UNLOCKING THE POWER OF

ELECTROSTATIC INTERVENTION TECHNOLOGY

The Inside Story Behind a Food Safety Breakthrough

Less Food Safety Chemicals
Less Water Waste
Better Coverage and a Safer Plant with Reduced Costs

FIND OUT HOW IT'S POSSIBLE ...

Presented by the food safety experts at Birko

TABLE OF CONTENTS

Introduction 3

Facing the Food Safety Facts

Part 1 4

Electrostatic Technology 101
How Electrostatic Technology Works
The Hope for Electrostatics in Food Safety

Part 2 6

The Inside Story of Research and Development
The Beginning of a Big Idea
The Food Safety Consortium
Laboratory Testing
R&D: Prototypes and In-Plant Testing
The Results

Part 3 11

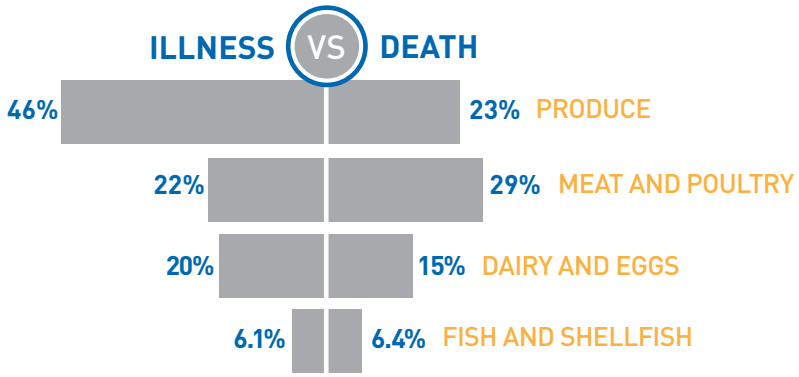
Introducing Elite 360® Precision Application Technology™
Features of the Elite 360®
What Electrostatic Intervention Technology Means for Food Processing

Conclusion 15

More About CSU's Center for Meat Safety and Quality (CMSQ)
More About Birko Corp.
Contact Information

FACING THE FOOD SAFETY FACTS

There is good news and bad news for food processing companies.



First, the bad news ...

Food safety issues appear to be on the rise in the United States. According to data from the U.S. Centers for Disease Control (CDC), 2018 was the worst year for multistate foodborne illness outbreaks in more than a decade.

The CDC launched 23 multistate investigations in 2018, and it estimates more than 25,600 people were sickened while 120 people died due to a foodborne illness.

The outbreaks come from not one but various industries. Previous research found around half of all foodborne illnesses are attributed to produce products while numbers show meat and poultry products are responsible for the most fatalities.

It is also important to consider the lasting damage of public perception and erosion of brand equity, which can cause issues for both private and public companies. When consumers see negative news coverage regarding food products and recalls, they avoid those items in the grocery store even after they are deemed safe to consume.

According to MMI Business Advisors' 2018 U.S. Grocery Shopper Trends Report, the top consumer safety concern for food products is "contamination by bacteria or germs," outpacing product tampering, hormones, pesticides and herbicides. The report found **75 percent of respondents are worried about the health risks of contaminated food**. And, nearly half of respondents identified food processing plants as the most likely place for food safety problems to occur.

Thankfully, there's some good news as well ...

Leaders in the beef processing industry teamed up with food safety experts at Birko and researchers from Colorado State University (CSU) to develop a new method for antimicrobial intervention that is poised to be revolutionary.

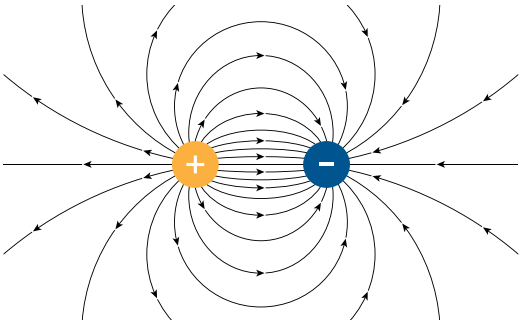
Picture a process that allows food companies to experience increased efficiency and cost-savings while reducing chemical and water usage through precise application. Now, imagine this new method significantly increases coverage and the elimination of foodborne pathogens.

That is the promise of precision with **electrostatic antimicrobial intervention technology**, which we will explore in this report.

