AMERICAN SOCIETY OF ANIMAL SCIENCE

Journal of Animal Science, 2020, Vol. 98, No. 9, 1–3

doi:10.1093/jas/skaa263
Advance Access publication September 15, 2020
Received: 7 August 2020 and **Accepted:** 12 August 2020
News and Views

NEWS AND VIEWS

Poultry and pork muscle defects and meat quality – consequences, causes, and management

John M. Gonzalez

University of Georgia, Department of Animal and Dairy Sciences, Athens, GA 30602

Corresponding author: johngonz@uga.edu

ORCiD number: 0000-0002-1905-9294 (J. M. Gonzalez).

The poultry and swine industries are in the business of producing muscle protein in a cost-effective manner. While great strides have been made in improving the efficiency of muscle protein deposition, several myopathies have appeared that diminish the quality of chicken and pork meat products. The term myopathy can have a broad definition, such as a common disease of muscle, or a more specific definition, such as a malfunctioning cell structure and metabolic abnormalities that ultimately cause loss of force production and contractile dysfunction. Poultry myopathies include white-striping, spaghetti meat, and woody breast, the most common abnormality (Caldas-Cueva and Owens, 2020). Within the pork industry the ham halo condition has become a major concern. The prevalence, cause and impact of these myopathies on the meat industry were the subject of the 2020 Meat Science and Muscle Biology Symposium.

Genetic selection within the broiler industry is based on a rapid growth rate and greater breast yield (high and standard lines). These high-growth potential birds are fed longer, which in 2019 resulted in over 57.4% of the birds possessing a live weight greater than 2.72 kg (Figure 1). Dr. Casey Owens-Hanning of the University of Arkansas reported on the occurrence and incidence of myopathies occurring in today's broiler population. Data were presented demonstrating that white-striping occurred between 10 and 20% of all carcasses from 3.18 kg birds, but increased to 35 to 40 % in carcasses of 3.86 kg birds. A similar trend was observed with woody breast wherein the incidence and severity of the myopathy increased as body weight increased from 1.81 to 5.44 kg and the incidence of the severe condition increased from 2.3 to 39.8%. Additionally, as breast yield increased from 21 to 36% of total carcass weight, the incidence of severe woody breast increased approximately 10-fold (Figure 2). Spaghetti meat, a fairly new myopathy, may be the result of harvesting birds when they are in the beginning phases of the onset of woody breast. Dr. Owens concluded her presentation with an overview of current methods for detection of muscle myopathies in the plant. The 2D imaging system examines the shape of the caudal portion of the breast and identifies inverted U-shaped breasts as those from carcasses with woody breast. In initial trials, r^2 values range from 0.40 to 0.68, with misclassifications rates ranging from 6.7 to 14.4%. The Side-View Machine Vision System is designed as an online vision technology which measures the degree of bend of boneless fillets. This technology is up to 98% accurate in identifying wooden breast filets and can be used by processing plants to sort deboned fillets for various uses.

Ms. Ashunti Jackson of Cobb-Vantress, Inc. discussed the genetic basis underlying the breast myopathies and management schemes for these birds. Cobb-Vantress currently is developing short- and long-term myopathy countermeasures that include changing the genetics of their breeders. In order to execute such changes, Cobb is conducting meat quality studies, training team members to palpate birds, utilizing ultrasound, and developing other objective measures to identify and remove affected family members. While Cobb is investing time and resources into changes within its breeding flock, rapid elimination of the myopathies are not expected. The broiler breeder selection strategy is based on 50 traits and any genetic changes employed today, will take 4 to 5 years to see the results of. Given the lengthy timeframe, Cobb also is manipulating nutrition, rate and length of growth, and housing conditions as short-term countermeasures. Ms. Jackson stated nutrition and physiology research will continue to decrease myopathy incidence; however, Cobb must be strategic in their decisions to balance breast yield and meat quality.

