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THE USE OF INFRARED THERMOGRAPHY IN THE IDENTIFICATION OF PODODERMATITIS IN BROILERS

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ABSTRACT: International trade in broiler' feet, mainly to Asian markets, has demanded better quality control. The objective of this research was to study the suitability of using chicken footpad surface temperature to determine early lesions of pododermatitis. The project was conducted in two houses A1 and A2) in a commercial farm during one production flock. A1 had reused litter of wood shavings and rice hulls, and A2 had a new litter of sawdust. Both houses had positive pressure ventilation. The inner area of the poultry was virtually divided into three quadrants. The footpads were checked for the feet quality, and a degree of pododermatitis was awarded. Thermal images were made to test the surface temperature of the foot and identify inflammation in a total of 30 birds per house, at ages 5, 19, 29, 28 and 40 days of grow-out. Conditions of the rearing environment as well as the surface temperature of the litter, litter moisture, and degree of compression, were recorded. The environment within the houses did not differ. The surface temperatures of the footpad did not differ between the groups. The minimum footpad surface temperatures within the scores were similar, except for the score 3, which did not occur in A1. There was a prevalence of severe injury in the house with a new litter.

KEYWORDS: rearing ambient, sub-clinical lesions, thermal image

USO DA TERMOGRAFIA INFRAVERMELHO NA IDENTIFICAÇÃO DE PODODERMATITE EM FRANGO DE CORTE

RESUMO: O comércio internacional de pés de frangos, sobretudo para os mercados asiáticos, demanda maior controle de qualidade. O objetivo da pesquisa foi estudar o uso de temperatura superficial dos pés de frangos de várias idades, para identificar a presença de lesões de pododermatite. O projeto foi feito em dois galpões de uma granja comercial durante um lote. Os aviários eram similares (A1 e A2). A1 tinha cama reusada de maravalha e casca de arroz e A2, cama nova de pó de serra. Os aviários tinham ventilação de pressão positiva. A área interna dos aviários foi dividida em três quadrantes. Os coxins foram checados para avaliara a qualidade dos pés sendo atribuído o grau de pododermatite. Imagens térmicas foram feitas para testar a temperatura superficial do pé e identificar a lesão em 30 aves por aviário nas idades de 5; 19; 29; 28 e 40 dias. Foram registradas a ambiência do alojamento, a temperatura da cama e sua compactação. O ambiente dos aviários não diferiu. As temperaturas superficiais dos pés das aves não diferiram entre os grupos. As temperaturas superficiais mínimas dentro dos escores eram similares, com exceção do escore 3, que não teve em A1. Houve prevalência de mais injúrias severas no aviário com cama nova.

PALAVRAS-CHAVE: ambiente de alojamento, imagem térmica, lesões subclínicas.

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INTRODUCTION

Broilers' feet has conquered new markets, especially in Asia, for instance in China and Hong Kong (BEDUTTI, 2011). Considering this growth in demand feet are already the third trait that has economic value, as the first are the breast and the wings. Broiler feet have generated a profit of 280 million dollars a year just in the United States (US SPEC, 2009). The fast-growing chickens usually have the welfare condition compromised, as older birds tend to present weakness in gait behavior due to the unbalanced breast weight (ALMEIDA PAZ et al., 2009). The industrial broiler rearing environment does not allow the birds' to deal appropriately with the thermal regulation process that leads to induce them to heat stress (PONCIANO et al., 2011).

The litter used in the housing system is one of the leading causes of pododermatitis. The excreta fermentation associated with the large flock density adopted in most houses affect broiler health, decrease gait ability and might lead to carcass condemnation. Litter quality might also induce feet lesions (pododermatitis) affecting the birds well-being. Feet lesion influence bird locomotion that might become unsound leading to reduction of feed and water intake, and consequent weight loss and pain are found during severe cases of pododermatitis (SCHMIDT & LUDERS, 1976; EKSTRAND et al., 1998; MARTRENCHAR et al., 2002; DAWKINS et al., 2004; BILGILI et al., 2009; HOFFMANN et al., 2013). Although Brazilian norms adopt other criteria for welfare audit (BRASIL, 1992), in the United States of America (USA), and the European Union (EU) the use of the degree of pododermatitis as a parameter for auditing broiler well-being in the slaughter-house is already used (NCC, 2010).

