Meat Quality Factors in Organic Poultry Meat

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In the U.S., over 8.5 billion broilers were produced in poultry industry last year (USDA-NASS, 2014). These broilers are marketed at a variety of market weights from around 2 lbs up to nearly 10 lbs, depending on the desired markets such as Cornish hen or heavy debone, for example. Poultry processing can be divided into several unit operations including preslaughter activities, stunning, slaughter, scalding and picking, evisceration and chilling. During processing, there will be issues that arise with product quality, or product defects. Several quality defects can be observed and some are associated with various steps in the process in terms of the time that they are first identified and/or the time at which they occur. These defects can result in products that are discarded in its entirety, or in parts, or products with decreased meat quality/functionality and/or consumer acceptance. These downgrades and quality issues can cost the industry millions of dollars each year.

Common quality defects

Bruising

Bruising occurs in the live animal with there is trauma to a vessel causing it to rupture. Bruising mostly occurs on the appendages of the broiler and can occur at any point prior to exsanguination during slaughter. The color of the bruise can give some indication on the time at which the bruise occurred. According to study by Hamdy et al. (1960), bruises will be red in the beginning within the first couple of minutes of the associated trauma. This redness will then change to a darker red-purple color within the first 12 hours. Within 24 hours, the bruise will change to a light shade of green-purple and then yellow-green at 48 h. Between 48 and 72 hours, the color will change to a yellow-orange color and then back to normal coloring by 96 hours. This is important to know when trying to identify root causes of bruising. The legs and wings are most susceptible during catching, transport (i.e., issues with transport modules) and unloading at the processing plant. Monitoring bruising at the plant can help to identify possible trends which can help, in turn, to correct problems that may be causing. Residual blood in meat or parts can reduce shelf life and cause other quality issues in processed meats. If blood is present in meat used for deli loaves, it can cause decreased consumer acceptance of that product.

Over-stunning

In the U.S., electrical stunning is the primary method of stunning broilers. Broilers are stunned in order to humanely render birds unconscious prior to slaughter, or exsanguination. Stunning also results in a better bleedout and cutting efficiency (cut all birds properly). Low voltage/amperage systems are predominant in the U.S., and these systems typically provide good product with limited quality defects. However, stun settings can be too high at times resulting in an “overstun.” This results in some quality issues such as broken bones, ruptured arteries and other hemorrhaging. Stunning causes a surge of blood pressure so when the settings are too high, the pressure can be so great that they rupture. This

leads to the ruptured arteries primarily in the thigh and the ruptured capillaries in the breast which results in "blood splash." Additionally, the high stun settings can cause a more forceful muscle contraction of the breast which can lead to breaking the clavicle, or wishbone. A classic sign of overstunning is the broken clavicle with associated hemorrhaging around the break. These quality issues can occur at a greater frequency when higher stunning amperages are used, as in the case of processors in Europe where higher amperages are legally required.

Overscalding

Overscalding can occur when the scalder water is too hot and/or birds are in scalder too long at higher temperatures. The heat of the scalders can begin to denature, or cook, the proteins on the surface of the breast fillets. Generally, two white bands with one 'pinkish' colored band in the middle will be apparent when the carcass is overscalded. The pinkish band is located just beneath the breast feather tract. The feather tract helps protect this area of the breast meat from the extreme temperature and prevents the denaturation of proteins. In cases of severe overscalding, the appearance of the fillet and the functionality/water holding capacity could be negatively affected.

Green Muscle Disease

Green Muscle Disease (GMD), or Deep Pectoral Myopathy, is a condition that occurs primarily in the *Pectoralis minor*, or breast tender. This occurs as a result of a physical stress on the bird in the antemortem state which causes necrosis in the tender. It is generally observed when the birds are cut into parts, or breast deboned, or at more problematic times when the consumer is first to observe it as they cut into their whole bird. As birds have been bred for larger breast muscle, or *Pectoralis major*, this muscle can cause trauma to the *Pectoralis minor* with major muscle contractions that can happen when birds flap. The movement of the wings is a function of the Pectoralis muscles. When the *Pectoralis minor* contracts, it also expands in volume (~25%), but because of its location under the *Pectoralis major*, there is little room for expansion (Bilgili and Hess, 2002). This results in increased pressure on the blood vessels which in turn causes decreased blood supply to the muscle until the muscle begins to die, where necrosis begins. The "green muscle" takes several days to develop after the trauma. Two to three days post trauma (i.e., wing flapping), the tenders will have signs of hemorrhaging with red color associated. Much like with bruising, the red color will begin to turn to a green color with time. This can occur 4 to 5 days post trauma and continue one through day 8+. Additionally, the *Pectoralis minor* will begin to atrophy over time (e.g., day 8+) and the fibers will readily separate. Due to amount of deboning and further processing, plants will identify most cases of GMD and remove it. However, GMD is particularly an issue when it is found by consumers in whole birds, including prepared rotisserie birds, or in some parts. Though it does not present a food safety issue, it is considered a quality defect. Minimizing stress on birds in the antemortem period can help to reduce this defect.

