



Prevalence and risk factors for pododermatitis in broilers: Insights from farmers in Maiduguri and Potiskum, Nigeria

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Abstract

A cross-sectional survey was conducted in Maiduguri Metropolitan Council and Potiskum town to determine the prevalence, management, and risk factors associated with pododermatitis among commercial broiler chicken farms, and to assess the occurrence of *Staphylococcus aureus* in lesions found on the legs of broilers affected with pododermatitis. The study visually examined the feet of 390 broilers from 30 farms in Maiduguri and 400 broilers from 20 farms in Potiskum for cases of pododermatitis. Swab samples were obtained from lesions on the legs of broilers affected with pododermatitis and tested for the presence of *Staphylococcus aureus* using Gram stain, Coagulase, and Catalase tests. Questionnaires on risk factors associated with pododermatitis were also administered to 30 and 20 of the farmers whose birds were sampled from Maiduguri and Potiskum, respectively. Respondents from Maiduguri were mostly adults (87%) and males (56%) whose flock sizes were less than 100(89.3%) broilers, of which they commonly reared on a concrete floor (60%). Similarly, respondents from Potiskum were adults (95.3%) and males (70%) whose flock sizes were less than 100(65%) broilers, which they commonly reared on a concrete floor (90%). Respondents considered the consumption of chicken feet as healthy, even though its specific demand was low. Pododermatitis was not considered to affect either the prices of broilers or the feed and water consumption of broilers. The overall prevalence of pododermatitis was 25.6% (100/390) in Maiduguri and 9.5% (38/400) in Potiskum. *Staphylococcus aureus* was detected in 43 of the 100 broilers affected with pododermatitis in Maiduguri and in 12 out of 38 broilers affected with pododermatitis in Potiskum. The study across all the 50 farms showed age ($\chi^2=9.455$, $P=0.0021$) and damp or wet litter ($\chi^2=4.059$, $P=0.0439$) were associated with the occurrence of pododermatitis. Improvements in litter management in broiler houses could likely reduce the occurrence of pododermatitis.

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Introduction

The chicken feet have nutritional benefits and is of economic and welfare importance. The chicken feet are good sources of collagen that is useful for the maintenance of skin elasticity and for the provision of strength to human body tissue. The high demand for chicken feet in China and other Asian countries has provided huge revenues to countries that export chicken feet, like the United States of America, whose revenue from chicken feet is over \$460 million annually (Anon, 2023). The health of the chicken feet is also used as an audit criterion for assessment of poultry health checks in America and Europe to assess the welfare conditions in which birds are raised (Shepherd & Fairchild, 2010).

Pododermatitis is a chronic pyro-granulomatous process in the subcutaneous region of the foot that often results in thick-walled swellings of one or more joints (Shepherd & Fairchild, 2010). The disease starts as an inflammation of the skin because of corrosive factors present in wet litter. The disease condition had been found to be mainly associated with *Staphylococcus aureus* in chickens, turkeys and other species of birds (Shepherd & Fairchild, 2010). Pododermatitis is characterized by inflammation and superficial to deep necrotic lesions that eventually form ulcers on the plantar surface of the footpads and toes of poultry (Miesle, 2021; Shepherd & Fairchild, 2010). Pododermatitis causes pain that limits birds' ability to walk about, thereby restricting access to food and water, which consequently leads to a reduction in growth and productivity of birds. If left

untreated, pododermatitis will compromise the internal tissues of the foot pads of birds like the mesoderm, tendons and bones and cause osteomyelitis, synovitis, laminitis, and eventually death (Miesle, 2021). Economically, pododermatitis causes downgrades of chicken paws, which often results in huge losses, especially to countries that export the chicken paws (Jacob *et al.*, 2016). Hashimoto *et al.* (2013) had reported pododermatitis as a major cause of carcass condemnation and live weight and leg weight losses in broilers.

