ANIMAL WELL-BEING AND BEHAVIOR

Investigation of the prevalence and severity of foot pad dermatitis at the slaughterhouse in fattening turkeys reared in organic production systems in Germany

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ABSTRACT The present study shows the prevalence and severity of foot pad dermatitis (FPD) in turkeys reared in organic production systems assessed at slaughterhouses in Germany. The investigations of altogether 1,860 turkeys of the strains Kelly Broad Breasted Bronze (Kelly BBB; 540 toms, 540 hens) and British United Turkeys (B.U.T.) 6 and the Test Product 7 (TP 7; 780 hens) showed that 97.7% of the examined turkeys were diagnosed with different degrees of FPD. Only 4.6% of the toms and 1.3% of the hens had feet without lesions. Most frequent were necrotic lesions measuring up to 2 cm in diameter (64.3% of all turkeys). Extensive necrotic lesions of the foot pads (toms: 29.8%; hens: 12.4%) and necrosis of superficial scales (toms: 11.3%; hens: 7.6%) were less frequent. Plantar abscesses were rare findings (1.9%). In general, the feet of the Kelly BBB hens were more affected by foot pad lesions than those of the Kelly BBB toms. There were significant differences between the investigated flocks concerning the occurrence of foot pad lesions. The aim in rearing turkeys must be the reduction of FPD.

Key words: organic poultry farming, fattening turkeys, foot pad dermatitis, animal welfare, husbandry conditions

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INTRODUCTION

Foot pad dermatitis (**FPD**), also known as plantar pododermatitis, is a condition characterized by lesions on the foot pads of poultry. The lesions vary from hyperkeratosis to severe erosions and ulceration (Clark et al., 2002; Mayne et al., 2004; Shepherd and Fairchild, 2010). These alterations may appear in the first few days of life, but more severe lesions are mostly seen during the fattening period (Mayne et al., 2006; Bergmann et al., 2013). The lesions can heal rapidly by secondary intention (Platt et al., 2004; Mayne et al., 2007). Generally, the plantar area of the foot and the weight bearing metatarsal pads are mostly affected. Several predisposing factors such as genetic line, rapid growth, feed, stocking density, litter quality, and diet composition have been discussed (Martrenchar et al., 1999; Hafez et al., 2005; Mayne, 2005; Rudolf, 2008; Youssef et al., 2011; Krautwald-Junghanns et al., 2013; Kamphues et al., 2014; Erasmus, 2017). Above all, high litter moisture is considered to be the main cause for FPD (Martland, 1984; Mayne et al., 2007; Abd El-Wahab et al., 2011; Wu and Hocking 2011; Vinco et al., 2017a). Foot pad dermatitis commonly occurs in fattening turkeys (Huff et al., 2000; Hafez et al., 2004a; Hafez et al., 2004b; Bergmann, 2006; Shepherd and Fairchild, 2010; Krautwald-Junghanns et al., 2013). Not only turkey flocks reared under conventional husbandry

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conditions are affected, but also flocks reared in organic poultry farming systems (Hocking and Wu, 2013).

These alterations are potentially painful and can, therefore, be used as indicators of animal welfare (Watanabe et al., 2013; Sinclair et al., 2015; Weber Wyneken et al., 2015). Since the amendment of the German Animal Welfare Act of 2013 July 13, animal caretakers are required to self-monitor with the help of appropriate animal welfare indicators (Federal Republic of Germany, 2017). Consequently, this is a means of evaluating and comparing different poultry farms. Establishing a precautionary monitoring system would allow an early detection of husbandry and management failures. It has to be non-extensive and easy to perform under field conditions. Several approaches to assess turkey welfare at the slaughterhouse are available and described (Hocking et al., 2008; Hocking et al., 2008; Allain et al., 2013). One of the most important innovations was the implementation of a health control program as a benchmarking system to ensure valid comparability of the poultry farms (Putenerzeuger, 2013; Andersson and Toppel, 2014).

Currently, there are only a few studies published related to rearing requirements of organic turkey farms and its potential effect on animal health, performance, and prevalence of FPD (Ermakow, 2012; Hocking and Wu, 2013; Habig et al., 2017).

The aim of the present study was to evaluate the prevalence and severity of foot pad lesions in turkeys reared in organic production systems at the slaughterhouse with special attention to stocking density, fattening duration, gender, and strain.