Pale, soft, exudative meat

Pale, soft, and exudative (PSE) meat became more apparent in the poultry industry about 20 years ago. PSE meat is characterized by a pale color, softer gels upon cooking, and poor water holding capacity (i.e., exudative). PSE meat is associated with antemortem and postmortem stressors including

heat stress, preslaughter handling practices (i.e., short term stress), and carcass chilling regimes (e.g, poor chilling rates). However, heat stress is a primary trigger of this condition and the incidence of PSE meat rises in the summer months as a result. It is has been estimated that this PSE type meat represents 5-40% of meat that is produced in the poultry industry (Barbut, 1996; Owens et al., 2000) and it can cost the industry millions of dollars each year. The degree of severity can vary and the more extreme cases cause problems with water holding capacity, product binding, etc., resulting in defective products, especially further processed products such as a deli loaf. In more mild cases, yields will be primarily affected. Remediation practices using functional ingredients (e.g., starch, gum, phosphate) can help to improve water holding capacity of PSE meat. More recent issues that can arise is dealing with PSE type meat while producing a product with clean labels, i.e., limited functional ingredients, no phosphates, etc. Because pale meat is highly correlated to low water holding capacity, sorting of meat is possible in plants to divert PSE meat away from products that require highly functional proteins such as whole muscle deli loaves.

Emerging Quality Defects

White striping

One issue that has become more apparent in recent years in the U.S. and other major global poultry markets is the appearance of white striations, or white striping, in the breast muscle, typically in larger broilers (Owens and Kuttappan, 2013). The condition is characterized by white striations, or "stripes," that run parallel to the muscle fibers on the ventral surface (skin side), often beginning at the cranial portion of the fillet near the wing attachment where it is most concentrated. The striped areas of the fillet show areas of muscle fiber degeneration along with an increase in fat cells (lipidosis) and connective tissue (fibrosis). The striping is readily visible even in moderate cases across the fillet, but can be distracting in severe cases where the lines are very prominent. As the condition worsens as in severe cases, the stripes, or striations, are visible throughout the fillet and can become wider in appearance and cover more area of the fillet. In fact, Kuttappan et al., (2012) showed reduced consumer acceptance of the visual appearance of the fillets as the severity of white striping increased. Not only is the appearance affected, but composition is also affected. Proximate analysis has shown increased fat percentage and decreased protein content. This condition results in decreased meat quality, characterized by decreased water holding capacity, poor product binding, changed nutritional content (fat, protein), and continued reduced consumer acceptance, all which can have negative economic impacts.

Woody Breast

Another emerging problem is a condition referred to as "Woody" or "Wooden" breast. At this time, little is really known about the condition. However, it is an issue that is observed worldwide especially in fast growing high breast yielding broilers. The condition can be characterized by breast tissue that is hard to the touch, much like a muscle would be tense or contracted. This hardness can be present in the live bird prior to processing and even in the growout period as early as a few weeks old (detected by palpation) in addition to the postmortem period. The degree of hardness can be subjectively identified and a scoring system can be used to categorize fillets. Some fillets can be

hardened throughout with limited flexibility while others can be hardened but with some flexibility toward the mid part of the fillet. Often times, a ridge or outbulge is described on the tail end of the fillet. This ridge is likely an artifact of the hardening and the architecture of the muscle where the muscle fiber is shorter in this region. There is no reported incidence, but anecdotal accounts suggest up to 50% in flocks at times. However, it is likely that the percentage of the most severe woody (hard) fillets would be much lower, likely less than 10%. Often times, this condition is also observed with the presence of white striping, especially in the heavy market birds. Sihvo et al. (2013) reported that hard, or woody, fillets accompanied by presence of white striping had histological signs of myofiber degeneration and connective tissue accumulation (i.e., fibrosis). These are the same characteristics observed with white striping alone. Therefore, more research is needed to fully characterize this condition taking care to separate it from fillets with white striping. It is not clear if these conditions are related to each other, or if they are both just related to rapid growth in conjunction with genetics, nutrition or other sources. Regardless, this condition can cause potential problems with processing methods such as deboning, portioning and even problems with marination in terms of pickup along with sensory qualities.

All of these defects discussed are some of the major quality defects that the poultry industry faces, but is it certainly not all. Broken bones and dislocations, cellulitis (inflammatory process), mis-cuts on parts, bones in boneless products, and reduced tenderness of broiler meat, etc., are also common quality defects. These defects will likely occur at some level year-round, but it is important to know if and when these defects increase in incidence. Monitoring the incidence of these defects can help to determine if there larger issue at hand where corrective actions need to occur.

References

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