The paucity of information on the occurrence and the impact of pododermatitis among broilers reared in Nigeria makes it necessary to undertake an exploratory study on the occurrence of the disease. This study aimed to investigate the occurrence of pododermatitis among broiler chickens in Maiduguri Metropolitan Council and Potiskum town and its associated risk factors.

Material and Methods

Study area

The study was carried out in Maiduguri Metropolitan Council Local Government Area (Figure 1), Borno State. Maiduguri Metropolitan Council has 15 wards that cover an area of about 69,436 km², which lies between latitude 11°32' and 11°42' N and between longitude 13°20' and 13°25' E. It is located between the Sudan and Sahel Savannah vegetation zones, with an ambient temperature of 40°C to 45°C. It is characterized by a short rainy season of 3-4

months (June to September) followed by a prolonged dry season.

The study was also carried out in Potiskum, which was located around latitude 11° 43 N and longitude 11°04E. It is the largest city in Yobe State with a projected population of 465,496 people in 2025 (WPR, 2025) and hosts one of Africa's largest cattle markets.

Study design and sample size

The sample size of 384 was calculated using a 50% expected prevalence from a formula outlined by Joachin (1998):

$$n = \frac{P \times (1-P) \times Z^2}{d^2}$$

$$= \frac{0.5 (1-0.5) \times 3.84}{0.05^2}$$

$$= 384 \text{ samples.}$$

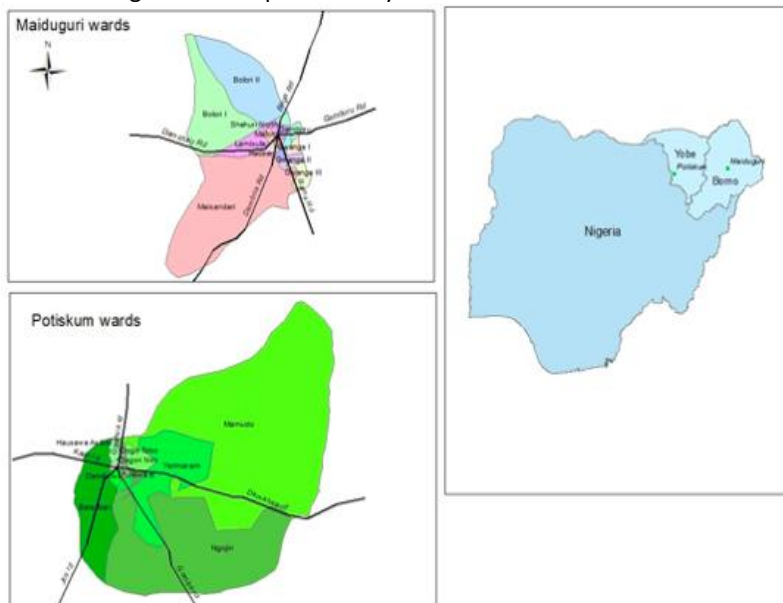


Figure 1: Map of sampled wards in Maiduguri metropolis and Potiskum town

Where: n = sample size, P = anticipated prevalence (0.5), d = desired precision (0.05) and Z = Normal value from the normal for the desired confidence (1.96). To achieve uniformity in the collection of samples, the sample size of 384 was increased to 390 and divided by 15 wards of the Maiduguri Metropolitan Council to arrive at 26 birds to be sampled from each ward. We further subdivided the sample size of 26 birds per ward by 2 and sampled 13 birds from two farms in each ward. Accordingly, the first and the third farms were systematically chosen for sampling of 30 farms in Maiduguri metropolis. Similarly, the sample size of 384 was increased to 400 and divided by the 10 wards in Potiskum to arrive at 40 birds to be sampled per ward. The number of birds per ward was further subdivided by 2 to arrive at 20 birds to be sampled per 20 farms in Potiskum. The first and the third farms were sampled in each ward.