Infrared thermography is a non-invasive technique that allows the visualization of the thermal profile of heat emitting object (WESCHENFELDER et al., 2013; NÄÄS et al., 2014). The animal surface temperature can be registered by the amount of infrared radiation the surface exchange with the environment, which is transformed into a thermal image (DENOIX, 1994; TESSIER et al., 2003). Current literature indicates the use of infrared thermography for diagnostics of heat stress as well as for detecting subclinical pathologies (NIKKHAH et al., 2005; SCHAEFER et al., 2004; GRACIANO et al., 2014).

This research aimed to investigate the suitability of using the broiler footpad surface temperature of various ages for determining the incidence of pododermatitis, and also to assess the presence of early lesions.

MATERIAL AND METHODS

The study was carried out in two commercial broiler houses at the Cooperativa Holambra, located at a latitude 22º 34'23" S; longitude 47º 10'21" W and an altitude of 650 m. The regional climate is characterized as a tropical climate of altitude with a rain season during the summer and dry season in winter. The mean local upper temperature is higher than 22 °C.

Husbandry and experimental procedure

The houses had dimensions of 108 m long, 10.5 m wide, and a height of 3 m. The roof had fiber-cement tiles, and the side curtains were made of yellow polypropylene. The flock density was 12 birds m^{-2}.

The houses were divided into three quadrants. The first was in the air inlet, the second in the center of the house, and the third in the air outlet. In the geometric center of each quadrant, the following variables were registered during 40 days using a data logger (Hobo, MicroDaq Ltd., New Hampshire, USA), dry bulb temperature (Tbs, ºC), relative humidity (UR, %), and wind speed (VA, m s^{-1}). Litter surface temperature (Tc, ºC) was registered using an infrared camera (Testo 882, Testo Instruments, Lenzkirch, Germany), with high resolution (320 x 240 pixels). The litter degree of compression (Comp., kg cm^{-2}) was measured using a portable penetrograph (Model FT 327, Wagner Instruments, Greenwich, England). The litter humidity was determined along with the other recordings. The sampling occurred in the three quadrants of each flock in each house (n=360). A volume of the litter was placed in a plastic bag, and the humidity was determined by weighing the

sample before and after the sample is dried at 105 ºC (BRASIL, 1992). The litter humidity was calculated as shown in [eq. (1)].

$$Litter\ humidity(\%) = \frac{(Initial\ weight - Final\ weight).100}{Initial\ total\ weight - Initial\ net\ weight} \quad (1)$$

Data were recorded during two flocks in two houses (A1 and A2). Both houses had positive forced ventilation. A1 had reused litter (wood shavings) while A2 had a new litter (sawdust).

For assessing the degree of pododermatitis 30 broiler were observed (10 birds in each quadrant) during the 5th, 19th, 29th, and 40th days of grow-out, and scored. For scoring the feet in each house quadrant, ten broilers were captured (n=30 in each flock, 60 in total). Each captured bird had the footpad surface temperature registered to assess the degree of lesion and inflammation. The infrared camera was positioned at 1 m distance from the target, and the adopted emissivity of skin was 0.95, and 0.91 for the litter (CANGAR et al., 2008; NÄÄS et al., 2010).

The degree of pododermatitis was estimated visually (FIGURA 1) using a 0 to 3 scale. The score 0= no lesion; score 1=birds with a lesion in less than 50% of the feet area; score 2=birds with an area of injury of 50-100% of the feet; and score 3=birds with 100% of the feet area with lesions (HASHIMOTO et al., 2011).