ELECTROSTATIC TECHNOLOGY 101

Before seeing how this groundbreaking development will dramatically advance food safety efforts for all types of products, let's take a look at the science behind electrostatic technology.

Electrostatics is a branch of physics that involves the study of electric charges at rest and the phenomena of attraction or repulsion of electrically charged particles. Those atomic particles are negatively charged electrons and positively charged protons.



How Electrostatic Technology Works

Opposites attract. That may be true in human relationships, but it's an indisputable fact in electrostatic science.

Negatively charged particles are drawn to positively charged particles. They adhere to one another, just like static cling from laundry or a balloon you rub on your shirt and stick to the wall. Protons and electrons seek to stabilize and find balance.

Electrostatic phenomena exist in everyday life, but the science is also being used in certain industrial applications. A common example is using electrostatic technology to paint cars in the automotive industry.

Spray paint is given a charge and the car's body has the polar opposite charge. As a result, a fine mist of paint is applied efficiently and evenly.

The Hope for Electrostatics in Food Safety

The ultimate goal of using electrostatic technology in antimicrobial intervention is to achieve a **higher level of transfer efficiency**. In other words, electrostatics have the potential to greatly improve how well a processor is able to cover a product with food safety chemistry over a 360-degree surface.

"There is a large amount of waste in current antimicrobial methodologies," explains Birko CEO Mark Swanson. "Most food processing operations either use a lot of water and chemical solution to achieve less-than-ideal coverage, or an enormous amount in an attempt to try and improve that coverage."

PART 1

Dip tanks, which are frequently used in poultry processing, represent a method used to get better antimicrobial coverage. Yet, Swanson points out that even though the entire product is submerged in the solution, there are other problems with dip tanks.

Mark Swanson, Birko CEO

"Are you treating the product for pathogen reduction or simply treating the water to minimize pathogen equilibrium across all products running through the dip tank?" he asks.

It's a bit like trying to get perfectly clean in someone else's used bath water. Since a dip tank involves a common antimicrobial solution for every piece of meat being processed, if one piece of chicken goes in with three logs of contaminant, and another goes in with zero, that second piece will actually come out with more contaminants on it.

"The equilibrium of pathogens on each piece that went into the bath will be the same," says Swanson.

Whether it's sprayers or dip tanks, both produce and protein processors are wasting water and chemicals due to inefficient application, and the products may still present a food safety risk due to inadequate coverage.

Doctor Keith Belk of Colorado State University's Center for Meat Quality and Safety, and head of the school's Animal Sciences department, is an expert in meat science. He explains the possibility of electrostatic technology in simple terms comparing it to an electric circuit, such as a car battery, in which there are positive and negative terminals and a ground to the vehicle.

"What we try to do is complete the circuit through the chemistry as it's applied to the product," Belk says. "That's where the charge is connected. There is an attraction between the solution and the product because they have opposite charges."

The belief was that just as spray paint is attracted to the body of a car, an antimicrobial solution that receives an electrical charge would adhere to food products more effectively.

"In theory, this should improve the application of the antimicrobial chemistry to maximize contact all over the surface of the food product," says Belk. "You don't have spots where it misses. The entire thing is literally coated with the compound."

The science seems simple and straightforward. But, what makes perfect sense in theory doesn't always turn out as well in practice. The use of this proposed method in food safety had to be tested, evaluated and refined.

Doctor Keith Belk, Colorado State University's Center for Meat Quality and Safety

Dr. Belk had witnessed ineffective attempts to use electrostatic technology in food processing in the past, and while Mark Swanson was intrigued by the possibilities, he also had his doubts.

"In the beginning, we had no idea how well this would work, or whether it would work at all," Swanson says.

These two individuals and a team of others were about to embark on a journey to find out, because the potential for what it could accomplish was too big to ignore.

PART 2

THE INSIDE STORY OF RESEARCH AND DEVELOPMENT

Important innovations rarely come easily.

They usually involve teams of people working hard to make it a reality rather than the brilliant breakthrough of a single person.

Such was the case with the development of electrostatic technology for use in food safety. It took a little bit of faith, a lot of dedication and plenty of cooperation.

The Beginning of a Big Idea

Many ambitious ventures get their starts inside the four walls of a humble garage.