Detection of ulceration on the foot pads

Thirteen (13) and 20 birds were randomly selected from each farm in Maiduguri and Potiskum town, respectively. We physically examined the birds for signs of ulcerations on their foot pads and classified the lesions based on their observed sizes according to the classification outlined by Hashimoto *et al.* (2013).

Sample collection

The affected foot surface was disinfected with 70% alcohol. The Plug covering the wound was carefully removed using sterile forceps. A sterile swab stick that was moistened with phosphate-buffered saline was used to swab the ulcerated wounds in the affected foot. Swab samples from Potiskum and Maiduguri were all packaged and transported over ice in a cold box to the Laboratory of the Department of Veterinary Microbiology, University of Maiduguri, Borno State, for the detection of *S. aureus*.

Detection of Staphylococcus aureus

Each bottle of nutrient broth was labelled. The swab sticks collected from the broiler lesions affected with food pad dermatitis were inoculated into labelled test tubes containing 1ml of nutrient broth and incubated at 37°C for 24 hours. Furthermore, each sample from the nutrient broth was sub-cultured into Mannitol salt agar for identification of *S. aureus* colonies (Cappucino & Welsh, 2019).

Gram staining

Gram staining was done on the colonies obtained on Mannitol salt agar (Cappucino & Welsh, 2019).

Briefly, a drop of distilled water was placed on the clean glass slide. A sterile loop was used to obtain samples from agar plates and make a thin smear on a grease-free slide, which was air-dried. The slide was later fixed with heat by passing it over the Bunsen burner three times. The smear was covered with crystal violet for 1 minute and then rinsed with water and covered with Lugol's iodine for 1 minute, rinsed with water and decolourized using 95% alcohol for 2 seconds and then rinsed immediately with tap water. The slide was subsequently covered with Safranin for 30 seconds, rinsed with water, and allowed to dry on a drying rack. The dried slides were later examined using a x100 objective lens by using oil immersion for purple colored grape like clusters that are characteristics for *Staphylococcus aureus*

Biochemical Test

Catalase test

Catalase test was performed as described by Cappucino & Welsh (2019), where a sterile loop was used to collect a small sample of the organism on an agar plate and placed on a labelled slide that was kept in a Petri dish. Three per cent (3%) hydrogen peroxide was placed on the organism without mixing. The cover of the Petri dish was placed to contain any aerosol. Samples showing immediate bubble formation were recorded as positive.

The coagulase test was performed using the slide test method for the identification and differentiation of *Staphylococcus aureus* from other staphylococci, which do not produce the coagulase enzyme (Cappucino & Welsh, 2019). The test was done by placing two drops of saline on a clean slide, emulsify small amount of the bacterial colony in one drop of saline, mixing, and adding a drop of rabbit plasma to both the bacterial and control suspension. Mix gently and observe for clot formation in 10-15 seconds for samples that were indicative of *S. aureus*.

Questionnaire

A closed-ended questionnaire was designed and pretested on six prototype farms. The pretested questionnaire was reviewed and validated by staff of the Department of Veterinary Public Health, University of Maiduguri. The questionnaire tries to elicit demographic information of farmers, their broiler management practices, and their perceptions on pododermatitis and risk factors for pododermatitis. The questionnaire was administered in an interview format and translated in Hausa dialect when necessary, on a total of 50 farmers: 30 broiler farmers in Maiduguri metropolis and 20 broiler

farmers from Potiskum town, to generate data on economic importance and risk factors for Pododermatitis in commercial Broiler farms in Maiduguri Metropolis.

Data analysis

Data were summarized using tables and charts. Counts and percentages were used to present the data in the tables and charts. Prevalence was calculated according to the formula outlined by Bennette *et al.* (1991):

Where prevalence:

$$= \frac{\text{No. of samples positive for Pododermatitis} \times 100}{\text{Total number of broilers examined.}}$$

To assess risk factors from the questionnaire, we used Chi squared test to compare some risk factors for the occurrence of pododermatitis.