MATERIAL AND METHODS

Animals

All investigations were carried out exclusively postmortem at slaughterhouses in Germany officially approved for slaughter of fattening turkeys.

In total, 12 organic turkey farms were investigated. Five farms reared both sexes of a medium weighted turkey strain with colored plumage and melanized scales on the legs and feet (Kelly Broad Breasted Bronze [**Kelly BBB**]) and seven farms reared hens of heavy weighted white feathered turkeys (supplied by Aviagen Turkeys; 5× British United Turkeys [**B.U.T.**] 6 and 2× Test Product 7 [**TP 7**]). For the evaluation, the results of all Aviagen hens were pooled since only two TP 7 farms were investigated and in principle comparable results concerning health and performance parameters can be expected (Simon, 2016). The investigations covered with two exceptions (farms 2 and 9): two flocks of each farm in two successive fattening periods; one during the summer months and one during winter time. In total 31 flocks (B.U.T. 6 or TP 7 hens: $n = 13$, the Kelly BBB hens: $n = 9$, and Kelly BBB toms: $n = 9$), were investigated.

All participating farms follow the legal requirements concerning organic farming that are determined by the Commission Regulation (EC) No 889/2008, laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labeling of organic products with regard to organic production, labeling, and control (European Commission, 2008).

Data Assessment at the Processing Plant

The scoring of the foot pads was carried out at the processing plant directly after slaughter. Three slaughterhouses across Germany were involved. The examinations were carried out by two observers with the help of a data entry form. A joint training at the slaughterhouse in the run up of the project ensured consistent evaluations.

From each flock, 60 random samples (both feet) were taken and scored. Depending on the speed of the slaughter line, every fifth to tenth turkey was investigated. In total, 1,860 fattening turkeys from 31 flocks were investigated (Kelly BBB toms: $n = 540$; Kelly BBB hens: $n = 540$; and B.U.T. 6 or TP 7 hens: $n = 780$).

The scoring of the foot pad health followed the same scoring system as described by Krautwald-Junghanns et al. (2011). It is designed in compliance with that evolved by Clark et al. (2002). The score consists of five categories as follows:

- score 0: surface of the skin of the foot pads without alterations, reticular scales regular developed, covering the whole plantar skin
- score 1: minimal alterations, several necrotic scales
- score 2: moderate alterations, necrotic lesions up to 2 cm in diameter, ablation of the horny layer of the epidermis
- score 3: pronounced alterations, necrotic lesions over 2 cm in diameter, deep lesions of the plantar skin. Extensive ablation of the epidermis with crater formation
- score 4: plantar abscess

Additional information about the flock-related data (average weight, age, strain, and sex) from the day of slaughter was collected (Tables 4 and 5).

Statistical Analysis

Statistical analysis of the data was done with IBM SPSS Statistics 22. If the double-sided P-value was lower than 0.05 results were considered as significant. For the prevalence rates of foot pad lesions a 95% confidence interval (**CI**) was calculated. Since the collected data are a random sample from the true population the CI provides a range of values for estimating the unknown population parameter. The interval limits comprise in 95% of all cases the true parameter of the whole population.

Table 1. Prevalence of foot pad lesions in organic Kelly Broad Breasted Bronze (Kelly BBB) toms and hens and British United Turkeys (B.U.T.) 6 or Test Product 7 (TP 7) hens at the processing plant. Numerical data in parentheses are 95% confidence interval (CI).

Turkey lineand sex	Number	Foot pad dermatitis (FPD) score				
		0	1	2	3	4
Kelly BBB toms* ($n = 540$)	(n)	25	61	286	161	7
	(%)	4.6 (3.4, 5.9)[a]	11.3 (9.4, 13.2)[a]	53.0 (50.0, 56.0)[a]	29.8 (27.1, 32.5)[a]	1.3 (0.6, 2.0)[a]
Kelly BBB hens*# ($n = 540$)	(n)	10	66	316	120	28
	(%)	1.9 (1.1, 2.7)[b,c]	12.2 (10.3, 14.2)[a,c]	58.5 (55.6, 61.4)[a,c]	22.2 (19.7, 24.7)[b,c]	5.2 (3.9, 6.5)[b,c]
B.U.T. 6 or TP 7 hens# ($n = 780$)	(n)	7	34	594	144	1
	(%)	0.9 (0.4, 1.4)[c]	4.4 (3.4, 5.4)[d]	76.2 (74.0, 78.4)[d]	18.5 (16.5, 20.5)[c]	0.1 (0.0, 3.1)[d]

*Significance regarding sex ($P = 0.00$).
#Significance regarding strain ($P = 0.24$).
[a,b]Means within each FPD score of Kelly BBB toms and Kelly BBB hens lacking a common superscript differ significantly ($P < 0.05$).
[c,d]Means within each FPD score of Kelly BBB hens and B.U.T. 6 or TP 7 hens lacking a common superscript differ significantly ($P < 0.05$).

