

Department of Animal Science

MANAGE LITTER QUALITY FOR BETTER PAW QUALITY

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Chicken paws (Figure 1) would be a waste product of U.S. poultry production were it not for their high demand in China as a delicacy food item. Their popularity there is somewhat similar to that of chicken wings in the U.S., according to the U.S. Poultry and Egg Export Council. A chicken “paw” is the portion of the leg below the spur; a chicken “foot” includes the paw as well as the portion of the leg below the feather line. The demand for paws in China is a windfall for poultry integrators in the U.S., who would otherwise have no choice but to sell paws to renderers for practically nothing just to be rid of them. However, in 2020 alone, more than 201,958 metric tons of paws were exported to China from the U.S., generating a revenue stream of \$461 million. Before the mid-1980s, chicken paws were of little economic value and were rendered along with feathers, blood and other unsaleable parts of the chicken. At that time, footpad dermatitis (FPD) was not considered a serious issue and little research or animal welfare efforts were invested on the topic. Fast forward to today, however, and the insatiable demand for high-quality paws for the export market has put a spotlight on paw quality and FPD. This increased attention comes from the fact that the lesions that result from FPD are a cause of animal welfare, food safety and product downgrade concerns. In addition, chickens with FPD may not perform as well which takes money out of growers’ paychecks.

Foot pad dermatitis

Foot pad dermatitis is a serious problem for today’s poultry industry, negatively affecting broiler health and welfare status, walking and feeding/drinking activity, growth performance, carcass quality, and economic profit (Swiatkiewicz et al., 2017). It is a condition of inflammation and necrotic lesions on the plantar surface of the foot pads, commonly observed in fast-growing broilers and turkeys (Shepherd and Fairchild, 2010). FPD appears as brown-black coloration and lesions on the foot skin, with inflammation, hyperkeratosis, and necrosis of the epidermis, found in histopathological examination (Greene et al., 1985). These lesions can serve as an entry point for *Staphylococcus aureus* and other microorganisms (Jensen et al, 1970; Hester, 1994). The occurrence of FPD is now used as an important audit criterion for welfare assessments in poultry production facilities in the U.S. and Europe (Berg 2004; National Chicken Council, 2017).

Paw Quality

Paw quality refers to the overall health of the foot, including the health of the toes and footpad. There are a multitude of factors that may influence the occurrence and severity of FPD including drinker design and management, environmental factors, diet composition, genetics, house temperature and humidity levels, bedding materials/litter conditions, sex and age of birds, genotype, lighting program, and gut health (Shepherd and Fairchild, 2010; Tabler et al., 2013; Swiatkiewicz et al., 2017). Of these, litter condition (specifically, wet litter) is likely the most important factor because foot pads are in constant contact with the material on the floor. FPD may not develop even though other factors may be present if the litter remains dry. However, wet litter (litter with more than 30 percent moisture) is associated with an increased incidence and severity of FPD in broiler and turkey housing systems (Martland, 1984; 1985).

Litter Management

Litter management is likely the most critical factor in maintaining good paw quality. Poultry litter (Figure 2) serves several important functions including thermal insulation, moisture absorption, a protective barrier from the hard floor, and it allows for natural behaviors (dust bathing and scratching). Type, quality and quantity of litter can affect the level of FPD in a flock. Pine sawdust, rice hulls and peanut hulls are acceptable and common bedding materials; however, kiln-dried pine shavings are most often the material of choice if available and the price is right. Although, other competitors that can outbid the poultry industry for pine shavings are making this material increasingly difficult to obtain. As a result, other bedding material options are being investigated such as miscanthus grass, switchgrass, sand and wheat straw. Numerous factors determine the choice of bedding materials, including cost, availability, moisture absorbance and particle size. Particle size is extremely important because smaller particles absorb and release moisture more rapidly than larger particles. Larger particles tend to slick over and form cake more quickly and hold moisture longer. Litter should be a minimum of 3 to 4 inches deep to maintain a good moisture absorbing capacity and reduce FPD.

Meluzzi et al. (2008) reported that controlling environmental conditions (ventilation, temperature, humidity, litter moisture, etc.) appeared to be the best way to control the onset of FPD. This requires diligent management on the part of the grower. Litter acts as a large sponge to soak up moisture in the house. Proper ventilation helps remove excess moisture and humidity and prevents the “sponge” from becoming saturated and forming caked litter. Caking refers to the compressing of litter layers into a single wet layer at the top of the litter material. This thick, dense, wet layer holds most of the moisture and fecal material in the litter (Shepherd and Fairchild, 2010). Mayne (2005) suggested that continually standing on wet litter will soften the footpad and make it more prone to damage, predisposing the bird to developing FPD. Shepherd and Fairchild (2010) reported FPD lesions have been found to be more severe as litter moisture increases, particularly when the litter contains high moisture along with sticky fecal droppings. Litter moisture can be greatly affected by drinker design and management. Water line height and pressure regulator adjustment must be carefully managed to prevent wet floors and maintain flock performance. Line height that is too low or water pressure that is too high will eventually result in wet floors. However, line height that is too high or pressure set too low will restrict water intake, thereby reducing feed intake and growth rate. Poor water quality may also cause intestinal upsets in the flock or cause nipple drinkers to leak and add excess water to the litter. Test poultry drinking water supplies and know what birds are drinking, from a mineral and bacteria standpoint.