That includes companies from Apple and Amazon to Microsoft and Google to Harley-Davidson and Disney. Yes, garages have given us everything from Mickey Mouse and motorcycles to personal computers. Something about the garage encourages tinkering, the entrepreneurial spirit and outside-the-box thinking.

A garage is where this story begins as well. A former Birko employee, now with a major U.S. beef processor, had been working from home on containing electrostatic technology for use in a packing facility. Word started to spread and eventually reached Dr. Belk.

"He'd actually built a prototype that was more of a plastic demonstration model in his garage," recalls Belk. "He met with me and asked that I connect with Mark (Swanson) at Birko and consider starting the process of trying to commercialize the technology. Mark and I talked, and we thought it was an exciting opportunity to develop a new product."

Belk says there was already interest around the possibility alone at that point. People understood that, if electrostatic intervention worked, it could help the entire food processing industry.

"So, we jumped in feet first," says Belk. "We bought an off-the-shelf, commercial sprayer and began testing how it might be used."

The Food Safety Consortium

Going from a garage to a full-scale protein processing facility is quite the leap. In order for this idea to get off the ground, there would need to be cooperation and collaboration within the industry. That's where Swanson came in to connect the right people and organizations to lead the effort.

"We knew we had to have a top-flight research institute as well as somebody with the knowledge and depth of experience that Dr. Belk has to help conduct the research," Swanson says.

Of course, research and development require significant financial backing.

"It took some dollars to do the development work," says Belk. "Mark is a visionary in this way. He put together a consortium of companies that fronted the development money for the work conducted in laboratories."

Those companies included American Foods Group, AB Foods, JBS and Central Valley Meats. These major players not only provided funding for electrostatic technology R&D, some of them also offered their facilities as a proving ground following laboratory testing.

"We had a plan and some very willing partners," says Swanson. "Between all those organizations, Colorado State heading up the research and Birko supplying engineers, microbiologists and the patent, we started down the path of trying to figure things out."

That path would include years of what Swanson calls "aha moments" as well as surprises and setbacks. But, determining what **didn't** work was all part of the process.

Laboratory Testing

Dr. Belk and his team at CSU started their research with promising results. Electrostatic antimicrobial technology exceeded expectations in a laboratory setting.

"It turned out that it worked quite well in a preliminary trial using off-the-shelf technology," says Belk. "Other groups have worked with electrostatics, but I think we're the only ones who've come up with something that's worked so well in the lab."

As Belk explains, what made early results even more impressive was the fact that food safety tests in the laboratory typically involve the worst case scenario in terms of contamination. Bacteria placed on the product during testing is at what microbiologists call the "stationary growth phase."

"That means bacteria are at the maximum stage of growth," he says. "The reason we do that is it's also the point at which bacteria are most resistant to being killed. So, it's a conservative point to look at the technology's ability to eliminate bacteria."

When an antimicrobial intervention is then tested in an actual plant, there are expectations that it will perform better than in the lab. This is because bacteria in real-world setting are still growing and have yet to reach stationary phase.

"When we performed the lab tests and saw the results we were achieving, it caught us all by surprise," Swanson remembers. "It surpassed anything else we'd tested. We were taken aback. It was almost too good to be true."

The next step was scaling up, and despite the early optimism, the group knew there were still many unanswered questions surrounding the capabilities of electrostatic intervention technology.

"We had the initial lab results from Dr. Belk and his team, which showed incredible promise," says Swanson. "We just kept growing with scale and with some skepticism wondering, 'Well, if we take it to a slightly bigger model, will we get the same results?'"

