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Declining nutritional value of factory farmed chicken

Summary

- Consumption of chicken meat has consistently increased in the US in the past 50 years, and is expected to continue to rise, at least in part due to its nutritional value and purported health benefits (especially compared to other animal proteins).
- The industry has responded to this increase in demand through genetic selection and intensification of production practices, which in turn have resulted in health and welfare concerns for broilers.
- There are recent scientific reports of an increase in the incidence of myopathies (muscle tissue disorders) in broilers, including conditions known as wooden breast and white striping; it is believed that selection for fast growth and increased muscle mass in broilers has played a key role in this increase.
- In recent experimental studies, the incidence of white striping has been found to be as high as 96.1%
- Conditions like white striping and wooden breast seriously affect the nutritional value and quality of chicken meat. Breast fillets affected by severe white striping have been found to contain up to 224% more fat and 9% less protein than normal breast meat.

- Economic losses due to white striping and other muscle disorders related to fast-growth in broilers have been conservatively estimated to be greater than $200 million per year.
- Muscle disorders like white striping are chronic, degenerative conditions that cause pain and suffering in broiler chickens.
- Studies comparing factory farmed chicken to chicken produced in higher welfare systems report higher nutritional values for the latter. Conditions like white striping are reported only in intensive production, and add to nutrition and welfare concerns for factory farmed broilers.

1. Introduction

In the United States, chicken has long been one of the most popular sources of animal protein, and its consumption has consistently grown since the 1950s, surpassing that of both pork and beef (National Chicken Council, 2016a). In 2015, almost 9 billion broiler chickens, weighing 53 billion pounds live weight were produced, and more than 40 billion pounds of chicken meat were marketed in the U.S. (National Chicken Council, 2016b). One of the reasons for the popularity of chicken is that like other “lean” meats, it has been reported to be healthier than other animal protein sources (Daniel et al, 2011). For example, in 1996, the Colon Cancer Panel of the World Health Organization Consensus Conference on Nutrition in Prevention and Therapy on Cancer issued a statement warning consumers of the carcinogenic potential of red and processed

meats, recommending fish and poultry as healthier animal protein alternatives (Scheppach et al., 1999). More recently, the International Agency for Research on Cancer (IARC) stated that there is now sufficient scientific evidence to establish that processed meat is a carcinogen, as well as some evidence for the carcinogenic potential of red meat (Boada et al, 2016). However, these recommendations fail to note the fact that poultry production has changed dramatically in the past thirty years, and that changes in poultry genetics and production practices have affected the quality of chicken meat, perhaps compromising some of the beneficial nutritional qualities attributed to chicken. For reference, in 1925, long before the development and large-scale adoption of fast-growing broiler strains, an average chicken raised for meat took 112 days to reach its market weight of 2.5 pounds; in 2016, broilers are ready for slaughter at 47 days, with an average weight of 6.18 pounds (National Chicken Council, 2016b). These exponential increases in growth rate and market weight have been achieved through a combination of genetic selection and the intensification of production practices, which have also resulted in lower prices for poultry as compared to other meats. Between 1960 and 2004, the US consumer price index for poultry products increased at half the rate of all other products (Zuidhof et al, 2014).

In addition to public health recommendations and pricing, consumers' perception, knowledge, and beliefs about meat also affect the kinds and amounts of meat consumed (Daniel et al, 2011). Studies on factors influencing meat purchases report that consumers are driven by sensory factors (color, tenderness, and flavor), as well as

cultural factors, lifestyle, and labeling signaling a guarantee of hygiene, safety, and ethical production (Hocquette et al, 2013; 2016). Since consumers have limited access to information regarding production practices and their impact on nutritional value, they largely rely on public health recommendations and food labels in order to select and purchase animal products. However, recent findings regarding the effects of intensive production practices on the quality of chicken meat may indicate that the product consumers are buying may be far from the lean, healthy meat they expect, and that nutritional values may deviate from what is reported on labels.

2. Muscle disorders:

The push to produce heavier chickens faster in order to meet rising demand has not only resulted in larger birds, but in animals with a strikingly different body conformation. In 2001, an average Ross 308 broiler (a fast-growing strain) weighed on average 4.7 lb. at 43 days of age, with the breast weighing about 0.8 lb. (Havenstein et al, 2003). In 2012, total body weight for the same kind of broiler at 35 days was very similar, but breast weight increased to over 1 lb. (Aviagen, 2012).

