ISSN: 2586-7342 © 2020 KODISA & KJFHC
KJFHC website: http://www.kjfhc.or.kr
doi: http://dx.doi.org/10.13106/kjfhc.2020.vol6.no4.11.

REVIEW: Footpad dermatitis (FPD) in chickens

Mohamed M. AMER[1]

1.First Author & Corresponding Author Department of Poultry Diseases, Faculty Veterinary Medicine, Cairo University, P.O. 12211, Giza, Egypt., E-mail: profdramer@yahoo.com

Received: July 25, 2020. Revised: August 24, 2020. Accepted: September 05, 2020.

Abstract

Footpad dermatitis (FPD) can be considered as a threat for poultry production due to it causes losses due to condemnation in slaughterhouse. The prevalence and the severity of FPD in broiler breeders increase over time with development of poultry industry. The condition is produced by multifactorial including include drinker design and management, diet composition, house (temperature and humidity levels), litter (type, quality, and quantity) and gut health. Bacterial infections can be associated. FPD lesions can develop in less than a week. FPD is a variable size of inflammatory lesion of the footpad in commercial poultry characterized by necrotic lesions on the plantar surface of the footpad of poultry. These lesions can be exposed after removal of fecal mass and litter stuck on it. There are considerable and numerous interactions between the environment and the genetic traits. Prevention depends mainly on improvement of litter condition. Genetic selection against footpad dermatitis must be contributed to reduce pain and suffering for particular bird experiencing contact dermatitis as well as to avoid economic losses. The objective of this review is to collect different literature written about FPD to be available to students, researchers and veterinarian in poultry practical.

Keywords: Footpad dermatitis, Broiler, Bacterial causes, signs, Lesions, prevention.

Major classifications: Healthy Food, and Economy

1. Introduction

Footpad dermatitis (FPD) was first reported as a skin condition in broilers in the 1980s (Greene et al., 1985; McFerran et al., 1983). A similar condition has been reported in turkeys as covered by Mayne (2005). Footpad dermatitis (FPD) is a variable size of inflammatory lesion of the footpad in commercial poultry characterized by necrotic lesions on the plantar surface of the footpad of poultry with significant animal welfare, and economic implications.

2. Synonyms

The condition had many names: footpad dermatitis (FPD), contact dermatitis (CD), bumblefoot or pododermatitis, all of which refer to a condition characterized by superficial to deep inflammatory and necrotic lesions of the plantar surface of the footpads and toes (Shepherd and Fairchild, 2010).

3. Incidence

Footpad dermatitis is a well-known factor affecting broilers (Ekstrand & Algers, 1997 ; Kyvsgaard et al., 2013). The prevalence and the severity of FPD in broiler breeders increase over time (Kaukonen et al., 2016). Thøfner et al. (2019) observed footpad lesions with increased frequency in more than 70% of the dead birds having lesions from week 40 and onwards and there is a correlation between footpad lesions and mortality due to infection with Gram-positive cocci. Pododermatitis has been observed in several layer flocks.

4. Economic importance

Foot pad dermatitis (FPD) is a widespread problem for commercial chicken production, including broilers, layers and broiler breeders, as well as turkeys (Abd El-Wahab et al., 2013; Ask, 2010; Mayne, 2005). Losses are mainly attributed to slaughterhouse condemnation of carcasses with contact dermatitis lesions (Pattison 1987). FPD may have an adverse effect on mobility and linked to weight loss in Turkey poults (Da Costa et al. 2014; Wyneken et al. 2015).

Footpad dermatitis in broilers may increase partial carcass condemnation rates in processing plants, and is an indication of bird welfare (Dullius *et al.*, 2011). Economic losses for the Brazilian poultry industry whom does not allow domestic trade and exports of broiler feet with severe injuries for human consumption to Asian market, especially Hong Kong and China (Bean et al., 2007). Footpad lesions are a source of microorganisms that can enter the blood stream and cause systemic infection of broilers and turkeys (Mayne, 2005). Occurrence of footpad lesions is used as a criterion in welfare assessments of poultry production in Europe and U.S. (NCC, 2010; Martland, 1985; Mayne, 2005).