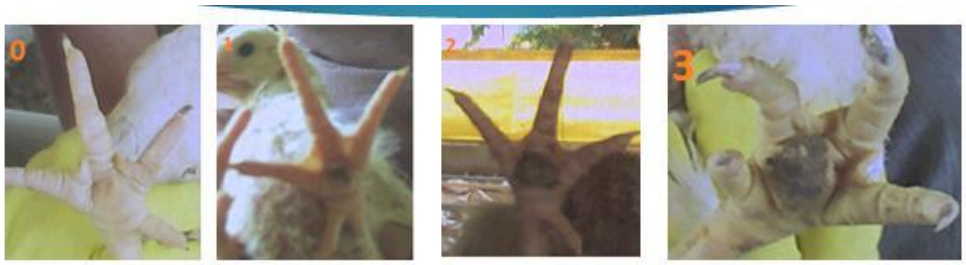


FIGURE 1. The visual image of the pododermatitis score in field conditions (HASHIMOTO et al., 2011).

Data analysis

The data from the environment were organized, and the mean values were compared. Broiler feet surface temperature was evaluated using five points randomly selected in each footpad in the image generated by the camera software (Testo Software, Testo Instruments, Lenzkirch, Germany). The maximum (Tspe max) and minimum values (Tspe min) were separated. Mean values were calculated and compared using t-Student test using a confidence level of 95%.

The degree of pododermatitis was interpreted as a discrete random variable, and the interactions between the degree of pododermatitis, bird age, and the feet surface temperature were tested with the Kruskal-Wallis test adopting a confidence level of 95% (HASHIMOTO et al., 2011).

For the statistical calculation, the software Minitab® v.1.5 (Minitab, Inc., State College, PA, USA) was used.

RESULTS AND DISCUSSION

Dry bulb temperature, relative humidity, and wind speed did not differ ($p > 0.05$) between the A1 and A2 (TABLE 1). The values of litter moisture and degree of compression also did not differ ($p > 0.05$). Both litter humidity and degree of compression are reported as probable causes for the

incidence of pododermatitis in broilers (BILGILI et al., 2009). The feet surface temperature values were also similar ($p > 0.05$), as seen in TABLE 2.

TABLE 1. Mean data and standard deviation of the rearing ambient of studied houses.

House	Tbs (ºC)	SD	UR (%)	SD	Va (m/s)	SD
A1	29.02	1.35	70.20	10.34	0.86	0.43
A2	29.16	1.21	64.20	9.87	0.69	0.33

Tbs=dry bulb temperature; UR=air relative humidity, Va=Wind speed. n=245. SD=standad deviation.

TABLE 2. Mean data and standard deviation of litter surface temperature and humidity and surface temperature of broilers' feet in the studied houses.

House	T_{litter} (ºC)	SD	Ul_{itter} (%)	SD	Comp (kg cm^{-2})	SD	Tspe (ºC)	SD
A1	29.53	1.37	21.66	3.22	21.30	4.75	36.0	1.30
A2	29.18	1.27	24.07	3.43	17.10	4.24	35.9	1.43

(T_{litter}=litter temperature, n=360; U_{litter}=litter humidity, n=360; Comp=litter degree of compression, n=245); (Tspe=foot surface temperature, n=1800); SD= standard deviation.

The mean and minimum footpad surface temperature of broilers within the scores 0, 1, and 2 did not differ ($p > 0.05$), as shown in FIGURE 2. The feet minimum surface temperature (Tspe) are those that indicate the necrosis in the central footpad area. The surface temperature decreases as an indication of insufficient blood circulation. The minimum footpad surface temperature did not differ within the scores when comparing the Tspe of the broilers from the two houses. The exception was the score 3 that did not occur in A1 (FIGURE 2). Authors indicate that the broiler feet lesions are a direct consequence of the litter fermentation and increase in temperature and decrease in pH, which are the characteristics associated with the reuse of the litter (BILGILI et al., 2009; MENDES et al., 2012). In the present study, the most severe footpad lesion was found in the house with new litter, probably due to the granulometry of the substrate. More tips and pointy corners are often found in new substrate leading to scratch the feet skin of chicks and developing lesions later on during the grow-out period (BILGILI et al., 2009).

