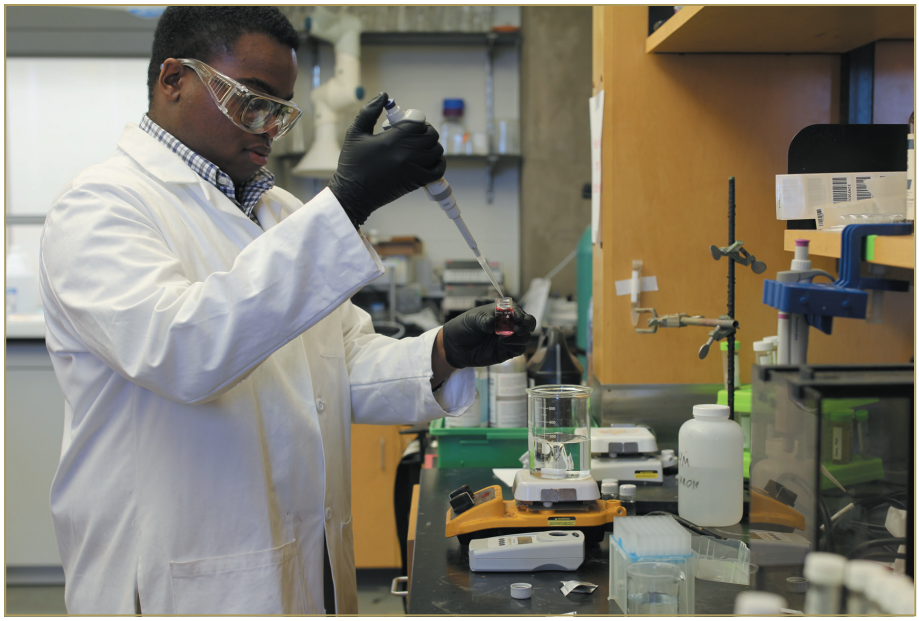
ENGINEERING TOMORROW'S POULTRY INDUSTRY

PoultryTech

VOLUME 35 NUMBER 2 FALL 2023

Unraveling the Decay Kinetics of Peracetic Acid in Poultry Chillers

Peracetic acid (PAA) is used as a food safety measure for microbial control in poultry carcass chilling operations. While it is an effective antimicrobial, it suffers one drawback — its decay kinetics that lead to varying concentration levels throughout the processing day. This variation has both food safety and cost implications as lower than expected PAA levels could mean less pathogen elimination, while dosage overcompensation can increase discharge costs. The exact contributors of PAA decay have not been fully documented, and poultry processors have expressed an interest in understanding the decay kinetics.



Austen Monteith, undergraduate student research assistant, measures PAA concentration using a colorimetric kit to provide data for decay calculations.

In response, researchers with the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP) have been conducting studies to quantify factors that primarily lead to the accelerated decay of PAA in chiller water under a variety of conditions. The team, led by Daniel Sabo, Ph.D., GTRI senior research scientist, recently released results of studies that explored the impacts of chemical formulations and incoming water quality on PAA decomposition. A summary of those studies is presented here.

Background

Peracetic acid (PAA) is a strong oxidizer and serves as an antimicrobial agent in poultry processing. PAA stock comes chemically stabilized. Once PAA is diluted with water or dosed into chillers, the chemical begins to decompose into acetic acid and water. PAA decomposition rates are reported in terms of chemical half-life and measured in minutes. The chemical half-life is the time required for a quantity of PAA to reduce to half of its starting value. PAA decays rapidly in the presence of high organic loading common in immersion chillers. Organics in the chiller are found in the form of Total Suspended Solids (TSS); Fats, Oils, and Grease (FOG); and Total Dissolved Solids (TDS), such as proteins, lipids, cations, and blood.