Achieving this disproportionate breast size in such short amount of time is not without consequence. In broiler lines genetically selected for increased muscle mass, muscle fibers can be three to five times larger in diameter, and this can result in alterations to muscle function; for instance, larger fibers are more likely to remain in a severely contracted state, and a high proportion of these large fibers may compromise

oxygen supply to the muscle as well as the adequate elimination of metabolites or waste products (Petracci et al, 2015; Velleman, 2015). Fast growth and selection for larger muscles are also believed to play a central role in the recent increase in myopathies (muscle disorders) in fast growing broilers. Myopathies are a disruption or malfunction in the structure or repair mechanisms of muscle tissue (Velleman et al, 2015). Three commonly reported types of breast muscle myopathies in broilers are deep pectoral myopathy (DPM), white striping (WS), and wooden breast (WB) (Bailey et al, 2015). DPM involves necrosis (death) of muscle fibers, presumably due to poor blood circulation in these disproportionately large muscles (Bailey et al, 2015). In both WB and WS, normal muscle tissue is replaced with fibrous connective tissue; in WB, this replacement is more extensive, resulting in a palpable hardening of the muscle, in WS, replacement is less extensive, but is still noticeable as a series of thin white lines across the breast muscle (Bailey et al, 2015).

Increases in the incidence of white striping have been found in experimental conditions as well as in commercial settings. In experimental conditions, a 2012 study found WS in 55.8% of breast muscle samples, while a more recent study found that 96% of samples were affected by WS, and furthermore, 2% were considered to present “extreme” WS, a category not present in prior studies (Kuttapan et al, 2013a; Tijare et al, 2016). A 2012 study examining 28,000 breast fillet samples at a commercial processing plant found a 12% incidence of WS, while a separate study in 2014 found 43% of samples to be affected (Petracci et al, 2013; Lorenzi et al, 2014). The latter

study also compared the incidence of WS in two broiler hybrids, one with standard breast meat yield, and the second with high breast meat yield, finding a higher incidence in the high yield birds (Lorenzi et al, 2014). Similarly, in a study comparing broiler lines with moderate breast yield and high breast yield, 49% of high yield broilers were reported to be affected by WS, whereas only 14% of moderate yield birds were affected (Bailey et al, 2015).

While the specific causes of muscular disorders like WS are still being researched, the vast majority of studies conducted thus far have found a correlation between fast growth, heavier weights, higher breast yield, and the development of myopathies in broilers (Kuttappan et al, 2016).

3. Nutritional and taste impact

The structure and function of the muscle ultimately affect meat quality, since muscular structure is largely responsible for quality attributes such as texture, taste, and appearance (Velleman, 2015). Myopathies such as WS have also been found to affect the chemical composition of breast meat. Studies comparing normal breast meat to meat severely affected by WS report dramatic variations in nutritional values, including a 224% fat content increase, a 9% protein decrease, and a 10% collagen increase, and an increase in fat calories from 7% to 21% (Petracci et al, 2014). While breast meat affected with severe WS is downgraded and used to manufacture processed chicken products such as sausages and nuggets, moderately affected meat is still marketed

alongside unaffected meat, despite the reported variations in nutritional value (Lorenzi et al, 2014). As such, consumers purchasing chicken meat precisely because it is reported to be a leaner, high quality protein could be getting a product that does not always meet these expectations.

4. Economic impact

Although meat affected by myopathies such as WS is still being marketed and sold, it is expected that the increased incidence of these conditions will result in significant economic losses. The downgrading of severely affected meat is already causing losses, but consumers' awareness of how these issues affect meat quality, nutrition, and animal welfare could result in even greater economic impacts. As previously mentioned, consumers' perceptions of the nutritional quality of meat, as well as its appearance and texture influence their purchases. Additionally, meat affected by WS has been found to result in a less palatable product when cooked, as it is less tender, and is reported to have higher cooking losses (Petracci et al., 2013; Mudalal et al., 2014; Tijare et al., 2016). In a 2012 study assessing the visual impact of WS on consumers' purchase intentions, 32% of consumers who were shown chicken breast fillets affected by WS stated that they would probably not buy them, while 19% said that they would definitely not (Kuttappan et al, 2012). Although the economic impact of WS and WB has not been quantified, the broiler industry is presumably already facing losses due to these conditions. In a Wall Street Journal interview, a chief executive from

a major US broiler company admits to having received complaints from restaurant and retail customers, forcing them to implement additional quality checks at their processing plants (Gee, 2016). It is estimated that the increased incidence of conditions like WS could result in losses in excess of $200 million per year (Kuttappan et al, 2016).