Numerous studies reported woody breast muscle histologically exhibited degenerating and regenerating muscle fibers (Velleman and Clark, 2015). Muscle satellite cells are stem cells responsible for postnatal muscle growth

and repair. Their participation in muscle repair suggests they may be intimately involved in the woody breast condition. To understand the role satellite cells play in the poultry myopathies, Dr. Jessica Starkey (Auburn University) presented data from several studies. Pectoralis major muscle fiber cross-sectional areas were larger in severe woody breast chickens at day 25 of growth, but the opposite was found at day 43 (Meloche et al., 2018). Immunohistology revealed that satellite cells in woody breast regions were more mitotically active at d43 of growth than at d25. In a follow up study, Ferreira et al. (2020) showed the density of satellite cells increased as the severity of woody breast increased. These results led Dr. Starkey to hypothesize the woody breast condition could be due to malfunctioning satellite cells, a current focus of her research program.

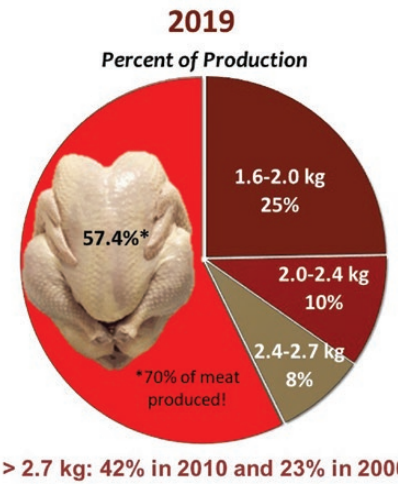

Figure 1. Distribution of the body weights of broilers harvested in 2019. Generated by and used with permission from C. M. Owens.

When asked, the first three speakers agreed that eliminating muscle myopathies will take a long time to occur or may never happen. Therefore, other uses of the affected product must be found. Dr. Alexander Stelzleni (University of Georgia) presented data from several further processed products. Blade tenderization reduced shear force values of woody breast meat (Tasoniero et al., 2019). Marination studies report variable results that are dependent upon the method of marination, and ingredients, breast location, and woody breast severity (Soglia et al., 2016; Bowker et al., 2018). When severe woody breast meat was used for patty production, sensory panel springiness and chewiness values were better than patties produced from normal breast meat (Sanchez Brambila et al., 2017). In data presented from his research group, Dr. Stelzleni showed linked sausage had darker raw and cooked color as the woody breast severity and inclusion percentage was increased, but there were no differences between normal and affected product texture profiles or sensory ratings. Several other studies presented showed commutating products to emulsion reduced the negative effects of woody breast on texture and sensory attributes (Xing et al., 2017; Madruga et al., 2019). To conclude his presentation, Dr. Stelzleni encouraged the meat science community to continue researching woody breast meat usage in other further processed products, ingredients, and processes.

The final presentation of the symposium covered a current muscle defect found in the pork industry, termed the ham halo condition. Dr. Andy King from the Meat Animal Research Center (USDA-Clay Center) presented progress toward identifying the causes of ham halo. The myopathy is characterized as hams possessing pale tissue on the superficial portion that leads to an inconsistent color of cured products. Initial research determined the pale color was due to a shift of biceps femoris muscle fibers to a glycolytic metabolism, leading to less myoglobin and lighter and less red instrumental values (King et al., 2018). Dr. King presented newly generated genomic data that indicated, depending on the type of analysis performed, between 392 and