R&D: Prototypes and In-Plant Testing

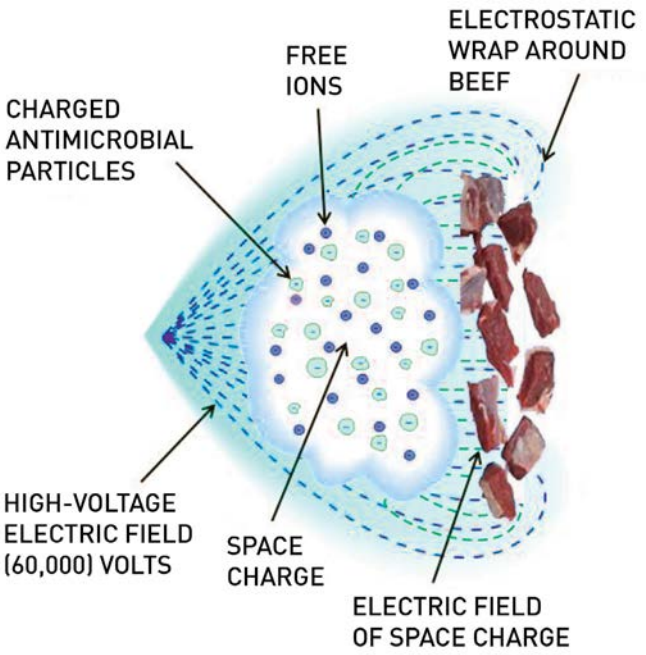
While there were encouraging results early in the process, Belk is quick to point out that it took plenty of experimentation and refinement in order to develop a solution that could harness the power of electrostatics and work for in-line production in a processing facility.

"It didn't just happen overnight," says Belk. "We built several iterations of the prototype and I don't think the final design is what anyone initially envisioned."

The following details include just a few of the factors the food safety consortium tested over the course of several years:

» Applying the Charge

Perhaps the most important discovery the team made was the best time and place to apply a charge in the antimicrobial intervention process. Tests revealed that applying a charge to spray nozzles wasn't effective, mainly because it was too difficult to control, and the team was unable to apply a sufficient charge for electrostatics to make a difference.



Researchers found the best way to achieve better transfer efficiency was to apply a significantly higher charge directly to the food safety chemistry before it was sprayed on the product, allowing it to effectively adhere and improve coverage.

Charging inside the cabinet at the source gives protein processors the ability to control the charged solution while maintaining fluid pressure and the output of kilovolts (kV).

The method also preserves most of the electric charge because it only travels a short distance from source to discharge (less than 100 feet). When a charge of 60,000 kV was applied to the source, it was still 45,000 to 50,000 kV when it reached the nozzles.

"While our group examined a variety of ways to apply antimicrobial intervention using electrostatics, applying a charge directly to the source was the only method that worked," says Swanson. "The rest had virtually no impact.

Both Swanson and Belk point out that charging the solution rather than nozzles at the point of application provides a much more cost-effective approach. As luck would have it, this method also works dramatically better.

» Getting Grounded

An important factor in refining the use of electrostatics in antimicrobial intervention was ensuring good contact between the product that food safety chemistry is to be applied to and the ground.

"You have to be grounded to feel that slight shock from static electricity," Belk explains. "The same was true here. Several iterations of prototype design were geared toward improving the ground contact so that processors could use less chemistry and water while maximizing application of the antimicrobial solution."

» Inside a Vacuum

One of the many questions researchers set out to answer was what happens when a vacuum is added to the process? At one point, it was believed a vacuum would need to be applied in order to get the technology to work properly and to comply with emissions regulations.

"The group also wondered if a vacuum could aid in the process by opening up the surface of the meat, allowing for deeper penetration and better reduction of pathogens," says Swanson.

As it turned out, tests revealed that applying the solution with electrostatics in a vacuum did not provide any additional benefits. Furthermore, regulatory compliance wasn't an issue either.

The group never viewed these experiments as failures or wastes of time. Understanding what did not work or provide value was just as crucial as discovering what did.

» Concentration Effect

The concentration of chemicals used in the antimicrobial solution was another factor the research team examined. In the meat processing industry, using lactic acid as an example, there is a 5 percent weight-base limit for solutions applied to cuts and carcasses.

However, if improved transfer efficiency lets processors reduce the total volume of solution needed to achieve a good application, it also reduces the volume of lactic acid being used in the antimicrobial intervention.

"Our thinking was that we could get approval to apply higher concentrations," says Belk. "Because at the end of the day, the absolute volume of chemicals being applied is much lower, even at higher concentrations."

However, if the concentration changed, would it impact the efficacy of the electrostatic technology? Belk's team found there is **some** effect from different concentrations, but it is much less than they suspected. The technology gets impressive results on a wide range of chemical concentrations.

» The pH Factor

Among the many other variables tested during R&D was the charge of the product itself, which as Belk explains, changes as a harvested animal goes into rigor mortis.

This is because muscle tissue continues to try to survive in postmortem. As it does, the muscle burns glycogen, or sugars, to try and produce energy and it creates lactic acid as a byproduct. The problem is that lactic acid has nowhere to go. So, it lowers the pH level of the product, making it more acidic.