5. Factors associated with the onset of footpad dermatitis

These include drinker design and management; diet composition; house temperature and humidity levels; litter type, quality, and quantity; and gut health.

5.1. Litter

Studies have shown that litter quality and substrate, genetics, nutrition, and broiler body weight and sex affect the incidence of pododermatitis (Hess et al., 2011). The corrosive effects of wet and/or damp bedding are resulting from high levels of dropping, water provision, stocking density, climatic conditions, and ventilation and even feed can singly or all have a synergistic effect. Wet litter (>30 percent moisture) is associated with increased incidence and severity of FPD in broiler and turkey housing systems (Martland, 1985). The occurrence was most prevalent during the winter-spring and autumn seasons (Dinev et al., 2019). Wet litter is a major risk factor for contact dermatitis, which can provoke lesions on the breast, hock and feet and therefore affect the welfare of the chicken (EFSA , 2010). Cengiz et al. (2013) examining the effects of floor system (litter, wire and wooden) and protein source on FPD scores and found the highest FPD scores with the wooden floor system. Other studies have found that differences in litter type could affect FPD rates as well as the timing of the onset of lesions (Nowaczewski et al., 2011; Xavier et al., 2010).

5. 2. Gut health

Any challenge to the gut can cause subclinical or clinical enteritis. Enteritis often causes diarrhea, resulting in increased nutrient and moisture excretion into the litter (Bilgili et al., 2010).

5. 3. Bird's sex

Broiler sex, strain and size have been investigated as factors affecting the onset of FPD. Male broilers tend to have higher incidence and more severe FPD than females (Harms & Simpson, 1975; Shepherd & Fairchild, 2010). The incidence of foot pad lesions was statistically different ($p < 0.05$) between strains and sexes, but there were no interactions between these factors (Jacob *et al.*, 2015; Martins et al., 2016).

5. 4. Genetic

Genetic variation between and within lines was present within 10 commercial broiler lines for both FPD and hock burns HB as indicated by between-line differences and heritabilities, and selection against FPD and HB is possible. (Ask, 2010). It has that genotype been suggested a causal factor affect the prevalence of FPD and HB; the existence of hybrid differences in the prevalence of FPD and HB indicates the presence of genetic variation (Mayne, 2005). Moreover, heritabilities of 0.31 ± 0.12 and 0.08 ± 0.08 have been estimated for FPD and HB, respectively (Kjaer et al., 2006). Hocking and Wu (2013) compared FPD in 4 turkey lines and found that FPD occurrence in the heaviest line began at earlier ages than the other lines. Furthermore, Kyvsgaard et al. (2013) found the incidence of FPD in a broiler flock with a low growth rate (42.1%) to be lower than in a flock with a higher growth rate (48.7%).

5. 5. Feeds

The incidence of dermatitis was high in young turkeys that ate high levels of soybean meal (Jensen et al. 1970). Feeds with high nutrient density, high protein levels, and high soybean meal levels shown to lead to increased levels of FPD in broilers (Nagaraj et al., 2007).

6. Interactions between the environment and the genetic traits

There are considerable and numerous interactions between the environment and the genetic traits that can seriously adversely affect welfare in areas such as lighting regimes, litter management, dietary deficiencies and contamination, air quality and temperature (EFSA, 2010). In a study carried out by Kapell et al. (2012) results showed that genotype × environment interaction had a significant effect on FPD levels, while, Ekstrand & Algers (1997) reported that genotype × litter type, genotype × litter depth and genotype × waterer type interactions all had different effects on FPD levels. interactions of factors on FPD scores mean were found to vary between genotype × production system × gender was found to have a significant effect on FPD occurrence ($P < 0.05$), whereas the interactions between genotype × production system, genotype × gender, genotype × age and gender × age had significant effects on live weight (Sarica et al., 2014).