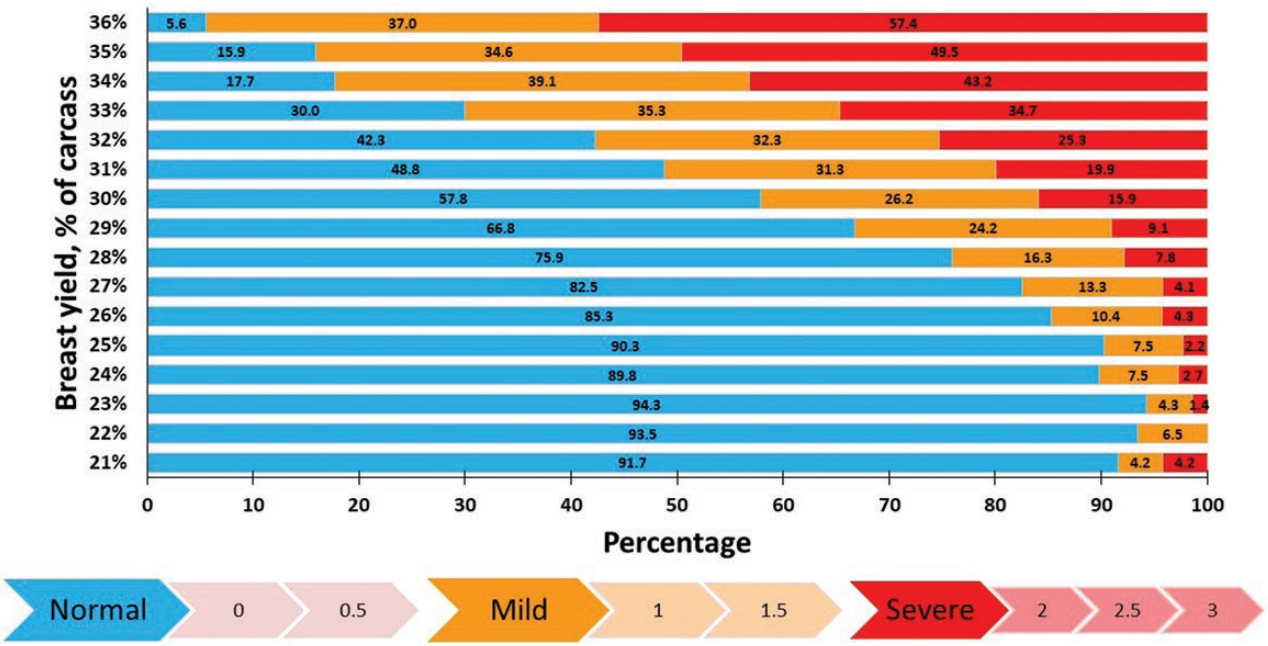

Figure 2. Relationship between broiler carcass breast yield (%) and the severity (1 to 3 scale) of woody breast (Mallmann, 2019). Generated by and used with permission from C. M. Owens.

695 differentially expressed genes were expressed between the normal and halo areas of the hams. Interestingly, the halo portion of the hams had increased expression of white fiber type specific genes and genes involved in mitochondria function, especially complexes I, III, IV, and V were also altered. Finally, in their genetic analyses, Dr. King and his team determined sire lines have a greater influence on severity of the halo condition; thus, this could serve as a strategy to reduce the incidence and severity of this condition.

Financially, it is really hard to determine the true economic impact of these myopathies. According to Dr. King's presentation, the ham halo condition is fairly new, customer complaints are not great, which makes estimating an economic impact difficult. Drs. Owens and Stelzleni cited research estimating losses due to poultry myopathies between $200 million and $1 billion dollars (Kuttappan et al., 2016; Huang and Ahn, 2018). Even more staggering, Dr. Stelzleni estimated that between 649 million and 2.6 billion pounds of chicken are affected by myopathies. While reducing the incidence and severity of these myopathies is a challenge that may take years to overcome, this symposium provided insight into the research, collaborations between academia and industry, and cutting-edge technologies being utilized to manage and eliminate their impact on meat quality.

Disclosures

The author has no conflict of interests to declare.