Diet and Nutrition

Much like wet litter, nutrition is a major factor in the onset of FPD, particularly with the use of more all-vegetable diets and antibiotic-free feeding programs today. Protein is an important dietary factor influencing litter quality, as excessive protein in the diet is metabolized to uric acid and excreted. Water intake in chickens increases with increasing protein content in the diet, thereby increasing litter moisture (Swiatkiewicz et al., 2017). Soybean meal has been investigated as a possible cause of FPD because indigestible carbohydrates (non-starch polysaccharides, or NSP) in soybeans and other plants may be sticky and caustic and contribute to FPD (Hess et al., 2004). Nagaraj et al. (2007) and Cengiz et al. (2013) reported that chickens fed a diet with all-vegetable protein had higher incidences and severity of FPD than broilers fed with a mixed vegetable and animal protein dietary source. Eichner et al. (2007) also observed increased litter moisture and FPD severity in chickens fed an all-vegetable diet, as did Hossain et al. (2013). Bilgili et al. (2010) indicated feeds should have optimum amino acid density but minimum crude protein levels, which is achievable using digestible and synthetic amino acids.

As NSP concentrations increase in the feed, gut viscosity increases, resulting in manure that more readily adheres to the footpads of the birds. Diets containing wheat with increased levels of viscous NSP tend to have lower metabolizable energy values and higher digesta viscosity than normal wheat diets. The viscosity of the gut contents can affect fecal dropping adhesion to the foot and over time may deteriorate the epidermis and keratin layers of the footpad. These diets can be improved with the addition of NSP-degrading enzymes, showing significantly lower digesta viscosity than a wheat diet alone (Choct et al., 1995).

Another factor that can contribute to FPD is litter friability (Eichner et al., 2007). Litter should be loose (friable) and dry because chickens tend to scratch, peck and work the litter material, improving aeration, speeding up drying and reducing particle size. As litter slicks over and becomes damp and wet, it eventually forms cake, and birds can no longer work the litter. As the birds walk and rest on this caked litter, the outer layer of the footpad begins to soften. The caked litter produces friction between the soft footpad and the floor, causing the outer skin layers to erode and setting the bird up for FPD (Fairchild and Czarick, 2011).

Temperature, Humidity and Stocking Density

Temperature and humidity inside the chicken house fluctuate with season of the year. Ventilation rates change as growers adjust to increasing and decreasing temperatures as seasons change. Lowest ventilation rates are in the winter as growers attempt to avoid reducing house temperatures and try to save on fuel costs. As growers attempt to conserve heat, they often sacrifice proper ventilation rates. In so doing, house humidity levels rise, and this saturated air eventually increases the moisture level in the litter causing wet and caked litter. For this reason, wet litter is a bigger problem in the winter than in other seasons of the year. As a result, FPD is seen more frequently in the winter. Although, excessive cool cell usage in summer that results in wet litter can also increase FPD. Regardless of season, it is important to maintain in-house relative humidity levels between 50 and 70 percent. Relative humidity over 70 percent for long periods of time will result in litter slicking over, becoming wet and forming cake, even with young chicks. It is less expensive to maintain the proper environment with judicious fuel use and adequate ventilation than to try and dry litter back out once it has become wet and slicked over from inadequate ventilation.

The information regarding stocking density is mixed. Some studies have reported that higher stocking densities are associated with a greater incidence of FPD whereas other studies have suggested that stocking density plays little or no role in the formation of footpad lesions (Shepherd and Fairchild, 2010). It is more challenging to keep up with the increased moisture removal demands associated with more birds in the house. However, many growers do a good job of managing these additional demands, even during winter months when ventilation rates are often reduced to conserve fuel. Therefore, management practices may play a more critical role in maintaining good paw quality than stocking density. Although having additional birds in the house makes maintaining litter quality more challenging, it has been concluded that stocking density itself has little effect on FPD if adequate house environmental conditions are provided (Dawkins et al., 2004).

Although it is widely accepted that management and environmental conditions, particularly litter moisture, are the main factors influencing the incidence and severity of FPD, some research indicates a different susceptibility in the development of FPD among different strain crosses or fast-growing genotypes (Kestin et al., 1999; Sanotra et al., 2003). Zampiga et al. (2019) also reported a difference in FPD related to genotype. Therefore, identifying genetic strains of broilers that may offer greater footpad resistance to challenging environmental conditions may be key for preserving animal welfare and profitability in the future (Zampiga et al., 2019).

Summary

The development of a multi-million-dollar export market for chicken feet has changed how the poultry industry regards litter management and footpad dermatitis in the broiler house. Today, only the breast and wings prevent chicken paws from being the most valuable part of the chicken. However, only high-quality paws meet rigid export standards, and it is vital to avoid footpad dermatitis issues which could knock paws out of the lucrative export market and into the rendering plant instead. Wet litter is likely the most important factor affecting paw quality, making litter management critical to protecting paw quality. Other factors also play a role including nutrition, environmental conditions, ventilation, genotype, lighting program, etc. However, growers should focus their attention on litter management to preserve paw quality. Dry litter usually means good paws, and good paws usually mean better flock health and welfare (and a bigger paycheck). So, while growers may not think they get paid for good paw quality, they most likely do if that good paw quality means their birds make more trips to the feeders and drinkers and perform better than they would with FPD and painful lesions on their feet.

Figure 1. Chicken paws.



Figure 2. Poultry litter.



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