7. Clinical signs and lesions

The first signs are lameness, impaired locomotion, and discoloration of the skin that may develop into ulcers. Swelling of the metatarsal region is due to perifocal inflammatory edema in plantar pododermatitis. Lesions were distinctly separated from the intact tissue and frequently, they appeared as crater-like grooves (ulcers) surrounded by an indented hemorrhagic area. These lesions can be exposed after removal of fecal mass and litter stuck on it (Dinev et al., 2019). FPD lesions can develop in less than a week. The ulcers can cause swelling, redness, and heat under the skin and cause the surface area to thicken (Meluzzi et al., 2008). The sores can be shallow or deep. Deep ulcers may lead to abscesses of the underlying tissue and structures (Greene et al., 1985). Often, a scab or crust will cover the lesion. If severe ulcers develop, they may cause pain, decrease growth rate, interfere with walking, and provide an entry for bacteria. In more advanced stages, macerated lesions were detected, and birds were dehydrated due to prolonged periods of lying down and the inability to eat or drink (Dinev et al., 2019).

Chen et al (2016) identification of biomarkers for FPD development and reported that regression analyses indicated the total amount of collagen protein and mRNA levels of TNX, TNC, COL1A1, COL3A1, TIMP3, ITGA2, ITGB1, TNFα, TLR4, VEGF, and the ratio of MMP2 to TIMP were all quadratically associated with foot pad lesion scores. It indicates that these parameters are interrelated with dynamic changes of footpad lesion scores.

8. Scoring system for FPD

Ekstrand score is scoring systems (Ekstrand et al., 1998) and the modified Ekstrand score (Pagazaurtundua & Warriss, 2006) are the ones that have been developed in the EU. In these scoring systems, the total surface area that the lesions cover determines the foot score rather than the depth of the lesion. These scoring systems are also designed for use at processing to evaluate the performance of farms. NCC (2010) uses footpad lesions and paw scores when they assess the welfare of poultry flocks in the U.S. FPD is characterized by hyperkeratosis in its early stage and by foot pad ulcers and necrosis in its late stage. Lesions may develop in less than a week after contact (Ekstrand & Algers, 1997).

9. Bacterial associated with FPD in poultry:

The lesions are not primarily caused by infection and it is believed to be caused by a combination of moist litter and chemical irritation of the skin due to a high ammonia content of the litter (Berg, 2004). The first report demonstrating a correlation between the presence of footpad lesions and systemic bacterial infections with Gram-positive cocci in broiler breeder birds was carried out by Thøfner et al (2019). *S. aureus* is the most frequently isolated pathogen from cases of bumblefoot (Wilcox et al., 2009). Olsen et al. (2018) identified 106 bacterial isolates from pododermatitis in table egg layers including mostly *S. aureus* (68%) and *Enterococcus faecalis* (14%), while the rest were *E.coli* (9.43%), *S. hyicus* (4.72%), *Gallibacterium anatis* (2.83%), *Trueperella pyogenes* (1.88%) and *Aerococcus urinaeequi* (0.94%).

10. Prevention

Control of ventilation program and reverse the wet litter condition. Feeds should have optimum amino acid density but minimum crude protein levels, which can be achieved using digestible and synthetic amino acids (Bilgili et al., 2010). Adding high levels of biotin or zinc to the diet can reduce the development and severity of FPD in turkeys on dry litter. The results of several experiments indicate that the optimal level of crude protein, biotin and electrolytes (Na, K) in the diet, as well as feed additives such as feed enzymes hydrolyzing non-starch polysaccharides and organic sources of microelements (zinc) may reduce the litter moisture as well as FPD incidence and severity in broiler chickens and turkey. Genetic selection against footpad dermatitis would contribute to reducing any pain and suffering for a particular bird experiencing contact dermatitis.

