchers liken this effect to adding sugar to unsweetened tea. Picture two glasses, one empty and one filled with ice. Now picture one sugar packet being added to both glasses and then each filled with the unsweetened tea. You will find that the glass containing ice will be sweeter. In other words, the sugar is in a smaller volume of liquid and more concentrated.

The same holds true for the ice slurry as a chilling medium. In this case, the PAA is the “sugar” and it is only in the liquid portion of the slurry. This means the PAA is more concentrated in the liquid water portion. The same applies to the salt concentration in the slurry.

The team considered this before conducting additional tests to control for these confounding variables and to hone in on the mechanical abrasive quality of the slurry.

“We proportionally reduced the volume of PAA added in the slurry based on the initial ice fraction so that both the slurry and the water chilling tests would effectively have the same initial [liquid-phase] concentration in either case,” says Haynes.

Therefore, adjusting for the PAA and salinity, results again generally showed an increase in pathogen reduction with the slurry compared with the chilled water, further adding validity to their hypothesis that there is a scrubbing phenomenon at play.

As such, researchers believe that ice slurry can potentially provide poultry processors with an alternative chilling medium that gives them the same antimicrobial effect without having to invest as much in PAA or other antimicrobial costs.

“By using slurry, we are indirectly increasing PAA’s kill potential. Because if you are adding the same volume of PAA in chilled water, it has a lower comparative concentration in parts per million, whereas in slurry water, it has a higher concentration. So there is still a cost savings. Processors can either reduce the amount of PAA or they can add the same amount of PAA and still get a higher kill of microbes than in just chilled water,” says Sabo.

The team is currently investigating whether the salt concentration within the ice slurry has an effect on PAA efficacy. Sodium chloride or salt is typically used as the freezing point depressant in making the slurry. PAA contains acetic acid and hydrogen peroxide that naturally breaks down in water. However, when salt is added to the mix, the hydrogen peroxide in the PAA breaks down quicker. Therefore, the team will test the concentration of PAA in water over time versus in salty water over time to determine if there is any significant effect on PAA efficacy.

The team is also investigating carcass salt uptake to determine if there are any labeling implications based on current regulations imposed by the U.S. Department of Agriculture’s Food Safety and Inspection Service (FSIS).

“In the long run, ice slurry could possibly become known as a natural sanitizing aid for poultry chilling,” says Haynes.

The project was the basis for Richter’s Master’s thesis titled “Investigating Ice Slurry’s Perceived Mechanical Abrasive Quality to Increase Pathogen Reduction on Poultry During Immersion Chilling.” She says being able to work on such a large interdisciplinary project has afforded her the opportunity to learn skills outside of a traditional biology thesis.

“After working three years on the ice slurry project, I am proud to say I still eat chicken,” says Richter.

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continued from page 1

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RESEARCHER PROFILE

Sean Thomas

Job title: Senior Research Technologist

Education: M.S., Electrical Engineering Technology and Management, Kennesaw State University

Areas of research expertise: Mechanical Design, Electrical Design, Fabrication, Lab Management

List of any poultry industry projects you’re working on and your role:

• Automated Cone Loading (Project Director)
• Intelligent Trimming (Mechanical Design)
• Ice Slurry Chilling (Mechanical Design, Electrical Design, Fabrication)
• Growout House Robot (Fabrication, Electrical)

What I find most rewarding about working on poultry industry projects: Helping the industry operate more efficiently

A talent I wish I had: Play a musical instrument

Another occupation I'd like to try: Pilot

My first job: Machine operator in an air-conditioner factory

If I could meet someone famous, who would it be and why: Richard Rawlings because he is successful in turning around failing businesses

One thing people may not know about me: My parents were Venezuelans

My day would not be complete without: Watching an episode of Street Outlaws

The last movie I saw: Black Panther

My favorite song: “Nota de Amor” by Wisin and Carlos Vives

My motto: A little every day, and you will get there

My hobbies: Car restoration, skateboarding, cinema, the beach

SAVE THE DATE

August 13-15, 2018
Hilton Sandestin Beach Golf Resort & Spa
Destin, Florida

The 2018 National Safety Conference for the Poultry Industry is designed specifically for poultry facility and corporate safety personnel. The three-day event features key presentations on important industry topics and updates on government policy. Other highlights include breakout sessions for discussing best practices and current challenges, as well as networking and knowledge exchange opportunities with other safety and health professionals.

To register, visit uspoultry.org/educationprograms
Scientists Recommend Strategies to Reduce Peracetic Acid Exposure among Workers in Poultry Processing Plants

BY JENNY HOULROYD, SENIOR RESEARCH SCIENTIST/INDUSTRIAL HYGIENIST IN THE SAFETY, HEALTH, AND ENVIRONMENTAL SERVICES UNIT OF GEORGIA TECH’S ENTERPRISE INNOVATION INSTITUTE

Researchers at Georgia Tech undertook a pilot project to investigate poultry worker exposure to peracetic acid (PAA) in a study funded by the U.S. Poultry & Egg Association. PAA use in food industry disinfection processes is increasing and due to limited air sampling studies, employers have struggled on the methods to best quantify exposures and subsequently control exposures for employees. Studies among healthcare workers using similar antimicrobial products containing PAA indicate a potential for developing work-related asthma and becoming sensitized to the exposure. To assist employers with better controlling employee exposure to PAA, researchers compared two industrial hygiene sampling methodologies for PAA at four different poultry processing plants in Georgia between the months of August and December 2017 and in various locations throughout each plant.