Testing the functional relationship between the target value (FPD) and potentially influencing factors (sex, age, strain, body weight, and stocking density) was done with multivariable ordinal logistic regression. This is used to analyze the potential effect of the independent variables (influencing factors) on the dependent variable (FPD).

For analyzing the differences between males and females, only the results of the Kelly BBB flocks were included. Concerning the differences between the genetic lines, only the results of the female flocks were analyzed.

RESULTS

Nearly all examined turkeys showed some degree of FPD (97.7% [95% CI: 97.0, 98.4]). On the other hand, only 4.6% [95% CI: 3.4, 5.9] of the Kelly BBB toms, 1.9% [95% CI: 1.1, 2.7] of the Kelly BBB hens, and 0.9% [95% CI: 0.4, 1.4] of the B.U.T. 6 or TP 7 hens had no alterations of the foot pads (Table 1). All investigated flocks were affected to some extent (Tables 2 and 3).

The statistical comparison of the left and right foot concerning FPD revealed a positive correlation between both feet (Spearman correlation: $r = 0.626$, $P \leq 0.01$), so there was no considerable difference between both feet. Consequently, only the left foot was included in further calculations.

Generally, hens were significantly more often and more severely affected than the toms ($P \leq 0.05$) (Table 1). Hens showed fewer feet without any alterations (score 0) and more frequently plantar abscesses (score 4) than toms. Necrotic lesions measuring >2 cm in diameter or deep lesions (score 3) were found more often in Kelly BBB toms than in Kelly BBB hens (hens: 22.2% [95% CI: 19.7, 24.7], toms: 29.8% [95% CI: 27.1, 32.5]).

There was a significant relation between the stocking density (birds/m^2) on the day of slaughter and the occurrence of FPD ($P \leq 0.01$) analyzing the total data of all investigated turkey flocks or the data of female flocks (Tables 4 and 5). For the toms exclusively, there was no significant relation between the stocking density (birds/m^2 and kg/m^2) and the occurrence of FPD (Table 5). In general, the number of birds/m^2 was higher in female flocks than in male flocks.

There were significant differences ($P \leq 0.05$) concerning the prevalence of FPD between the farms (Tables 2 and 3). In 14 out of 22 female flocks, all investigated birds were affected to some degree (Table 2). As concerns the toms, two examined flocks (flock 2 and 4) showed a prevalence of 100% of affected foot pads (Table 3).

Alterations of score 4, plantar abscesses, were rarely seen. At this point, again differences between the farms became apparent. In three farms keeping hens, foot pad alterations of score 4 could be detected in at least one flock (flocks 1, 2, 4, and 16; see Table 2).

Analyzing the results of the female flocks, there was no significant difference between the two turkey strains regarding the incidence of FPD ($P \geq 0.05$).

A higher prevalence of more severe lesions (scores 3 and 4) was found in hens and toms of Kelly BBB in comparison to the B.U.T. 6 or TP 7 hens. 76.2% [95% CI: 74.0, 78.4] of the B.U.T. 6 or TP 7 hens and still more than half of the Kelly BBB (hens: 58.5% [95% CI: 55.6, 61.4]; toms: 53.0% [95% CI: 50.2, 56.0]) showed moderate lesions (score 2) (Table 1). Foot pads without any alterations were more frequently seen in both sexes of Kelly BBB turkeys (hens: 1.9% [95% CI: 1.1, 2.7], toms: 4.6% [95% CI: 3.4, 5.9]) than in B.U.T. 6 or TP 7 hens (0.9% [95% CI: 0.4, 1.4]).

The duration of the fattening period (hens: between 17 and 23 wk of age; toms: between 22 and 24 wk) did not have a significant influence on the occurrence of FPD (Tables 4 and 5). Additionally no seasonal effects could be evidenced. There was no difference between the two fattening periods ($P \geq 0.05$).