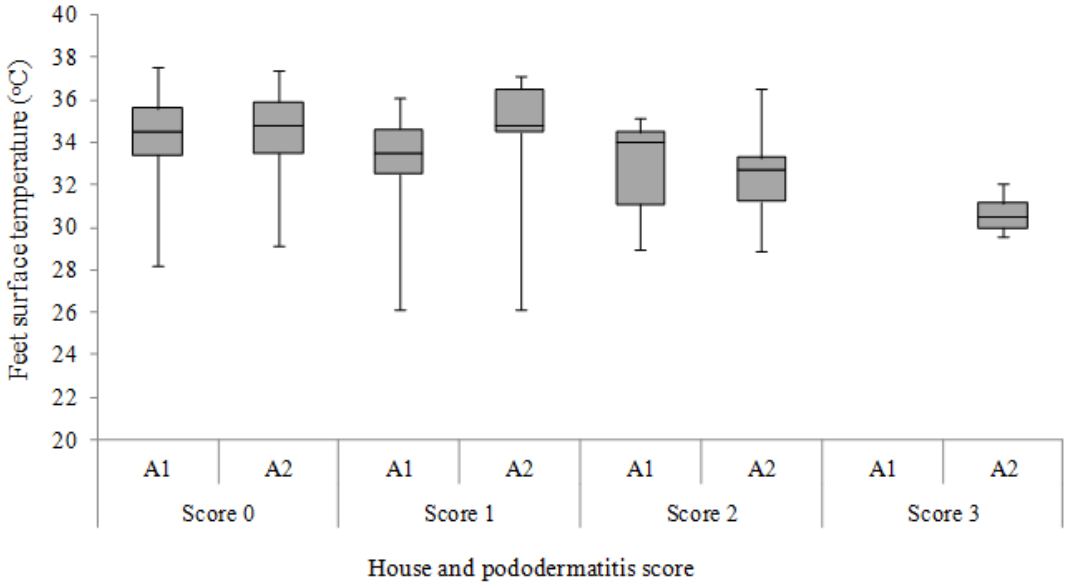
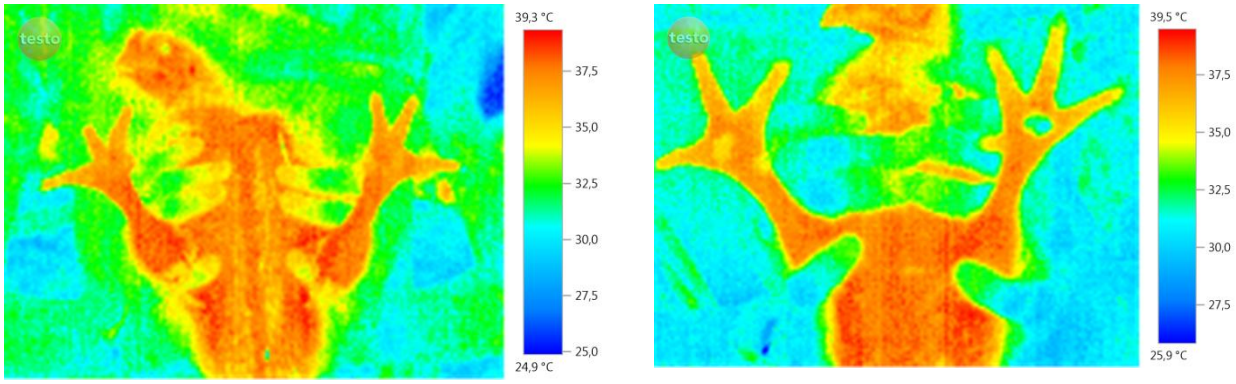


FIGURE 2. Minimum broiler feet surface temperature in each pododermatitis score in each studied house.