Justification and Objectives

The justification for the study was based on food safety concerns and cost implications. On the food safety side, lower than expected PAA levels in the chiller could mean less pathogen elimination, resulting in higher pathogen loads on carcasses. Additionally, increases in organic loads in the chiller, typical during a processing shift, result in PAA drop-off and fluctuations that can cause variability in pathogen loads throughout the day.

continued on page 2

IN THIS ISSUE

Unraveling the Decay Kinetics of Peracetic Acid in Poultry Chillers

continued from page 1

Cost implications come into play as processors use more PAA than necessary due to TDS from incoming potable water degrading PAA faster under typical chiller conditions. If starting potable water is treated first, the total amount of required PAA will be lower throughout a typical processing day. This reduces the treatment stress of the wastewater stream and could reduce discharge costs.

During the study period, researchers focused on two objectives: determine the decomposition of different stock PAA formulations, which vary in the percentage of peracetic acid and hydrogen peroxide; and examine incoming potable water quality effects on the stability of PAA within immersion chillers.

Key Results

The formulation of the stock PAA was shown to have an effect on overall stability. Specifically, when high levels of hydrogen peroxide (≥20%) are present, PAA lasts longer under chiller conditions.

In addition, Sabo says one of the largest takeaways from the research is the fact that the starting water quality has a large impact on PAA stability down the line in the pre- and main immersion chillers.

He explains that by having TDS in the starting water, even as low as 25-50 ppm, the stability of PAA can decrease by almost 50%. Therefore, pretreating the potable water to a lower TDS can have a meaningful impact on PAA levels down the line in the chillers.

Indeed, these initial studies are providing much needed information to plant managers about what is causing PAA to decay in the processing plant.

"With this knowledge, we are looking to resolve the PAA concentration variability, allowing for better control over pathogen reductions as well as reducing the treatment stress of the wastewater stream. Both of these could reduce overall operating costs while maintaining target pathogen levels," says Sabo.

Key Takeaways

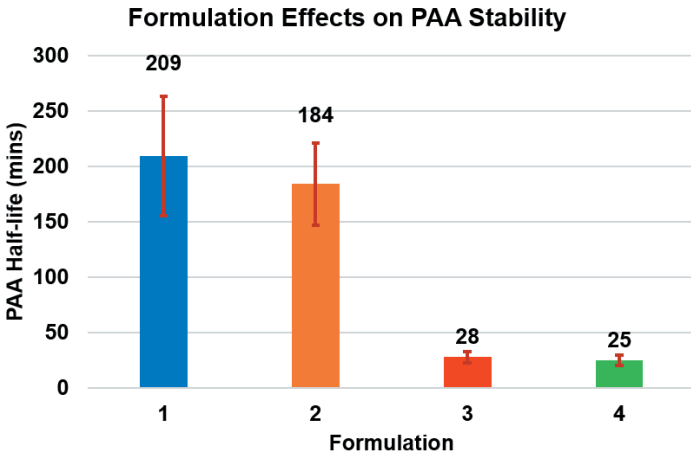
- Typical municipal water contains 25-55 ppm of TDS.
- When the TDS of starting water is above 25 ppm, there is a faster decay of PAA in the chiller.
- The higher the starting TDS, the faster the rate of decomposition.
- When combining TDS and chiller organics, PAA rapidly breaks down as starting TDS increases.
- The formulation of the stock PAA does have an effect on overall stability.
- When high levels of hydrogen peroxide (≥20%) are present, PAA lasts longer under chiller conditions.
- PAA is most stable at pH 4.0. As pH is raised to poultry processing relevant levels, there is a negative impact on PAA stability.

Research Methodology and Results

PAA formulation on its overall stability under chiller conditions

Four formulations of PAA were tested:

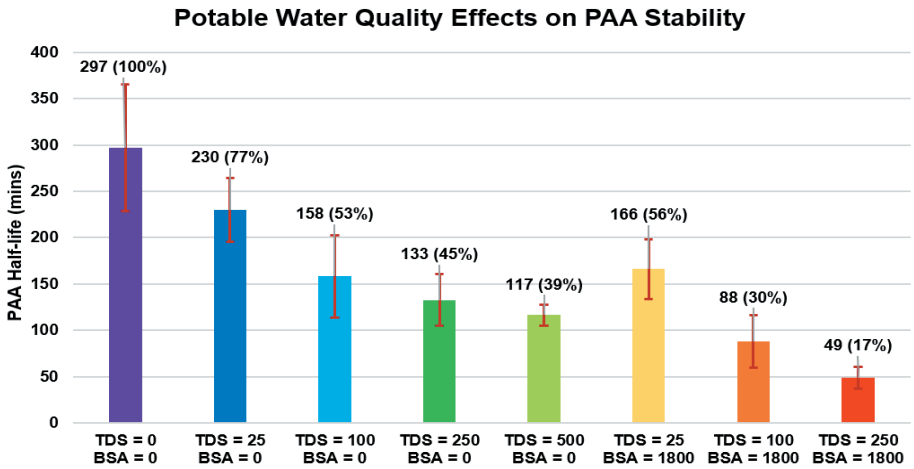
- Formulation 1: 6% PAA + 26% H_2O_2
- Formulation 2: 15% PAA + 22% H_2O_2
- Formulation 3: 22% PAA + 5% H_2O_2
- Formulation 4: 15% PAA + 5% H_2O_2



All four formulations were from the same manufacturer. Each one was subjected to the same simulated chiller media: TDS at 250 ppm, protein at 1,800 ppm, and a starting pH of 9.0. The starting PAA concentration targeted 160 ppm, and concentrations were measured at 1, 5, 15, 30, 60, and 90 minutes post PAA addition. From this data, the half-life was calculated.

Effects that the starting potable water quality had on PAA stability under immersion chiller conditions

Formulation 3 was utilized for the study, as it is commonly used in the poultry processing industry. Starting water quality was varied through the addition of TDS (cations including magnesium and calcium). The test parameters were as follows: TDS ranged from 0 to 500 ppm with and without protein at 1,800 ppm. The figure below shows the exact ratios of TDS to BSA (Bovine Serum Albumin). Each solution was held at pH 9.0, and 160 ppm of PAA was added. PAA concentrations were monitored at 1, 5, 15, 30, 60, and 90 minutes post PAA addition. From this data, the half-life was calculated.



MANAGER'S CORNER

As the Agricultural Technology Research Program (ATRP) closes out our 50th Anniversary year, I invite you to listen to our special anniversary podcast series. Hosted by our very own Stephanie Richter, GTRI research scientist II, the series commemorates ATRP's remarkable journey over the past 50 years as Stephanie speaks with present and past individuals key to ATRP's success. On behalf of the program, I'd like to give a special thanks to Stephanie along with Eric Klein, GTRI senior research associate, who helped with podcast production; the GTRI Communications Office; and all the podcast guests who took the time to reflect and share their memories and insights of their ATRP experiences. See below for descriptions of the episodes and visit atrp.gatech.edu/atrp50-podcast for links to each episode.

Doug Britton, Ph.D.
ATRP Program Manager

Episode 1:
Doug Britton, ATRP Program Manager
Britton speaks about his circuitous path from being an electrical engineer by training to his joining ATRP, and some of the lessons he's learned and people he's met along the path to being program manager. Britton also discusses present and future technologies being researched by ATRP.

Episode 2:
Craig Wyvill, ATRP Director Emeritus
Wyvill speaks about ATRP's origin and early developments.

Episode 3:
Abit Massey, President Emeritus, Georgia Poultry Federation
Massey discusses how ATRP first began in 1973.

Episode 4:
Mike Giles, President, Georgia Poultry Federation
Giles traces the almost lockstep development of ATRP with the Georgia Poultry Federation, which began in 1951. Together, the two entities have had a profound impact on the Five P's of Georgia Agriculture: peaches, peanuts, pecans, pine, and, of course, poultry.

Episode 5:
Dale Atkins and Chuck Ross
Two former GTRI employees discuss their time with ATRP. Dale Atkins was a former program director of ATRP, and Chuck Ross helped establish the wastewater and food safety research areas.

Episode 6:
Four ATRP Trailblazers
Former research engineers Richard Carey, Wayne Daley, Chris Thompson, and Costas Soulakos trade stories about their individual and collective experiences that are both enlightening and entertaining.