Literature Cited

Bowker, B. C., A. D. Maxwell, H. Zhuang, and K. Adhikari. 2018. Marination and cooking performance of portioned broiler breast fillets with the wooden breast condition. *Poult. Sci.* **97**:2966–2970. doi:10.3382/ps/pey144

Caldas-Cueva, J. P. and C. M. Owens. 2020. A review on the woody breast condition in the contemporary poultry industry. *J. Anim. Sci.* **98**:1–10. doi:10.1093/jas/skaa207

Ferreira, T. Z., L. Kindlein, J. J. Flees, L. K. Shortnacy, S. L. Vieira, V. P. Nascimento, K. J. Meloche, and J. D. Starkey. 2020. Characterization of pectoralis major muscle satellite cell population heterogeneity, macrophage density, and collagen infiltration in broiler chickens affected by wooden breast. *Front. Physiol.* **11**:529. doi:10.3389/fphys.2020.00529

Huang, X., and D. U. Ahn. 2018. The incidence of muscle abnormalities in broiler breast meat – a review. *Korean J. food Sci. Anim. Resour.* **38**:835–850. doi:10.5851/kosfa.2018.e2

King, D. A., S. D. Shackelford, T. Schnell, L. Pierce, and T. L. Wheeler. 2018. Characterizing the ham halo condition: A color defect in fresh pork biceps femoris muscle. *Meat Mus. Bio.* **2**:205–213. doi:10.22175/mmb2018.02.0001

Kuttappan, V. A., B. M. Hargis, and C. M. Owens. 2016. White striping and woody breast myopathies in the modern poultry industry: A review. *Poult. Sci.* **95**:2724–2733. doi:10.3382/ps/pew216

Madruga, M. S., T. C. da Rocha, L. M. de Carvalho, A. M. B. L. Sousa, A. C. de Sousa Neto, D. G. Coutinho, A. S. de Carvalho Ferreira, A. J. Soares, M. de Sousa Galvão, E. I. Ida, *et al.* 2019. The impaired quality of chicken affected by the wooden breast myopathy is counteracted in emulsion-type sausages. *J. Food Sci. Technol.* **56**:1380–1388. doi:10.1007/s13197-019-03612-0.

Mallmann, B. A. 2019. *Prediction and Evaluation of Breast Myopathy*. Dissertation, Fayetteville (Arkansas): Univ. of Arkansas.

Meloche, K. J., W. A. Dozier III, and J. D. Starkey. 2018. Skeletal muscle fiber morphometrics and in vivo myogenic stem cell mitotic activity in broiler chickens affected by Wooden Breast. *Poul. Sci.* **97**:4401–4414. doi:10.3382/ps/pey287

Sanchez Brambila, G. S., D. Chatterjee, B. Bowker, and H. Zhuang. 2017. Descriptive texture analyses of cooked patties made of chicken breast with the woody breast condition. *Poult. Sci.* **96**:3489–3494. doi:10.3382/ps/pex118

Soglia, F., S. Mudalal, E. Babini, M. Di Nunzio, M. Mazzoni, F. Sirri, C. Cavani, and M. Petracci. 2016. Histology, composition, and quality traits of chicken Pectoralis major muscle affected by wooden breast abnormality. *Poul. Sci.* **95**:651–659. doi:10.3382/ps/pev353

Tasoniero, G., B. Bowker, A. Stelzleni, H. Zhuang, M. Rigdon, and H. Thippareddi. 2019. Use of blade tenderization to improve wooden breast meat texture. *Poul. Sci.* **98**:4204–4211. doi:10.3382/ps/pez163

Velleman, S. G. and D. L. Clark. 2015. Histopathologic and myogenic gene expression changes associated with wooden breast in broiler breast muscles. *Avian Dis.* **59**:410–418. doi:10.1637/11097-042015-Reg.1

Xing, T., X. Zhao, L. Cai, Z. Guanghong, and X. Xu. 2017. Effect of salt content on gelation of normal and wooden breast myopathy chicken pectoralis major meat batters. *Food Sci. Tech.* **52**:2068–2077. doi:10.1111/ijfs.13485