DISCUSSION

Foot pad dermatitis is currently an important animal welfare issue. While there are many studies concerning FPD in conventional turkey farms, only a few examinations have been analyzing organic turkey production systems (Clark et al., 2002; Hafez et al., 2004b; Krautwald-Junghanns et al., 2011; Habig et al., 2017).

Table 2. Prevalence of foot pad lesions in hens from 5 organic farms rearing 9 flocks of Kelly Broad Breasted Bronze (Kelly BBB) strain ($n = 540$) and 7 organic farms rearing 13 flocks of British United Turkeys (B.U.T.) 6 or Test Product 7 (TP 7) strain ($n = 780$) at the slaughterhouse. Presentation of the percentage of foot pad dermatitis (FPD) ordered according to the farms. Numerical data in parentheses are 95% confidence interval (CI). Age is given in wk.

				FPD score				
Farm	Turkey strain	Flock age	Number	0	1	2	3	4
1	Kelly BBB	1	(*n*)	0	2	5	27	26
		20 wk	(%)	0.0	3.3	8.3	45.0	43.3
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 7.8)	(1.3, 15.3)	(32.4, 57.6)	(30.8, 55.8)
		2	(*n*)	0	0	36	23	1
		18 wk	(%)	0.0	0.0	60.0	38.3	1.7
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 0.0)	(47.6, 72.4)	(26, 50.6)	(0.0, 5.0)
2	Kelly BBB	3	(*n*)	3	30	25	2	0
		18 wk	(%)	5.0	50.0	41.7	3.3	0.0
		($n = 60$)	CI	(0.0, 10.5)	(37.3, 62.7)	(29.2, 54.2)	(0.0, 7.8)	(0.0, 0.0)
3	Kelly BBB	4	(*n*)	0	12	26	21	1
		18 wk	(%)	0.0	20.0	43.3	35.0	1.7
		($n = 60$)	CI	(0.0, 0.0)	(8.9, 30.1)	(30.8, 55.8)	(22.9, 37.1)	(0.0, 5.0)
		5	(*n*)	0	1	53	6	0
		20 wk	(%)	0.0	1.7	88.3	10.0	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 5.0)	(80.2, 96.4)	(2.4, 17.6)	(0.0, 0.0)
4	Kelly BBB	6	(*n*)	2	9	38	11	0
		21 wk	(%)	3.3	15.0	63.3	18.3	0.0
		($n = 60$)	CI	(0.0, 7.8)	(6.0, 24.0)	(51.1, 75.5)	(8.5, 28.1)	(0.0, 0.0)
		7	(*n*)	3	9	45	3	0
		19 wk	(%)	5.0	15.0	75.0	5.0	0.0
		($n = 60$)	CI	(0.0, 10.5)	(6.0, 24.0)	64.0, 86.0)	(0.0, 10.5)	(0.0, 0.0)
5	Kelly BBB	8	(*n*)	0	2	34	24	0
		20 wk	(%)	0.0	3.3	56.7	40.0	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 7.8)	(44.2, 69.2)	(27.6, 52.4)	(0.0, 0.0)
		9	(*n*)	2	1	54	3	0