11. Conclusion

Footpad dermatitis can be considered as a threat for poultry production due to it causes losses due to condemnation in slaughterhouse. The condition is produced by multifactorial and bacterial infections can be associated. Prevention depends mainly on improvement of litter condition. So, good hygiene is recommended to minimize losses due to FPD in chickens.

12. Declarations

12.1. Availability of data

All data collected in this review are included in this published article.

12.2. Competing interests

The author declares that they have no competing interests.

References

Abd El-Wahab, A., Visscher, C.F., Beineke, A., Beyerbach, M., & Kamphues, J. (2012). Experimental studies on the effects of different litter moisture contents and exposure time to wet litter on development and severity of foot pad dermatitis in young fattening turkeys. *Archiv für Geflügelkunde*, *76*, 55-62.

Ask, B. (2010). Genetic variation of contact dermatitis in broilers. *Poultry Science* , 89: 866- 875. doi.org/10.3382/ps.2009-00496

Bean, C., Jacobson, J.B., & Ryan, S. (2007). Peoples republic of poultry and products chicken paw, wing and wing tip exports to China 2007 (gain report CH7006). *Beijing: Global Agriculture Information Network;* 2007. https://apps.fas.usda.gov/gainfiles/200702/146280147.pdf

Berg, C. (2004). Pododermatitis and hock burn in broiler chickens Measuring and Auditing Broiler Welfare, *CABI Publishing, Wallingford*, UK, pp 37- 49.

Bilgili, S. F., Hess, J. B., Donald, J. & Fancher, B. (2010). Practical considerations for reducing the risk of pododermatitis.

Aviagen Brief, September 2010.

Cengiz, O., Hess, J.B., & Bilgili, S. F. (2013). Effect of protein source on the development of foodpad dermatitis in broiler chickens reared on different flooring types. *Archiv für Geflügelkunde, 77*, 166-170.

Chen, J., Tellez, G., & Escobar, J. (2016). Identification of Biomarkers for Footpad Dermatitis Development and Wound Healing. *Frontiers in Cellular and Infection Microbiology, 6,* 26. Published online 2016 Mar 4. doi: 10.3389/fcimb.2016.00026

Da Costa, M. J., Grimes, J.L., Rondón, E.O., Barasch, I., Evans, C., Dalmagro, M., & Nixon, J. (2014). Footpad dermatitis severity on Turkey flocks and correlations with locomotion, litter conditions and body weight at market age. *Journal of Applied Poultry Research, 23* (2), 268- 279. doi: 10.3382/japr.2013-00848.

Dinev, I., Denev, S., Vashin, I., Kanakov, D., & Rusenova, N, (2019). Pathomorphological investigations on the prevalence of contact dermatitis lesions in broiler chickens. *Journal of Applied Animal Research, 47* (1), 129-134. doi: 10.1080/09712119.2019.1584105

Dullius, A.P., Espinha, L.P., Lazzari, M., Pacheco, P.S., Vale, M.M., Pedro, D., Gabriel Dallazen Machado, G.D., & Santos , M.A.J. P. (2011). Incidência de pododermatite em frangos de corte das Linhagens Ross e Cobb. *Anais do 38º Conbravet - Congresso Brasileiro de Medicina Veterinária*; 2011; Florianópolis, Santa Catarina. Brasil. http://www.sovergs.com.br/BKP/site_/38conbravet/resumos/408.pdf

EFSA (2010). Panel on Animal Health and Welfare (AHAW): Scientific Opinion on the influence of genetic parameters on the welfare and the resistance to stress of commercial broilers. *European Food Safety Authority J., 8* (7), 1666. (82 pp). doi/10.2903/j.efsa.2010.1666.

Ekstrand, C., & Algers, B. (1997). Rearing conditions and foot-pad dermatitis in Swedish broiler chickens. *Preventive Veterinary Medicine, 31*, 167-174.