5. Animal welfare impact

Myopathies of fast-growing broilers have been determined to be chronic, degenerative conditions (Kuttappan et al, 2013b). In other words, they are a breakdown of the basic structure of the muscle that occurs over an extended period of time, undoubtedly adding to the host of health and welfare issues known to affect fast-growing broilers, such as skeletal deformities, footpad lesions, breast blisters, ascites, and sudden death syndrome (Bessei, 2006).

In these broiler lines, fast muscle growth is achieved mainly through hypertrophy, that is, a rapid increase in size of existing muscle fibers, rather than the addition of new fibers (Velleman, 2015). These fibers increase in size so quickly that they outgrow their support systems, including oxygen supply and waste elimination, leading to degeneration and often permanent damage (Velleman, 2015). Although the specific welfare impacts of broiler myopathies have yet to be researched, it is reasonable to assume that the extensive inflammation and muscle damage involved necessarily result in pain and suffering that only adds to fast-growing broilers' already compromised welfare.

6. Higher welfare systems

Conditions such as white striping are undoubtedly affecting the welfare of broilers, and the quality and nutritional value of chicken. However, even before these conditions were reported, prior studies had found important differences in nutritional values of factory farmed chicken compared to chicken produced in higher welfare systems. Higher welfare systems for broilers use lower stocking densities, slower growing strains, and provide stimulating environments that result in better welfare for broilers (Jones, 2016).

Nutritional values affected by genetics and rearing system include fat content, omega-3 and omega-6 fatty acid content and ratio, vitamin E, and iron. A report on the nutritional value of higher welfare animal products found that meat from slower-growing chicken strains generally contains less fat than fast-growing strains (around 10-30% less for medium-growing strains and 20-65% less for slow-growing strains), and has a higher proportion of omega-3 fatty acids compared with intensively-reared chicken meat, with a similar ratio of omega-6 to omega-3 (Pickett, 2012). Levels of vitamin E are also higher in the meat of slower-growing strains compared with fast-growing strains (Pickett, 2012). A study comparing Ross broilers raised in organic versus intensive conditions found that fat content was considerably higher in intensively reared broilers, reporting fat content in breast meat as 0.72% vs. 1.46% at 56 days, and 0.74% vs. 2.37% at 81 days (Castelini et al. 2002). Chicken meat from slower growing strains and

from birds reared organically has also been found to contain more iron than meat from fast-growing strains and birds reared intensively, with higher welfare options providing around 5-6% of the adult RDA in a 100g serving (Pickett, 2012).

In summary, both genetics and production system play an important role in determining welfare outcomes and nutritional values in broiler chickens. The combined effects of slower-growth genetics, lower stocking densities, and more enrichment offered in higher welfare systems leads to a healthier bird, and a healthier resulting meat product for consumers.

7. Conclusions

Consumers' preference of chicken meat over other animal proteins is grounded in the belief that it is leaner and generally healthier than other meats. In response to the constant increase in demand for chicken, the broiler industry has focused on boosting productivity through selection for fast-growth and other intensive production practices. These practices, however, have resulted in poor welfare for broilers, and a lower quality product for consumers; one that does not meet the expectations of a leaner, healthier protein. White striping is one example of how intensive production practices affect both nutritional quality and welfare outcomes, and furthermore, the high incidences found by some studies (up to 96%) demonstrate that the problem is widespread. The effect of conditions like white striping on the nutritional value of chicken cannot be ignored: affected breast fillets have up to 224% more fat, and 9% less protein. The broiler

industry is already facing economic losses as a result of the increase in muscle disorders like white striping, and losses will continue to grow if practices remain unchanged. Previous studies have compared the nutritional value of chicken raised in intensive systems (factory farms) and chicken from higher welfare systems, finding the latter to have less fat (up to 220% less), more vitamin E, and more iron. These findings confirm that higher welfare systems are not only better for chickens, but also for consumers looking for healthier meat options.

In order to address nutritional and welfare concerns, producers and food companies need to modify their production practices and supply chains to include higher welfare practices. These changes include:

- Improved strains of chicken
- More space
- Improved environments

These improvements are a crucial step in working toward results that are better aligned with what both food companies and consumers want from ethical and nutritional standpoints.

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