		18 wk	(%)	3.3	1.7	90.0	5.0	0.0
		($n = 60$)	CI	(0.0, 7.8)	(0.0, 5.0)	(82.4, 97.6)	(0.0, 10.5)	(0.0, 0.0)
6	B.U.T. 6	10	(*n*)	0	6	52	2	0
		17 wk	(%)	0.0	10.0	86.7	3.3	0.0
		($n = 60$)	CI	(0.0, 0.0)	(2.4, 17.6)	(78.1, 95.3)	(0.0, 7.8)	(0.0, 0.0)
		11	(*n*)	3	8	48	1	0
		18 wk	(%)	5.0	13.3	80.0	1.7	0.0
		($n = 60$)	CI	(0.0, 10.5)	(4.7, 21.9)	(69.9, 90.1)	(0.0, 5.0)	(0.0, 0.0)
7	B.U.T. 6	12	(*n*)	0	0	56	4	0
		20 wk	(%)	0.0	0.0	93.3	6.7	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 0.0)	(87.0, 99.6)	(0.4, 13.0)	(0.0, 0.0)
		13	(*n*)	1	7	52	0	0
		18 wk	(%)	1.7	11.7	86.7	0.0	0.0
		($n = 60$)	CI	(0.0, 5.0)	(3.6, 19.8)	(78.1, 95.3)	(0.0, 0.0)	(0.0, 0.0)
8	B.U.T. TP 7	14	(*n*)	0	1	15	44	0
		20 wk	(%)	0.0	1.7	25.0	73.3	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 5.0)	(14.0, 36.0)	(62.1, 84.5)	(0.0, 0.0)
		15	(*n*)	0	0	58	0	0
		18 wk	(%)	0.0	3.3	96.7	0.0	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 7.8)	(92.2, 101.2)	(0.0, 0.0)	(0.0, 0.0)
9	B.U.T. TP 7	16	(*n*)	0	0	22	37	1
		19 wk	(%)	0.0	0.0	36.7	61.7	1.7
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 0.0)	(24.5, 48.9)	(49.4, 74.0)	(0.0, 5.0)
10	B.U.T. 6	17	(*n*)	0	0	47	13	0
		19 wk	(%)	0.0	0.0	78.3	21.7	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 0.0)	(67.9, 88.7)	11.3, 32.1)	(0.0, 0.0)
		18	(*n*)	1	0	42	17	0
		19 wk	(%)	1.7	0.0	70.0	28.3	0.0
		($n = 60$)	CI	(0.0, 5.0)	(0.0, 0.0)	(58.4, 81.6)	(16.9, 39.7)	(0.0, 0.0)
11	B.U.T. 6	19	(*n*)	0	0	47	13	0
		20 wk	(%)	0.0	0.0	78.3	21.7	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 0.0)	(67.9, 88.7)	(11.3, 32.1)	(0.0, 0.0)
		20	(*n*)	0	1	48	11	0
		20 wk	(%)	0.0	1.7	80.0	18.3	0.0
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 5.0)	(69.9, 90.1)	(8.5, 28.1)	(0.0, 0.0)
12	B.U.T. 6	21	(*n*)	0	8	50	2	0
		21 wk	(%)	0.0	13.3	83.3	3.3	0.0
		($n = 60$)	CI	(0.0, 0.0)	(4.7, 21.9)	(73.9, 92.2)	(0.0, 7.8)	(0.0, 0.0)
		22	(*n*)	2	1	57	0	0
		23 wk	(%)	3.3	1.7	95.0	0.0	0.0
		($n = 60$)	CI	(0.0, 7.8)	(0.0, 5.0)	(89.5, 100.5)	(0.0, 0.0)	(0.0, 0.0)
Mean value			(*n*)	0.8	4.5	41.4	12	1.3
			(%)	1.3	7.6	68.9	20.0	2.2