Ekstrand, C., Carpenter, T.E., Andersson, I., & Algers, B. (1998). Prevalence and control of foot pad dermatitis in Sweden. *British Poultry Science*, 39, 318-324.

Greene, J. A., McCracken, R. M., & Evans, R. T. (1985). A contact dermatitis of broilers-Clinical and pathological findings. *Avian Pathology*, *14,* 23- 38. doi:10.1080/03079458508436205

Harms, R.H., & Simpson, C.F. (1975). Biotin deficiency as a possible cause of swelling and ulceration on footpads. *Poultry Science, 54* (5), 1711-1713. doi:10.3382/ps.0541711

Hess, J.B., Bilgili, S.F., Dozier, W.A., Lien, R.J., & Blake, J.P. (2011). Efeito do Manejo da água e tratamento de cama nas lesões de patas e dermatitis. *Anais da Conferência Facta 2011 de Ciência e Tecnologias Avícolas*; Santos, São Paulo. Brazil. Campinas: Facta; 2011. pp: 85- 90.

Hocking, P.M., & Wu, K. (2013). Traditional and commercial turkey show similar susceptibility to foot pad dermatitis and behavioural evidence of pain. *British Poultry Science, 54*, 281-288. doi:10.1080/00071668.2013.781265

Jacob, F.G., Baracho, M.S., Naas, I.A., Souza, R., & Lima, N.D. (2015). Influência da linhagem e na incidência de pododermatite em frangos de corte. *Proceedingos of the 1º Workshop Internacional de Ambiência de Precisão*; Campinas, São Paulo. Brasil, May, 2015.

Jensen, L. S., Martinson, R. & Schumaier, G. (1970). A foot pad dermatitis in turkey poults associated with soybean meal. *Poultry Science, 49*, 76-82. doi:10.3382/ps.0490076

Kapell, D.N.R.G., Hill, W., Neeteson, A.M., McAdam, J., Koerhuis, A.N.K., & Avendano, S. (2012). Genetic parameters of foot-pad dermatitis and body weight in purebred broiler lines in 2-contrasting environments. *Poultry Science, 91*, 565-574. doi:10.3382/ps.2011-01934

Kaukonen, E., Norring, M., & Valros, A. (2016). Effect of litter quality on foot pad dermatitis, hock burns and breast blisters in broiler breeders during the production period. *Avian Pathology, 45,* 667–673. https://doi.org/10.1080/03079457.2016.1197377

Kjaer, J.B., Su, G., Nielsen, B.L., & Sorensen, P. (2006). Foot pad dermatitis and hock burn in broiler chickens and degree of inheritance. *Poultry Science, 85*, 1342-1348. https://doi.org/10.1093/ps/85.8.1342

Kyvsgaard, N.C., Jensen, H.B., Ambrosen, T., & Toft, N. (2013). Temporal changes and risk factors for foot-pad dermatitis in Danish broilers. *Poultry Science*, *92*, 26-32. https://doi.org/10.3382/ps.2012-02433

Martins, B.B., Martins, M.R.F.B., Mendes, A.A., Fernandes, B.C.S., & Aguiar, E. F. (2016). Footpad Dermatitis in Broilers: Differences between Strains and Gender. *Brazilian J. of Poult. Sci.*, *18*(3), 461-466. https://doi.org/10.1590/1806-9061-2015-0105.

Martland, M. (1985). Ulcerative dermatitis dm broiler chickens: the effects of wet litter. *Avian Pathology, 14,* 353–364. https://doi.org/10.1080/03079458508436237

Mayne, R.K. (2005). A review of the aetiology and possible causative factors of foot pad dermatitis in growing turkeys and broilers. *World's Poultry Science Journal, 61,* 256-267. https://doi.org/10.1079/WPS200458

McFerran, J.B., McNulty, M.S., McCracken, R.M., & Greene, J.A. (1983). Enteritis and associated problems. *Proc. International Union of Immunological Societies: Disease Prevention and Control in Poultry Production*. No. 66, University of Sydney, Australia: pp 129- 138.