Episode 7:
ATRP 50th Anniversary Celebration
Host Stephanie Richter takes listeners back to the 50th Anniversary Celebration of the Agricultural Technology Research Program, held at the Historic Academy of Medicine at Georgia Tech.

To listen to these episodes and several more, scan the QR code or visit atrp.gatech.edu/atrp50-podcast.

Envisioning the Future of Poultry Production

Each year the Agricultural Technology Research Program (ATRP) funds a number of small-scale research projects. These "exploratory" projects investigate unconventional ideas that, if successful, could lead to significant improvements over current systems and/or processes. As such, the projects seek to tackle the challenge of envisioning the future of poultry production. The following briefs highlight research results of four FY 2023 projects, which ended June 30.

AMMONIA CAPTURE AND RECOVERY

Researchers are exploring ways to reduce ammonia levels inside poultry growout houses. A low-cost gas adsorbent to capture the ammonia was developed, with preliminary studies indicating the adsorbent has similar removal efficiency compared to current commercially available products. Researchers further plan to develop a method to produce a concentrated ammonia stream that can be used as a value-added fertilizer.

CANONICAL MANIPULATION

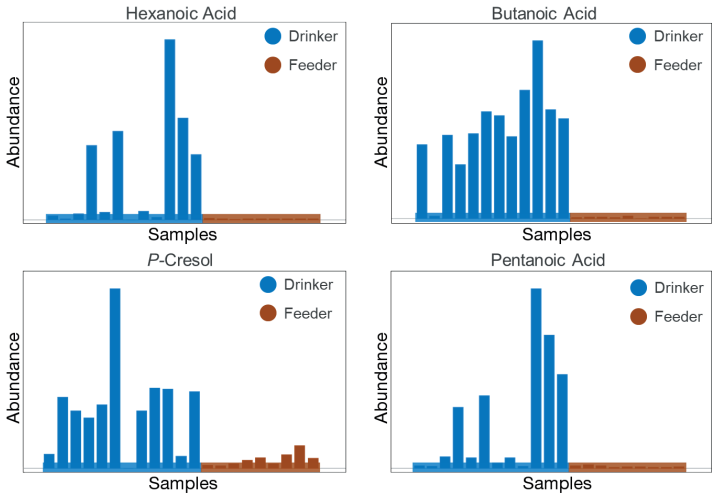
Researchers are exploring the use of advanced image sensing and high degree-of-freedom robotic path planning to create a generalized pipeline for single and multi-arm autonomous robotic manipulation in poultry processing operations. During FY 2023, both the manipulation and perception experienced significant improvements over previous years' efforts. The manipulation strategy was improved to be significantly faster and more robust, completing the rehang task in approximately 65% of the time needed previously (concluding in about 20 seconds rather than 30 seconds). The perception pipeline was also greatly improved, with a new methodology for scanning and training the canonical model. Notably, performance in perception deteriorated during final testing on real WOG (whole bird without giblets) images due to noisy canonical mapping estimations, partially arising from the difficulty in associating distinct scans to live data. These challenges, however, could be overcome by a more robust training set. Overall, results showed that autonomous rehang using machine vision and robotic labor is possible, but it will take the efforts of future work to make the system feasible for industrial use.

INTELLIGENT BUTTERFLY TRIMMING

Researchers are exploring ways to increase overall yield and reduce labor in deboned chicken breast (known as butterfly fillets) trimming operations. A prototype semi-automated trimming device has been designed that can remove cartilage, bone, and fat from the fillets while reducing excess trimming. During FY 2023, researchers modified the device, making it more ergonomic and lightweight. Added functionality included installing vacuum power for removing product trimmings that can then be placed in an adjacent container. Yield studies revealed the trimming mechanism removed less usable product while still targeting unwanted cartilage, bone, and fat. Further testing in a commercial facility is planned for FY 2024.

