Electrical Stimulation (ES) in the Poultry Industry

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BACKGROUND

The science behind using electricity to tenderize poultry in its basic form is to reduce the amount of chemical energy available in the muscle after slaughter as quickly as possible. This reduction allows faster onset of Rigor to occur by reducing the time required in the delay phase. Commercial system manufactures claim an overall reduction in required processing (aging) time by 4 to 6 hours. To the poultry producer, a reduction of 6 hours in aging can deliver significant savings in cooler space and yields. Consider a poultry process where 240 BPM are being processed. A 6 hour process savings translates to reducing storage requirements for 86,400 carcasses; considering that the average carcass is 5.5 lbs., this translates to 475,200 pounds of product that can be moved through the facility 6 hours faster. Even though the loss of water soluble proteins from the carcass occurs rapidly at first, the loss levels off after time; moisture kept in the carcass will help to improve tenderness, flavor and the overall nutrition of the meat, not to mention profit to the producer.

Assuming that the value of the WOG is $ 0.50 per pound, every 1% in moisture loss translates to a monetary loss on the volumes mentioned above of $ 7,392 per 16 hour day or $ 1.848MM per year. The cost to treat this protein waste in the plants effluent should not be discounted from annualized savings.

The poultry producer is under constant pressure to minimize costs, maximize value without a decrease in quality, Electrical Stimulation is one method when managed correctly will assist in the production of quality products while generating sustainable savings.

THE MECHANICS OF A BASIC ES SYSTEM

Electrical Current is cycled through the bird from the contact plate to the grounding bar as the bird moves through the process. The on / off cycling of the current depletes energy reserves in the muscle reducing the amount of time associated with the delay phase of Rigor. This electrical cycling will give the appearance of wing movement through muscle contractions generated in the breast.

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STEPS IN DEVELOPING A MANAGED PROCESS

Developing a tenderness strategy (where are you and where do you want to go?)

The first step in developing an ES program is determining the initial descriptive statistics of the poultry flocks as they relate to tenderness. Knowing the initial conditions will help provide the process direction required for a tender product. Tenderness can vary by location, understanding the average tenderness and the standard deviation of the incoming material at time of deboning is the first step in developing a managed ES program. Sample collection practices should be comprehensive as possible; as an example, the sampling plan should consider the types of housing, collection conditions or any other parameter the producer feels important. There can be a great deal of variation in the incoming flocks; the producer should have a well-defined sample plan capturing diverse samples in order to understand their baseline quality before making tenderness corrections with an ES system.

The second step in managing an ES system is understanding what's expected by the consumer. This knowledge allows a performance (success) criteria to be defined. Understanding how the adjusted meat fits into the facilities manufacturing scheme, allows the performance expectations of the system to be consistently realized. One example is a fresh meat item; coupling aggressive electrical stimulation with time may result in a product that's perceived as too tender, another example is holding treated meat over an extended period of time prior to use will result in decreased water holding capacity ultimately resulting in lower than expected further processing yields.

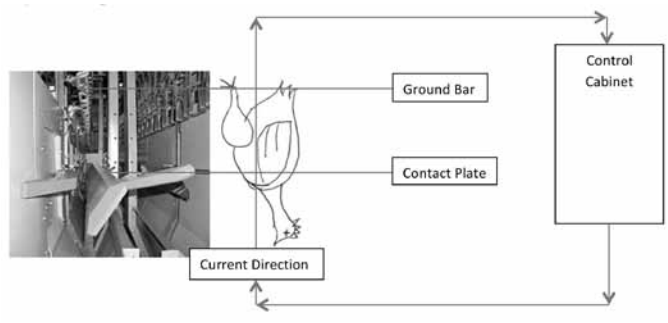

Figure 1. Representative ES Hardware
https://www.meyn.com/en-GB/31/electrical-stimulator.html

ES MANAGEMENT

The final step of a successful ES process is in management training, the decision makers in the facility should be educated in the basic science behind the ES process and the importance of a how the process can fail.

Management failures can occur in many ways, from not turning the system on, sanitation failures that leave the contact surfaces with insulating protein layers or by making arbitrary changes to the systems set points when a change is not required. Modern commercial ES systems are passive devices that are located after the kill blade and can be easily ignored if all other systems are functioning properly. Routine management checks and documentation should include that the system is activated, the set points have not been changed from the proven process, and that the birds are actively cycling during the stimulation process. These basic checks are critical for the facility in managing a process that delivers expected results.

The role of sanitation is critical in achieving consistent results. The electrical current that is used to activate muscle contraction will be impeded by contact plates that are fouled by feather residue and blood. The impact of fouled contact plates will be seen through tougher products and can be realized as quickly as between shifts or can be a gradual creep causing increased toughness through several weeks. If the ES systems are not properly cleaned, the rate that the system efficiency degrades depends on the commercial system used and where they are located in the process.

Combining time on the bone aging and an ES process that is not intended for on the bone aging can result in the perception that the ES system is over stimulating as indicated by yield reductions in the deboning department. Non typical meat left on the frame can falsely lead management to lower established ES settings in an attempt to correct a problem that in reality doesn't exist. An established change management process and management discipline are critical in making appropriate system changes that protect quality attributes regarding tenderness.

Change management

Poultry processors in the United States typically use chilled water baths to lower the carcass temperatures; these chilling systems may hold production runs for periods greater than 90 minutes. Considering the production scenario initially discussed, this 90 minute chilling period translates to over 25,000 carcasses heading to processing; there is nothing that can be done to alleviate the impact of an ES system that was set too high. Making incorrect, drastic changes to established set points once a problem is identified places future product at a risk for increased tenderness variability in the final products. Changes to the ES system should be made once the root cause is determined to be the set points and only changed in a step wise procedure. A step change process is developed by the specific system and by the facility.