Table 3. Prevalence of foot pad lesions in toms from 5 organic farms rearing 9 flocks of Kelly Broad Breasted Bronze (Kelly BBB) strain ($n = 540$) at the slaughterhouse. Presentation of the percentage of foot pad dermatitis (FPD) ordered according to the farms. Numerical data in parentheses are 95% confidence interval (CI). Age is given in wk.

				FPD score				
Farm	Turkey strain	Flock age	Number	0	1	2	3	4
1	Kelly BBB	1	(*n*)	1	8	26	25	0
		22 wk	(%)	1.7	13.3	43.3	41.7	0.0
		($n = 60$)	CI	(0.0, 5.0)	(4.7, 21.9)	(30.8, 55.8)	(29.2, 54.2)	(0.0, 0.0)
		2	(*n*)	0	2	31	25	2
		22 wk	(%)	0.0	3.3	51.7	41.7	3.3
		($n = 60$)	CI	(0.0, 0.0)	(0.0, 7.8)	(39.1, 64.3)	(29.2, 54.2)	(0.0, 7.8)
2	Kelly BBB	3	(*n*)	1	5	48	6	0
		22 wk	(%)	1.7	8.3	80.0	10.0	0.0
		($n = 60$)	CI	(0.0, 5.0)	(1.3, 15.3)	(69.9, 90.1)	(2.4, 17.6)	(0.0, 0.0)
3	Kelly BBB	4	(*n*)	0	8	35	17	0
		22 wk	(%)	0.0	13.3	58.3	28.3	0.0
		($n = 60$)	CI	(0.0, 0.0)	(4.7, 21.9)	(45.8, 70.8)	(16.9, 39.7)	(0.0, 0.0)
		5	(*n*)	1	0	19	37	3
		23 wk	(%)	1.7	0.0	31.7	61.7	5.0
		($n = 60$)	CI	(0.0, 5.0)	(0.0, 0.0)	(19.9, 43.5)	(49.4, 74.0)	(0.0, 10.5)
4	Kelly BBB	6	(*n*)	5	10	37	8	0
		23 wk	(%)	8.3	16.7	61.7	13.3	0.0
		($n = 60$)	CI	(1.3, 15.3)	(7.3, 26.1)	(49.4, 74.0)	(4.7, 21.9)	(0.0, 0.0)
		7	(*n*)	4	2	26	27	1
		24 wk	(%)	6.7	3.3	43.3	45.0	1.7
		($n = 60$)	CI	(0.4, 13.0)	(0.0, 7.8)	(30.8, 55.8)	(32.4, 57.6)	(0.0, 5.0)
5	Kelly BBB	8	(*n*)	9	24	24	3	0
		23 wk	(%)	15.0	40.0	40.0	5.0	0.0
		($n = 60$)	CI	(6.0, 24.0)	(27.6, 52.4)	(27.6, 52.4)	(0.0, 10.5)	(0.0, 0.0)
		9	(*n*)	4	2	40	13	1
		22 wk	(%)	6.7	3.3	66.7	21.7	1.7
		($n = 60$)	CI	(0.4, 13.0)	(0.0, 7.8)	(54.8, 78.6)	(11.3, 32.1)	(0.0, 5.0)
Mean value			(*n*)	2.8	6.8	31.8	17.9	0.8
			(%)	4.6	11.3	53.0	29.8	1.3

The results revealed that nearly all examined turkeys showed a certain degree of FPD at the slaughterhouse. More than 90% showed necrotic lesions (scores 1 to 3) or plantar abscesses (score 4), only 2.3% were unaffected.

The results of the present investigation show that hens were more frequently and more seriously affected than toms. Differences concerning the prevalence of FPD between both sexes may be due to the higher number of birds/m^2 (Tables 2 and 3). For organic poultry farming, the stocking density should not exceed 10 birds/m^2, or 21 kg/m^2 (European Commission, 2008). Hens are often reared in a higher number of birds/m^2, which take up more feeds what leads to a greater amount of excreta and thereby to higher litter moisture (Rudolf, 2008; Krautwald-Junghanns et al., 2011; Ellerich, 2012). The results of the present study reveal a relation between the stocking density and the occurrence of FPD. This confirms other studies which reported that a higher stocking density is associated with higher incidence of FPD (Noll et al., 1991; Martrenchar et al., 1999; Martrenchar et al., 2001; Hafez et al., 2005; Erasmus, 2017). The above-mentioned results lead to the litter condition as the decisive factor. Poor litter quality has a great influence on the emergence of foot pad lesions. High litter moisture in particular is presumed to be a main cause for such alterations (Martland, 1984; Clark et al., 2002; Mayne et al., 2007; Berk et al., 2013).

The difference between the investigated flocks (Tables 2 and 3) underlines the crucial role of management in the emergence of FPD and its multifactorial etiology. It is important to detect farms with a high prevalence of FPD to initiate specific means to decrease it. Besides the various influencing factors on foot pad health that concern all turkey production systems, like sex, strain, litter and feeding (Mayne, 2005; Shepherd and Fairchild, 2010; Tabler et al., 2013; Vinco et al., 2017a), there are further aspects to consider for organic poultry farming (Sundrum et al., 2004; Rahmann et al., 2005). As the access to an outdoor area is mandatory for turkeys reared under organic poultry farming system, its impact on foot pad health is an interesting issue. The measurement of this influence is difficult to conduct. The condition of the area depends on weather and climate. Ponding can lead to humid milieu around the feet and thereby to increasing inflammation of the foot pads. The difficulty is to measure which and how often birds use the outdoor access, how long they stay there, and whether they stand in the puddles or on dry ground. According to Pagazaurtundua and Warris (2006) and Berk (2013), birds with access to an outdoor area show a higher prevalence of FPD, but further studies investigating this impact with special regard to the above-mentioned factors are of interest. In addition, turkeys have a longer rearing period under organic farming system. This means that the birds remain longer on the same litter leading to adverse litter condition if not managed properly. Furthermore, the farmers are often not able to meet the turkeys' feeding requirements due to legal regulations prohibiting

Table 4. Flock and animal related data of hens from 5 organic farms rearing 9 flocks of Kelly Broad Breasted Bronze (Kelly BBB) strain ($n = 540$) and 7 organic farms rearing 13 flocks of British United Turkeys (B.U.T.) strain ($n = 780$) at the day of slaughter.