POULTRY PRODUCTION ODOR ANALYSIS

Researchers are seeking to gain a deeper understanding of the compounds and conditions that are responsible for poultry house odors. Litter and soil samples were collected from poultry houses and analyzed using two-dimensional gas chromatography mass spectrometry (GCxGC-MS). Results revealed numerous compounds that make up the overall odor associated with poultry production. While ammonia is a component of that odor profile, given its volatility compared to many of the other compounds found, it seems to be of little concern to neighboring areas. Compounds of particular importance belonged to the fatty acid class as well as several nitrogen and sulfur containing classes as well. This project also revealed how crucial it is to maintain drinker lines in a state of good repair as areas that were damp from leaking drinker lines showed high levels of odorous compounds, particularly fatty acids, compared to drier areas under well-maintained drinkers and feeder lines. Ultimately, this research demonstrates that you can better control the odor, including ammonia, if you can control the moisture. This baseline study of the sources and makeup of poultry production odor can serve as a basis for mitigation efforts and future house improvements in moisture management.



Odorous compounds show increased levels of intensity in moist areas under drinker lines (blue) compared to litter samples collected underneath feeder lines (brown). Low molecular weight fatty acids (butanoic, pentanoic, and hexanoic acids) are particularly foul smelling.

RESEARCHER PROFILE

William Freidank

Job title: Research Engineer I

Education: B.S., Mechanical Engineering, Georgia Institute of Technology; currently pursuing a master's degree in Mechanical Engineering at Georgia Tech

Areas of research expertise: Robotics, Control Systems, Mechatronics, Mechanical Design, Software Development

List of any poultry industry projects you're working on and your role: Automated chicken deboning (force feedback control)

What I find most rewarding about working on poultry industry projects: Reducing strenuous and/or repetitive labor tasks that do not present ideal conditions for human work

A talent I wish I had: Sight-read music

Another occupation I'd like to try: Fighter pilot

My first job: This one!

If I could meet someone famous, who would it be and why: Roberto Benigni so that I could experience firsthand the comedic and somber person who made "Life is Beautiful"

One thing people may not know about me: While my last name reveals my love for schnitzel, my heritage is much more immediately intertwined with Spain, and I speak Spanish fluently

My day would not be complete without: A clementine

The last book I read: The Brothers Karamazov by Fyodor Dostoyevsky

The last movie I saw: Ana Karenina by Leo Tolstoy

My favorite song: "Hopeless Wanderer" by Mumford & Sons. Also "Cello Concerto in E Minor, Op. 85" by Edward Elgar

My motto: "What is life for if not for being given?"

My hobbies: Piano, pipe organ, photography

Visit ATRP in Booth C18155 — Exhibit Hall C at the 2024 International Production & Processing Expo

The Agricultural Technology Research Program (ATRP) is excited about its plans to participate in the 2024 International Production & Processing Expo (IPPE), scheduled for January 30 through February 1, 2024, at the Georgia World Congress Center in Atlanta, Georgia.

ATRP's exhibit will highlight the program's research advancements and display prototype systems that seek engineering solutions that enhance process efficiency and product safety in today's poultry plant. Program researchers will be available to answer questions, and a program video and handouts will describe current projects.

For more information, visit ippexpo.org

Christopher Heist Selected as R. Harold and Patsy Harrison Research Faculty Fellow in Poultry Technologies

Analytical chemist Christopher Heist has been selected as the R. Harold and Patsy Harrison Research Faculty Fellow in Poultry Technologies at the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP).

Made possible through an endowment from the R. Harold and Patsy Harrison Foundation, the fellowship recognizes innovative, promising early-career research faculty interested in exploring breakthrough applied engineering and science research to address poultry industry challenges. Fellows are selected through a competitive application process.

Heist, who earned a Ph.D. in analytical chemistry from Oregon State University and joined GTRI in 2021 as a research scientist II, will focus his research efforts on developing portable sensors and sensing systems for use in poultry environments. He will hold the fellowship from July 1, 2023, to June 30, 2026, and receive research funding of $40,000 per year.