Acidic substances release positively charged hydrogen ions, which one might think would affect how well the solution adheres to products with an acidic surface.

"We were worried how variations in acidity might impact the ability to make that electrostatic connection between the chemistry and the product," says Belk. "But after testing, we discovered that acidity of the product had no effect, which surprised me."

» Keeping Up with the Pace

Numbers regarding how well the method eliminated pathogens were important, but the equipment also had to match production line speeds. So, Birko engineers set out to develop a prototype that would be a good fit for meat processing plants. The approach they identified was a conveyor system designed to meet the speed of beef and poultry processing.

"Finding ways to control electrostatics in a pass-through system proved to be a significant challenge," says Swanson. "Antimicrobial intervention cannot be done in batch mode. Food production lines don't stop. That's why the final equipment design is a conveyor system that exposes all surface areas and maintains line speeds as it moves through the system.

The Results

Of all the interesting observations and surprises that came out of five years of research and development, none were as eye-opening as the actual results showing what electrostatic intervention technology could achieve in food safety. Throughout the time leading up to development of a viable product, the group saw plenty of positive results.

It started back at the beginning of the journey, with impressive test results in the lab where Dr. Belk and researchers from CSU tried out the new antimicrobial intervention methodology on poultry.

"The first time we tested this technology we were using peroxyacetic acid (PAA), and we tested it on chicken surfaces, which is where there's a real problem trying to get rid of salmonella," says Belk. "We were seeing between 3 and 4 log reductions."

For comparison, in lab testing, you'd normally expect to see a 2 log reduction, or a 95 percent reduction of bacteria at stationary phase on the surface of the product. "If you see that, the thought is the chemical is working quite well," Belk adds.

Each log reduction equates to a decimal point. So, 1 log reduction means the number of pathogens is 10-times smaller, a 2 log reduction is approximately 100-times smaller. A log reduction of 3 or 4 is phenomenal, reducing bacteria by as much as 10,000 times.

"We had to do it again to make sure we weren't imagining things or messing up somewhere," Belk says. And remember, lab testing involves a worst case scenario, which means results could be as good or better in the plant.

"With most antimicrobial interventions used today, you'll see a 1.0 to 1.75 log reduction," Swanson says. "Our results are exponentially better than those achieved with virtually any other type of commercial intervention. Plus, we are using less chemistry and water at the same time."

In-plant testing indicates processors can expect log reductions of at least 2.0 to 2.6 or better, which meets or exceeds USDA requirements for pathogen reduction. Now, a new piece of equipment is being rolled out at select beef processing facilities. The group is completely confident this innovation will deliver.

"We scaled up three or four times, really put the technology through the paces, and every time it kept performing," says Swanson. "Now, we're at the point where we actually ran a full-size system at line speed in a plant and it worked just as well as the first prototype in the lab."

PART 3

INTRODUCING ELITE 360® PRECISION APPLICATION TECHNOLOGY™

Innovation in food safety equipment

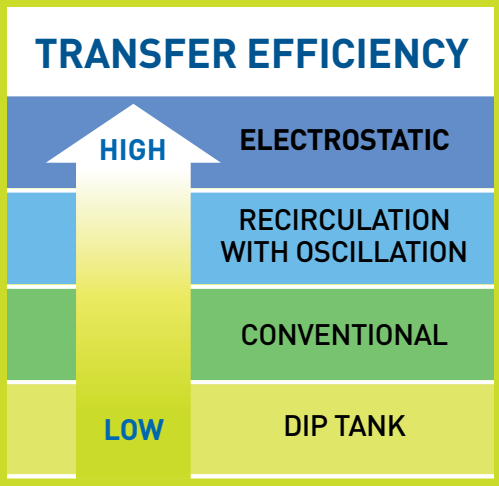
The final result of years of experimentation and engineering is Birko's Elite 360® with Precision Application Technology™. This innovative piece of patented food safety equipment harnesses the power of electrostatic technology in a way that no one else has been able to accomplish.

Elite 360® operates by moving food along a conveyor in a pass-through system while the electrostatically-charged solution is sprayed on the product as it slowly rotates to expose all surfaces at constant line speeds.