Farm	Turkey strain	Flock	Flock size (n)	Stocking density	Age on slaughter	Average weight on slaughter
1	Kelly BBB	1	2,124	2.31 birds/m^2 24.9 kg/m^2	20 wk	10.8 kg
		2	1,851	2.21 birds/m^2 22.82 kg/m^2	18 wk	10.3 kg
2	Kelly BBB	3	2,478	2,38 birds/m^2 15.3 kg/m^2	18 wk	8.5 kg
3	Kelly BBB	4	2,505	2.13 birds/m^2 19.4 kg/m^2	18 wk	9.1 kg
		5	1,852	1.5 birds/m^2 15.7 kg/m^2	20 wk	10.3 kg
4	Kelly BBB	6	2,194	1.79 birds/m^2 18.63 kg/m^2	21 wk	10.4 kg
		7	2,012	1.61 birds/m^2 14.75 kg/m^2	19 wk	9.2 kg
5	Kelly BBB	8	1,975	1.86 birds/m^2 20.85 kg/m^2	20 wk	11.2 kg
		9	1,513	1.43 birds/m^2 14.26 kg/m^2	18 wk	10 kg
6	B.U.T. 6	10	2,462	1.8 birds/m^2 14.73 kg/m^2	17 wk	8.2 kg
		11	1,760	1.28 birds/m^2 14.64 kg/m^2	18 wk	11.4 kg
7	B.U.T. 6	12	2,627	2.06 birds/m^2 23.11 kg/m^2	20 wk	11.2 kg
		13	1,733	–*	18 wk	10.4 kg
8	B.U.T. TP 7	14	3,147	36.6 kg/m^2	20 wk	11.6 kg
		15	3,321	2.01 birds/m^2 20.13 kg/m^2	18 wk	10.2 kg
9	B.U.T. TP 7	16	2,416	1.34 birds/m^2 14.62 kg/m^2	19 wk	10.9 kg
10	B.U.T. 6	17	2,310	1.77 birds/m^2 16.29 kg/m^2	19 wk	9.2 kg
		18	2,280	1.75 birds/m^2 17.67 kg/m^2	18 wk	10.1 kg
11	B.U.T. 6	19	2,111	2.08 birds/m^2 20.15 kg/m^2	20 wk	9.7 kg
		20	2,248	2.22 birds/m^2 23.97 kg/m^2	20 wk	10.8 kg
12	B.U.T. 6	21	2,342	1.46 birds/m^2 10.52 kg/m^2	21 wk	7.2 kg
		22	3,111	1.94 birds/m^2 22.2 kg/m^2	23 wk	11.4 kg

*Data not available.

the addition of synthetic amino acids, vitamins, minerals, and trace elements (European Commission, 2008). Inadequate formulation may lead to malnutrition or intestinal disorders and thereby to higher litter moisture. Bellof et al. (2010) compared various "organic" feed mixtures with different energy contents, which revealed that the mixture containing the lowest energy value contained the highest amount of non-starch polysaccharide, thus leading to poor condition of excreta. Lack of essential amino acids and higher amounts of raw protein and thereby protein bound electrolytes, which are eliminated through the renal system, have an influence on the health condition of the birds and the condition of the excreta (Jeroch, 2013; Kamphues et al., 2014).

All these aspects need to be considered when a high prevalence of FPD at the slaughterhouse shall lead to controls and targeted measures on the farm.

In addition to the husbandry conditions themselves, the turkey strain might be interesting for the animal caretaker for deciding which is most suitable for organic poultry farming systems. The present study does not provide a clear answer to that subject for there is no significant difference between both strains ($P \geq 0.05$) (Table 2). Similar results were found in the study by Platz et al. (2003), investigating the same conventional turkey breeds under organic outdoor rearing conditions.