An expert in gas chromatography (GC) and microfluidics, Heist aims to take analytical chemistry out of the lab and into the field by developing a micro-GC for poultry applications such as monitoring volatile organic compounds (VOCs) and ammonia levels in poultry houses, sexing poultry eggs, as well as food safety applications. Successful implementation of these monitoring techniques can not only increase production efficiencies and offer cost savings, but can increase safety and animal welfare as well.

"It is an absolute honor to receive this recognition as I continue to further my career in the poultry industry. I want to extend a special thanks to the R. Harold and Patsy Harrison Foundation, GTRI, and ATRP for this honor and opportunity. I'm looking forward to continuing to use analytical chemistry and further develop sensing technologies to help solve issues within the poultry industry," said Heist.

"ATRP is extremely honored to be awarding this fellowship made possible by our friends at the R. Harold and Patsy Harrison Foundation to Dr. Chris Heist. This fellowship will enable him to build a professional network, learn about the challenges facing the poultry industry, and provide him with a launching pad to drive new innovations to solve these challenges," said Doug Britton, ATRP program manager.

Lance Barrett Receives Certificate of Excellence for Oral Presentation at the 2023 Poultry Science Association Annual Meeting

ATRP congratulates Lance Barrett on winning a best presentation award in the Student Competition: Processing and Products category at the Poultry Science Association's 2023 Annual Meeting held July 10-13, in Philadelphia, Pennsylvania. Barrett received the Certificate of Excellence for Oral Presentation and a $100 cash prize for his presentation titled "Validation of a Novel, Interferometric-based, Sensing Technology for PAA Monitoring." A former R. Harold and Patsy Harrison Student Intern in the Abit Massey Student Internship Program, his presentation highlighted his work on advanced sensing projects aimed at improving poultry processing wastewater treatment. He participated in the projects during his 2022 internship under the direction of Jie Xu, GTRI principal research scientist.

Victor Lim Selected as R. Harold and Patsy Harrison Student Intern in the Abit Massey Student Internship Program

The Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP) has selected Victor Lim as the R. Harold and Patsy Harrison Student Intern for the Fall 2023 through Spring 2024 academic year.

Funded by an endowment from the R. Harold and Patsy Harrison Foundation, the internship is awarded to a Georgia Tech undergraduate student participating in ATRP's Abit Massey Student Internship Program. During the academic year, interns work alongside ATRP researchers on real-world challenges facing poultry production and processing, and have the opportunity to gain practical industry knowledge by networking with staff at local poultry companies. The goal is to prepare the next generation of researchers and professionals to produce significant advances in innovation and technology.

Lim, a third-year biomedical engineering major, will work with Jie Xu, GTRI principal research scientist, on designing advanced adsorbent materials to improve nutrient recovery and recycling from poultry production environments. He will specifically focus on recovering phosphorus and nitrogen species from waste generated in poultry growout houses. These recovered nutrients can then be recycled to produce products like fertilizer.

An Atlanta native and gardening enthusiast, Lim was drawn to agricultural research while gardening one day and thought it would be fascinating to do research on plants, particularly studying how phosphorus affects plant growth. That interest led him to discovering ATRP and the program's work on nutrient recovery and recycling in the poultry industry.

On accepting the internship, Lim expressed his excitement to gain exposure to the field and further his understanding of the poultry industry.

"I look forward to working with cross-functional teams to investigate ongoing issues and work toward solutions. Through this experience, I hope to also improve my skills as both a researcher and engineer to solve problems of the future," said Lim.

Georgia Tech Research Institute
Agricultural Technology Research Program

CREATING THE NEXT IN AGRICULTURAL TECHNOLOGY … HOW TO GIVE

The R. Harold and Patsy Harrison Foundation endowment also provides foundation for a broader fundraising effort to further support the Abit Massey Student Internship Program and other research programs within the Agricultural Technology Research Program (ATRP).

To inquire about making a gift, contact Ricardo Hubler at ricardo.hubler@dev.gatech.edu or 404-894-6007.

Established in 1973, ATRP develops advanced technology in support of Georgia's multibillion-dollar poultry industry, the state's leading agricultural sector. The technologies help poultry processors optimize operations and improve efficiency, safety, product yields, and environmental sustainability.