Features of the Elite 360®

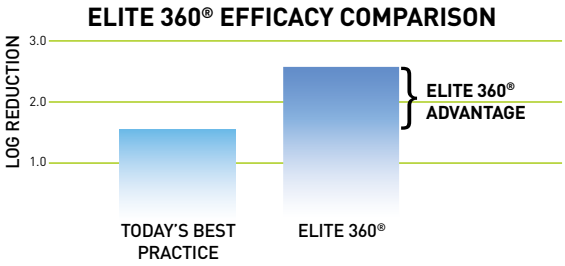
Reducing waste and improving coverage with Precision Application Technology™ is one of this innovation's greatest successes.

It has the highest transfer efficiency of any antimicrobial intervention method on the market. Studies indicate Elite 360® provides equal coverage to a dip tank while using 95 percent less solution.



PART 3

10x IMPROVEMENT
on current best practices



Antimicrobial Efficacy

Using approved levels of peracetic acid (PAA) in-plant pathogen reduction with Elite 360® produces log reductions in the range of **2.0 to 2.6 or better.**

250-750 LBS
per minute

Throughput Capacity

Elite 360® maintains constant line speeds with the ability to apply antimicrobial solution to **250-750 lbs.** of meat products per minute.

10' LONG
60" diameter

Equipment Size, Installation and Support

The latest commercial design for the Elite 360® is **10 feet long and 60 inches in diameter**. It is factory-assembled and tested before installation.

Birko provides technical support, maintenance, service reports and regular inspections.

AS MUCH AS
95% $AVINGS

» on antimicrobial chemistry
» water usage
» wastewater treatment costs

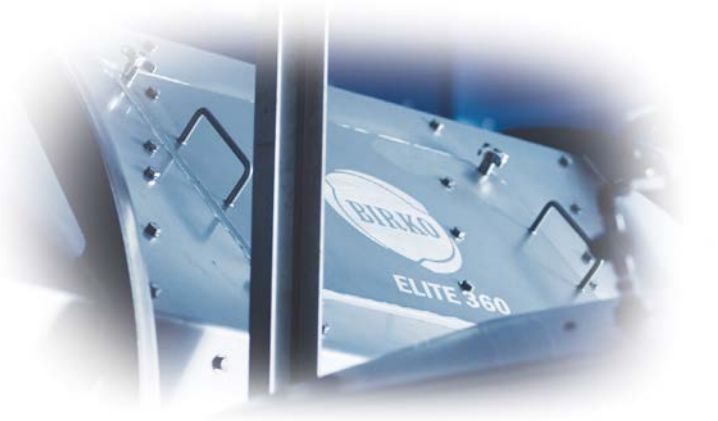
Potential Savings

While the dollar amount saved will depend largely on the type, size and output of a facility, it's easy to see how **much more cost-efficient** the Elite 360® is.

Precision Application Technology™ reduces wasted antimicrobial solution from dip tanks and overspray, which means water and chemistry savings as well as sustainability benefits.

What Electrostatic Intervention Technology Means for Food Processing

The advantages of electrostatic intervention technology to improve food safety and sanitation go far beyond the features and capabilities of Elite 360®. Installation of this groundbreaking equipment comes with a host of additional benefits that bring a return on investment.



Sustainability Benefits

Efficient use of water and chemicals certainly produces cost savings, but it can also help food companies reach sustainability goals. In cases where states are imposing strict water conservation regulations, Elite 360® can help processors achieve compliance.

"There's a lot of pressure on the industry to become more sustainable, including finding ways to reduce their carbon footprint, greenhouse gas emissions, and water usage," says Belk. "This is a viable option to help them address these issue."

Precision application means far less wasted water during antimicrobial intervention and less wastewater for food processing facilities to treat after the fact.

"The precision achieved from utilizing electrostatics has the potential to dramatically reduce waste without compromising food safety," says Swanson. "Protein processing facilities have large amounts of wastewater that need to be treated in-house. More efficient use of antimicrobial solution significantly reduces money and resources needed for water treatment."

Facility Management Benefits

In addition to the direct savings on water and chemistry, Elite 360® has indirect benefits on a processor's bottom line. For one thing, repair and maintenance costs could shrink thanks to precise application of food safety chemistry.

"The overspray of antimicrobial solution can unintentionally land on other surfaces and equipment," Swanson says. "Due to the acidic nature of chemical such as PAA, low pH levels can lead to corrosion and damage, requiring repairs or additional maintenance."