It was verified that broilers without footpad lesions presented feet with uniform surface temperature (FIGURE 3a) while broilers that presented pododermatitis had points in the footpad

with low surface temperature indicating tissue necrosis (FIGURE 3b). Broilers with pododermatitis degree 1 to 3 had a substantial decrease in the surface temperature in the center of the lesion (FIGURE 3b) when compared to sound footpad (FIGURE 3a). For instance, a broiler 32 days old with a degree 3 of pododermatitis had a minimum feet surface of 32.5 ºC in the center of the lesion, while another broiler with sound footpad had a surface temperature of 37.5 ºC. The inflammation is a cellular, humoral and vascular response that enhances the protection of the skin (COELHO, 2002). The clinical signs are an increase in the vascularization, increased heat production, and pain in the affected area. The results of the footpad with lesion is the impairment of the locomotion leading to pain and discomfort. When the injury and the gait impairment are severe, a consequence might be the presence of hyperkeratosis in the footpad area (SHEPHERD & FAIRCHILD, 2010).

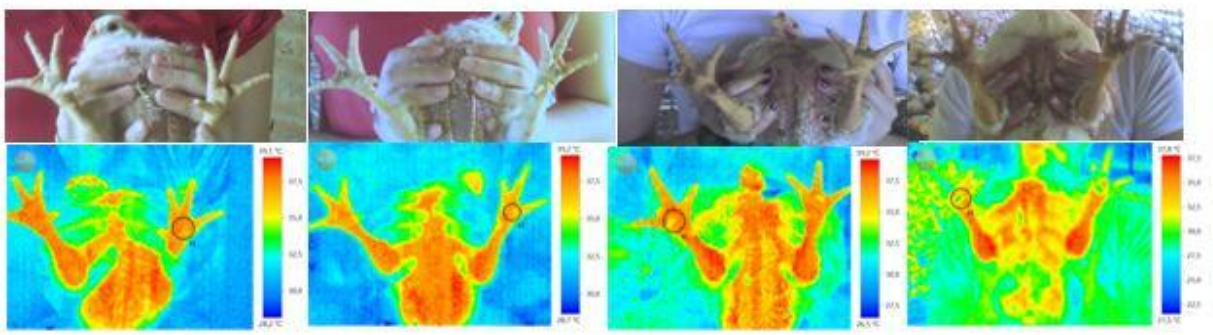
Results of the Kruskal-Wallis test indicated that the incidence of pododermatitis increased with the age of the broilers ($p \leq 0.05$), showing a higher frequency of the condition between 18 to 20 days of grow-out. BILGILI et al. (2006) also found similar results in an experiment with 21 days old broilers and increasing proportionally to the slaughter age. Several authors indicate that the presence of pododermatitis is directly related to the litter humidity and degree of compression (BILGILI et al., 2009; SHEPHERD & FAIRCHILD, 2010; MENDES et al., 2012; MARTINS et al., 2013). However, in the present study, no correlation was found between the lesion and the litter studied characteristics.



a b

FIGURE 3. Bird with score 0 of pododermatitis (a) and bird with score 2 of pododermatitis (b).

The Kruskal-Wallis test results showed a correlation between the degree of the lesion and the footpad surface temperature ($p \leq 0.05$). It was also found that as the feet surface temperature decreases (indicating the presence of necrosis) the degree of pododermatitis also increases ($p \leq 0.05$), mainly in the scores 2 and 3 (FIGURE 4).



0 **1** **2** **3**

FIGURE 4. Comparison between the visual identification of pododermatitis and the identification using infrared thermography for the same scores described by HASHIMOTO et al. (2011).

The identification of inflammatory conditions in horses, swine, and dairy cows using thermal infrared images are well documented in the literature (DENOIX, 1994; GLOSTER et al., 2011; GRACIANO et al., 2014; NÄÄS et al., 2014). There is also an indication of the use of infrared thermography for determining heat exchange in broilers (YAHAV et al., 2004; NÄÄS et al., 2010, NASCIMENTO et al., 2014). In the current study, it was possible to use the broiler footpad surface temperature to identify the clinical and sub-clinical footpad lesion allowing transposing the visual score to the use of infrared images and making the evaluation more accurate.

CONCLUSIONS

It was possible to improve the accuracy of the diagnosis of footpad dermatitis in broilers using infrared thermography since the technology detects the footpad lesion before the visual diagnosis.

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