Exposure levels were found to be highly variable in regions of a poultry processing plant where the PAA was applied as a spray and the humidity levels are high, such as the evisceration lines and near On-Line Reprocessing (OLR) Antimicrobial Systems.

There currently are no enforceable Occupational Exposure Limit standards for PAA, and accurately quantifying employee exposure to PAA using the currently available sampling methods is challenging due to the specifications of the methods. This was confirmed when researchers compared sampling results for PAA from the two methods. Exposure levels were found to be highly variable in regions of a poultry processing plant where the PAA was applied as a spray and the humidity levels are high, such as the evisceration lines and near On-Line Reprocessing (OLR) Antimicrobial Systems.

The question remains, what can employers do now while researchers further investigate how to more accurately assess employee exposure to PAA? Based on field site observations, researchers recommend that employers implement the following strategies to work toward reducing employee exposure to PAA:

- Examine the airflow throughout the plant with relationship to the placement of OLR cabinets and other application sources of PAA. As an example, at one of the research sites, the employee working in the position of Mirror Trim along the evisceration line reported a difference in symptoms of exposure depending on whether she was working on the inside versus on the outside of the evisceration line.

- Develop policies and procedures to assess employee exposure to PAA. This includes establishing a PAA monitoring program, educating employees about the health effects from exposure to PAA (as required by the OSHA hazard communication standard 29 CFR 1910.1200), and conducting regular walkthroughs of the production plant to assess the ventilation in the facility with respect to the location of where employees are working and the sources of PAA exposure.

- Adjust any drip pans positioned under conveyor lines to an angle that would prevent collection of standing water, which may be an additional source of airborne PAA in the workplace. This surface area may promote the conversion of PAA into the vapor phase from the water, and adjustment of the water drip pans to drain this water away from employee workstations may reduce concentrations of PAA in the air.

- Provide a mechanism for employees to report any adverse health effects resulting from exposure to PAA.

- When possible, increase employee distance from the source of PAA. Researchers found the farther an employee stood from the final chiller, the lower the employee’s exposure to PAA. This principle held true in all areas of the plant; distance from standing water-containing concentrations of PAA or OLR cabinets used in the spray application of PAA were key indicators of the employee exposure to airborne concentrations of PAA.

- Work with Quality Assurance employees responsible for adjusting the concentration of PAA to discuss the implications for employees working alongside of the processing line.

- Consider adding ventilation to the chiller baths.

- Monitor closely employee exposure to PAA when working near any location where PAA is added to the water, as these concentrations may be much higher than in other locations in the plant.

- PAA is an unstable compound; it decomposes to its original constituents (acetic acid and hydrogen peroxide) under conditions that vary with concentration, temperature, and pH. This means that concentrations within and between poultry processing plants may vary greatly.
Did You Know?

The National Chicken Council’s website has a Chickopedia of terms that may appear on the labels of chicken products. Read on to learn the definitions of a few popular terms. And visit nationalchickencouncil.org to learn more about the industry and other terms in the Chickopedia.

“Farm-Raised”
All chickens are raised on farms. So any chicken could be labeled “farm-raised.” When this term is used on restaurant menus and the like, it usually refers to chickens raised on a local farm.

No Hormones Added
Despite what you may hear, no artificial or added hormones are used in the production of any poultry in the United States. Regulations of the Food & Drug Administration prohibit the use of such hormones. No such hormones are used. So any brand of chicken can be labeled “Raised without hormones” or something like that. However, any package of chicken with that type of label must also have a statement that no hormones are used in the production of any poultry.

Antibiotics
Finding ways to raise chickens without any antibiotics is the latest example of an industry committed to innovation, producing a wide range of chicken products for a wide range of consumers.

The administration of antibiotics is only one FDA-approved tool to keep chickens healthy. It is not a silver bullet. Companies use a variety of management tools to keep birds healthy, including: more individualized nutrition plans, the use of probiotics and vaccines, barns with better air circulation and temperature controls, and additional training programs and education efforts for farmers and service technicians.

But just like people, chickens sometimes get sick, and treating illness is a responsible part of animal care. When this happens, farmers work with animal health experts and veterinarians to determine if an antibiotic is needed.

A “No Antibiotics Ever” or “Raised without Antibiotics” label is typically only one of a company’s product lines. Some flocks on a no antibiotic program may get sick, just like other flocks, and some have to be treated with antibiotics. These flocks that have been treated with antibiotics are no longer eligible to be marketed as “No Antibiotics Ever” or “Raised without Antibiotics.” A no antibiotics program is not a magical program for producing disease-free birds. Rather, it’s a program which intends to raise birds without antibiotics and labels those which are successfully raised without antibiotics as such. Those chickens that must be treated with antibiotics are labeled with another designation.

Even if a chicken is given antibiotics in the course of its life to treat or prevent disease, the bird must go through a withdrawal time before leaving the farm. In addition, FDA and USDA have extensive monitoring and testing programs to make sure that food at the grocery store does not contain harmful antibiotic residues.

All-Vegetable Diet
Poultry feed is made primarily from corn and soybean meal. Poultry feed sometimes includes some processed protein and fats and oils from meat and poultry by-products. The composition of all animal feed ingredients used in the United States is regulated by the Association of American Feed Control Officials (AAFCO). If the chicken company chooses not to use these ingredients, the feed would contain no ingredients derived from animals and could be described as “all vegetable.”

Chickens: Made in the USA
Nearly all the chickens and chicken products sold in the United States come from chickens hatched, raised, and processed in the United States. The only exception is a small amount imported from Canada, which has food safety and quality standards equal to our own.

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