That's much less of a problem when you reduce overspray. And, Precision Application Technology™ has human benefits, too. Eliminating overspray means less chemical odor and better indoor air quality (IAQ) for workers in a food processing plant. That creates a safer and healthier environment for employees.

Brand Reputation Benefits

Elite 360® makes it possible to reduce chemical and water needs and boost efficiency with precise application of the antimicrobial solution. But, the biggest benefit is that it does not compromise the process – it **improves food safety efforts** with 360-degree coverage.

That means Elite 360® helps protect your organization from a product recall, which could damage your brand and have financial and legal ramifications. Of course, Dr. Belk rightly points out that food safety serves an even more critical purpose.

"Recalls aren't really the issue," he says. "What should be more important to food companies is a reduced likelihood of transporting a foodborne illness to humans that creates a public health issue. Our true goal is to help companies reduce liability while protecting consumers against foodborne illness."

What's Next for Electrostatic Intervention Technology?

The Precision Application Technology™ that comes with Elite 360® includes the ability to precisely measure and control the electrostatic charge that is applied at the source. What this means is that, while research took place primarily in beef processing facilities, the technology can be adapted for use on many other food products.

Swanson explains that the food safety consortium started with protein processing and applying electrostatic technology in a conveyor system because that presented the biggest challenge.

"We knew if we could solve the problem in an area where it was most difficult to solve, everything else would be much easier to test and implement," he says.

At the time of this writing, Elite 360® is being installed in three beef processing plants. Testing in a poultry processing facility is underway, and a pork processing plant will implement the technology soon as well.

"Based on all the research Dr. Belk and his team have accomplished, we're going to be rolling this out in several other areas including applications on the carcass as well as applications in the produce industry where it has enormous potential," Swanson says. "Birko has patents pending on these areas of application as well."

While produce and fresh cut products certainly stand to benefit, especially in the wake of recent negative press and recalls, there's still room for further adaptions in protein as well. Dr. Belk is confident electrostatic intervention technology will continue making a significant impact in other areas of protein processing.

"Carcass application is where the big sinkhole is for water, chemical and electrical usage in packing plants," he says. "Once electrostatic intervention is implemented there, it will have a substantial impact on the bottom line and product safety."

After five years of developing this technology for food processing, Swanson and Belk say they look forward to continuing to work together, exploring new ways to use and improve electrostatic antimicrobial intervention.

Dr. Belk says the choice to invest in the technology should be "a no-brainer." Swanson elaborates on exactly why.

"The real question is, if you have any cares or concerns related to sustainability, efficiency, public safety and brand equity, how could you not invest in this groundbreaking equipment?"

CONCLUSION

For more information on Birko's Elite 360® with Precision Application Technology™, visit www.birkocorp.com/elite360/ where you can view a video and see the system in action.

More About CSU's Center for Meat Safety and Quality (CMSQ)

The CMSQ at Colorado State University is dedicated to researching and targeting international and individual issues in food safety.

CMSQ aims to address national and global food safety and quality issues to ensure that consumers worldwide have access to a dependable supply of safe, high quality and affordable food products, to educate and train undergraduate and graduate students to assume food safety positions in industry, and to provide outreach education to the public.

CMSQ scientists have interacted and lectured in more than 20 countries, on top of their partnerships in over 30 groups within the United States.

More About Birko Corp.

Protecting the food chain for more than three generations. Saving lives. Reducing costs, liability and risk. Birko takes food safety seriously. Nothing is more important to the company than making sure the food chain is secure, safe and pathogen-free.

That's why Birko is committed to turning great science into valuable new products, developing innovative custom equipment that saves time and resources, and providing excellent customer service. It's all part of The Birko Advantage - integrated food safety solutions provided by highly trained and experienced professionals.

"Birko's continuous investment in science and technology to improve food safety efforts is what drives us to be a trusted and innovative partner in the industry."

Bob Ogren, Vice President, Birko Equipment

Contact Information

Birko continues to innovate food safety solutions, specializing in resource savings through precision application of antimicrobials and water.

Visit www.birkocorp.com or email bogren@birkocorp.com to learn more.

Special Thanks to the Following Partners:

Colorado State University · AB Foods · American Foods Group · CVM Central Valley Meat Company · JBS · Beef Industry Food Safety Council · NAMI North American Meat Institute