Comparing the obtained results with those from conventional turkeys investigated at the slaughterhouse following the same study setup, no significant differences were observed concerning the occurrence of FPD (Krautwald-Junghanns et al., 2011). In general, conventional turkeys were more often affected; however, turkeys reared under organic poultry systems showed more severe lesions like scores 3 and 4. Both hens

Table 5. Flock and animal related data of toms from 5 organic farms rearing 9 flocks of Kelly Broad Breasted Bronze (Kelly BBB) strain ($n = 540$) at the day of slaughter.

Farm	Turkey strain	Flock	Flock size (n)	Stocking density	Age on slaughter	Average weight on slaughter
1	Kelly BBB	1	1,647	0.69 birds/m^2 11.26 kg/m^2	22 wk	16.3 kg
		2	1,820	0.76 birds/m^2 10.99 kg/m^2	22 wk	14.4 kg
2	Kelly BBB	3	2,328	2.24 birds/m^2 11.7 kg/m^2	22 wk	10.1 kg
3	Kelly BBB	4	1,268	1.03 birds7m^2 15.87 kg/m^2	22 wk	15.5 kg
		5	904	1 bird/m^2 12.75 kg/m^2	23 wk	16.0 kg
4	Kelly BBB	6	853	0.86 birds/m^2 13.60 kg/m^2	23 wk	15.9 kg
		7	939	1.08 birds/m^2 19.59 kg/m^2	24 wk	18.2 kg
5	Kelly BBB	8	885	1.15 birds/m^2 22.14 kg/m^2	23 wk	19.2 kg
		9	860	1.12 birds/m^2 20.61 kg/m^2	22 wk	18.4 kg

and toms reared under conventional poultry farming system showed more low-grade alterations (score 1). More than half of all examined turkeys, reared under conventional or organic farms or both, showed moderate lesions, score 2. That means FPD is an important welfare issue in both rearing systems.

The question is at which point do these lesions become a relevant animal welfare issue? It is decisive whether only severe lesion scores or whether the general occurrence of foot pad lesions is of importance. Decisive is the depth of alterations, which determines the clinical relevance. Because of the resulting pain, such pathological alterations have to be seen as an impact on animal health and consequently a relevant animal welfare issue (Sinclair et al., 2015; Weber Wyneken et al., 2015). Therefore, FPD is a suitable indicator for animal welfare (Watanabe et al., 2013). The problem is that it can only be measured when the damage has already occurred. The most convenient place to do the survey is at the slaughterhouse. Following the health control program implemented by Andersson and Toppel (2014), a standardized benchmarking system using a uniform scoring system has to be established in every slaughterhouse for both turkeys reared in conventional and organic production system. As a result, it has to provide simplified information about the status quo, especially deficiencies like excessive stocking densities, inadequate litter management and feeding, in the management of the farms. It has to be clearly identified at which point an intervention is necessary. This can only be implemented by defining a threshold. Following the project of Vinco et al. (2017b), a trigger level can be calculated with the help of a formula for simplifying the scoring.

As a further approach to decrease FPD not only by assessing the prevalence rate at the slaughterhouse, the German Animal Welfare Act demands self-monitoring by the animal caretaker using appropriate animal welfare indicators (Federal Republic of Germany, 2017). Only by this means early detection of foot pad lesions is possible and can lead to timely intervention. Another point to prevent the occurrence of FPD is the monitoring of the litter moisture in the barn. Studies show that the visual scoring of litter condition is most reliable as compared to the measurement with the help of portable instruments (Vinco et al., 2017b).

A new avenue to early detection of inflammatory processes of the foot pad gives a recent study by Moe et al. (2018) revealing a negative association between the foot pad temperature and the visual detected early stages of FPD, assuming that the inflammatory processes in the early stages of FPD are either negligible or hyperkeratosis is shielding heat emission of the foot pad. Using infrared thermography could be new possibility for early detection of FPD, but more studies concerning foot pad temperature in relation to with FPD are necessary.

Taking these early assessment methods of animal welfare indicators going along with a generally mandatory and uniform benchmarking system at all slaughterhouses targeted measures can be taken. A survey of FPD prevalence is the starting point to implement a controlling program by documenting the status quo and by detecting problematic farms.

Taking into account today's poultry farming system, both conventional and organic, it does not seem possible to avoid the occurrence of foot pad lesions completely. Foot pad dermatitis has to be seen as a profound animal welfare issue and the aim has to be to reduce its occurrence and to have intact foot pads in the long term.

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