The R. Harold and Patsy Harrison Foundation was founded by the Harrisons' daughter, Bobbie Ann Harrison Reynolds, and her husband, Raymond H. Reynolds, Jr. (a Georgia Tech industrial engineering alumnus), in honor of her late parents with a primary goal to strengthen and support education. Her father founded Harrison Poultry in 1958 in Bethlehem, Georgia.

The Abit Massey Student Internship Program honors Massey, president emeritus of the Georgia Poultry Federation, who was instrumental in ATRP's founding in 1973 and remains a dedicated supporter to this day.

"These gifts enable us to invest in our people and equip the next generation to address future challenges facing the poultry industry."

— Doug Britton, ATRP Program Manager

Why Do Chickens Today Appear to be Supersized, Compared to Previous Years?

Chickens today are in fact bigger and grow faster! As the demand for chicken as a protein has increased, especially chicken parts like breasts or thighs versus whole birds, farmers have worked to create larger and healthier chickens to meet that demand.

In the 1920s, the average chicken at market weight was 2.5 pounds and the U.S. population to feed was 115 million. Through a number of improvements in breeding, nutrition, veterinary care, and bird health, today's chicken farmers are able to raise bigger and healthier birds faster — an average of about 6 pounds at market weight today — to feed the current U.S. population of approximately 320 million.

In raising broiler chickens, farmers and producers keep an equal focus on size and health. Animal care is of utmost importance to farmers and the industry, and steps are taken at each stage of production and processing to ensure that chickens' health has been well maintained.

Even before a broiler chicken is hatched, it has a healthier start on life than a chicken from even just 25 years ago, being raised larger and healthier through:

- Improved, modern breeding.
- Better living conditions through climate-controlled chicken barns, and protection from predators and extreme temperatures.
- Up-to-date biosecurity practices to keep diseases out.
- Healthier nutrition plans with feed tailored to each stage of a chicken's life
- Daily care by dedicated farmers.
- Regular veterinarian oversight and the use of vaccines to prevent disease.

It's also important to note what isn't making your chicken bigger:

- Added hormones or steroids. No chicken you buy contains added hormones or steroids, regardless of whether or not this is called out on the label. In fact, the use of hormones has been expressly forbidden by U.S. Food & Drug Administration (FDA) law since the late 1950s.
- Genetic engineering. No commercially available chickens are genetically modified, not for any purpose.

Source: chickencheck.in/faq/supersized-chicken
(a website sponsored by the National Chicken Council)

Technical Assistance Is Just a Phone Call Away

The Agricultural Technology Research Program (ATRP) provides no-cost technical assistance to Georgia-based firms and individuals in the poultry industry. These assists range from simple inquiries regarding information or help needed to address a problem to extensive on-site consultations in which researchers collect data and provide a report on their findings and recommendations. The program also offers in-plant energy usage/cost assessments and workplace safety evaluations.

To inquire about the program or to schedule an assist, call ATRP Program Manager Doug Britton at 404-407-8829 or email him at doug.britton@gtri.gatech.edu.

Like Us on Facebook

ATRP's Facebook page features information about exciting research initiatives underway, interesting poultry and food industry news, industry events, photos, videos, and more!

facebook.com/ATRP.GTRI

PoultryTech

Published by the Agricultural Technology Research Program of the Georgia Tech Research Institute, a program conducted in cooperation with the Georgia Poultry Federation with funding from the Georgia Legislature.

Agricultural Technology Research Program
GTRI/ATAS/ISTD
Atlanta, GA 30332-0823

Phone: 404-407-8812
FAX: 404-407-8569

Angela Colar
Editor
angela.colar@gtri.gatech.edu

Steven Thomas
Graphic Designer/Photographer
steven.thomas@gtri.gatech.edu

Doug Britton, Ph.D.
ATRP Manager/Editorial Adviser
doug.britton@gtri.gatech.edu

Online:
atrp.gatech.edu

***PoultryTech* is published twice a year (Spring and Fall) and delivered free of charge to subscribers. To subscribe, visit atrp.gatech.edu/subscribe or scan our QR code.**