The natural variability in bird performance between farms should also be considered when making changes to an ES system. The processor should consider making system changes only after several farms display abnormal yield loss as defined by a measured value that is predetermined trigger point for either a decrease or increase in system parameters. Making changes based on a visual opinion and not a numerical measurement will only increase the likelihood of an incorrect change to the process. Scrape test data from deboned frames are a valuable tool in correct decision making.

Managing by the numbers

Accurately determining the performance of an ES system may be accomplished by measuring the force required to shear through the muscle on a sample size accurately representing the population. There are a variety of shear devices that can be used to determine the force required to sever the meat. Regardless of the shearing system or process selected, the producer should have a standardized procedure that is used within the facility and throughout the company.

The sample size should be correlated to the specific line volumes where tenderness is a performance metric. Determining the shear average and shear variation is critical in understanding the performance of the system and in making process changes. Management values for shear average and shear variation should be determined based on the market the producer is supplying. Lower shear variations demonstrate a process that is under control reducing the opportunity for consumer complaints.

Sampling

The volume of samples collected for shear analysis should be correlated directly to the volume of the production line and the level of confidence of the results desired by the producer; however, the sample size will most likely be limited by the facilities personal and the capacity of the lab. Sample volume and frequency should be determined to accurately represent the entire day's production; although convenient, grab samples will not always give a true representation of the packed product. Samples collected at routine intervals will provide a better representation of the day's production. Samples should be selected from the same side of the breast preventing the small chance of duplicating a sample from the same bird.

Quickly freezing the samples provide the lab with flexibility if samples are to be processed later. Sample allowed to remain at a tempered state, allows the natural aging process to continue and will give a "false low" shear value. Shear analysis of fresh products "tray pack" should be done after the time period it would normally take for the consumer to cook or freeze the product. Fresh samples

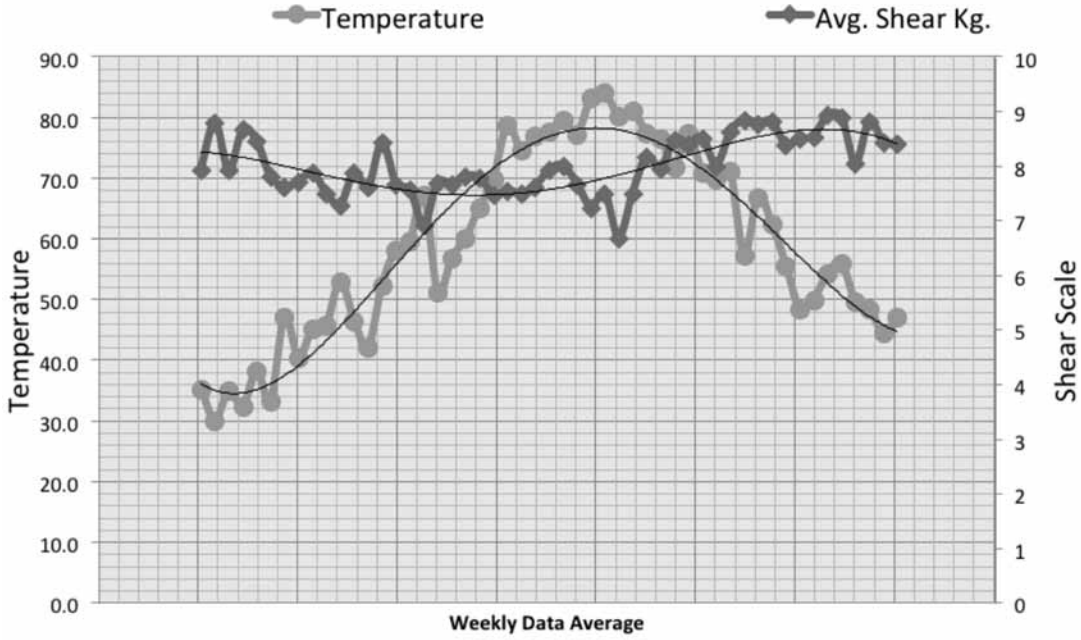

Figure 2. Shear Force vs. Transport Temperature

can be quick frozen after the lag time and processed at a later time for an accurate representation of the tenderness that will be experienced by the consumer.

System maintenance

System maintenance requirements vary from system to system; universal requirements on all of the ES systems are quality electrical connections in the field at the contact plates and grounding bars. The physical contact of the system and the birds should also be managed to the changes in bird sizes that are occasionally seen throughout the week. Poor contact between the bird and the system increases the variability of the shear values thus diminished quality.

ENVIRONMENTAL FACTORS IMPACTING TENDERNESS

Transport temperature

Analysis of shear data collected over a 12 month period indicates a high correlation between the temperature difference of the poultry house and outside transport temperatures. Data indicates that the warmer the outside temperatures the lower the average shear values. Shear differences between summer and winter months can show a shear difference of up to 2 kg of force. The data shown in Figure 2 clearly shows that the producer should expect these impacts and if the shear values are outside their upper control limits make adjustments in the process to accommodate this increase in toughness during the colder months.

SUMMARY

Successful expectations of critical systems in any process require detailed knowledge of the system and consistent management if the producer expects to achieve predictable results. Below is a list of some of the key items that should be considered important in establishing a sustainable ES program.

- Management Education
- Understanding the level of natural variability of the birds entering the system.
- Knowing how the treated meat interacts with the downstream process.
- Having a clear understanding of what tough and tender means from a quantitative perspective.
- Having a well-developed action plan in place prior to a failure in the system.
- Understanding the mechanisms of failure.
- Preventative Maintenance