Meluzzi, A., Fabbri, C., Folegatti, E., & Sirri, F. (2008). Survey of chicken rearing conditions in Italy: effects of litter quality and stocking density on productivity, foot dermatitis and carcass injuries. *British Poultry Science, 49*(3), 257-264. https://doi.org/10.1080/00071660802094156

Nagaraj, M., Wilson, C. A. P. , Hess, J. B., & Bilgili, S. F. (2007). Effect of high protein and all vegetable diets on the incidence and severity of pododermatitis in broiler chickens. *Journal of Applied Poultry Research*, *16,* 304-312. https://doi.org/10.1093/japr/16.3.304

NCC. National Chicken Council (2010). Animal Welfare Guidelines and Audit Checklist for Broilers, Washington, D.C. Available at: http://www.nationalchickencouncil.org/wp-content/uploads/2012/01/NCC-Animal-Welfare-Guidelines-2010-RevisionBROILERS.pdf .

Nowaczewski, S., Rosinski, A., Markiewicz, M., & Kontecta, H. (2011). Performance, foot-pad dermatitis and haemoglobin saturation in broiler chickens kept on different types of litter. *Archiv für Geflügelkunde*, *75*, 132-139.

Olsen, R.H., Christensen, H., Kabell. S. & Bisgaard, M. (2018). Characterization of prevalent bacterial pathogens associated with pododermatitis in table egg layers. *Avian Pathology, 47* (3), 281-285. https://doi.org/10.1080/03079457.2018.1440066

Pagazaurtundua, A., & Warriss, P.D. (2006). Measurements of footpad dermatitis in broiler chickens at processing plants. *Veterinary Record, 158*, 679- 682. https://doi.org/10.1136/vr.158.20.679

Pattison, M. (1987). Problems of diarrhoea and wet litter in meat poultry. In: Harsign, W., Cole, D.J.A, editors. *Recent advances in animal nutrition* (pp. 27–37), London: Butterworths.

Sarica, M., Yamak, U. S., & Boz, M. A. k. (2014). Effect of production systems on foot pad dermatitis (FPD) levels among slow-, medium- and fast-growing broilers. *European Poultry Science, 78*. doi: 10.1399/eps.2014.52

Shepherd, E.M., & Fairchild, B.D. (2010). Footpad dermatitis in poultry. *Poultry Science,* 89, 2043-2053. Doi:10.3382/ps.2010-00770

Thøfner, I.C.N., Poulsen, L.L., Bisgaard, M., Christensen H., Olsen R.H., & Christensen J. P. (2019). Correlation between footpad lesions and systemic bacterial infections in broiler breeders. *Veterinary Research, 50*, 38. doi:10.1186/s13567-019-0657-8

Wilcox, C.S., Patterson, J., & Cheng, H.W. (2009). Use of thermography to screen for subclinical bumblefoot in poultry. *Poultry Science, 88*, 1176–1180. Doi: 10.3382/ps.2008-00446

Wyneken, C.W., Sinclair, A., Veldkamp, T., Vinco, L.J., & Hocking, P.M. (2015). Footpad dermatitis and pain assessment in Turkey poults using analgesia and objective gait analysis. *British Poultry Science,* 5, 522-530. https://dx.doi.org/10.1080%2F00071668.2015.1077203

Xavier, D.B., Broom, D.M., McManus, C.M.P. , Torres, C., & Bernal, F.E.M. (2010). Number of flocks on the same litter and carcase condemnations due to cellulitis, arthritis and contact foot-pad dermatitis in broilers. *British Poultry Science, 51*, 586- 591. https://doi.org/10.1080/00071668.2010.508487 .