Results

The demographic characteristics of the farmers (Table 1) showed most of the farms were owned by adults greater than 18 years in both Maiduguri (87%) and Potiskum (95.3%) who were mostly males (56% in Maiduguri and 70% in Potiskum) with less than 5 years of experience (56% in Maiduguri and 75% in Potiskum).

Most of the farms surveyed in this study belong to small-scale broiler farmers whose flock sizes were less than one hundred birds in both Maiduguri (90%) and Potiskum (65%) (Table 2). And whose birds were all raised on a deep litter system of production (Table 2). While the consumption of chicken feet was considered to be healthy by most farmers in both Maiduguri (83.3%) and Potiskum (80%) (Figure 2), the

specific demand for chicken feet however, was not considered to be high in both Maiduguri (86.6%) and Potiskum (90%) (Figure 2).

Pododermatitis was not considered by farmers in Maiduguri (66.4%) and Potiskum (75%) to affect the final price of their broilers (Figure 3), nor was the disease considered by farmers in both Maiduguri (66.7) and Potiskum (76.7%) to affect feed/water consumption.

Pododermatitis was detected at different levels of severity in some broiler farms in both Potiskum and Maiduguri (Plate I). The overall prevalence pododermatitis among broiler farms was 25.6% (Table 2) in Maiduguri Metropolis and (9.5%) in Potiskum (Table 3) in Potiskum, respectively.

Staphylococcus aureus was detected in 43/100 and 12/38 swab samples collected from the lesions of birds with pododermatitis in Maiduguri and Potiskum, respectively, using catalase, Coagulase test and Gram staining.

The study across all the 50 farms (Table 5) showed age of birds (Chi squared=9.455, P=0.0021) and damp or wet litter ($\chi^2= 8.062$, P= 0.0045) were associated with the occurrence of pododermatitis.

Discussion

The finding that the majority of the farm owners were adults >18 years was similar to what obtains in village chicken production (Sule *et al.*, 2014) and could be related to the availability of time and resources that adults have when compared to younger respondents who were likely to be in school to pursue commercial broiler chicken production. Poultry farming demands

Table 1: Demographic variables of Broiler farmers in Maiduguri Metropolis and Potiskum

Variables		No. (%) of variables from Maiduguri	No. (%) of variables from Potiskum
Age	<18	4 (13.0)	1 (5.0)
	>18	26 (87.0)	19(95.3)
Total		30 (100.0)	20 (100.0)
Sex	Female	13(43.0)	6(30.0)
	Male	17(56.0)	14(70.0)
Total		30 (100.0)	20 (100.0)
Occupation	Civil servant	11(36.7)	7(35.0)
	Business	12(40.0)	6(30.0)
	Full time farmers	2(6.7)	3(15.0)
	Student	5(16.7)	2(10.0)
	Artisan		2(10.0)
Total		30(100.0)	20(100.0)
Years of experience in poultry production	<5	23(76.0)	15(75.0)
	>5	7(23.0)	5(25.0)
Total		30 (100.0)	20(100.0)

Table 2: Characteristics of broiler farms sampled in Maiduguri and Potiskum towns

Description	Maiduguri		Potiskum	
	Number	%	Number	%
Housing type				
Open sided	20	66.7	14	70.0
Others	10	33.3	6	30.0
Total	30	100.0	20	100.0
Floor Type				
Concrete	18	60.0	18	90.0
Other types	12	40.0	2	10.0
Total	30	100.0	20	100.0
Use of litter material				
Yes	25	75.0	19	95.0
No	5	25.0	1	5.0
Total	30	100.0	20	100.0
Flock size				
0-99	27	90.0	13	65.0
100<	3	10.0	7	35.0
Total	30	100.0	20	100.0
Age of Broilers				
3 weeks	10	33.3	5	25.0
4 weeks	8	26.7	6	30.0
5 weeks	5	16.7	2	10.0
6 weeks	3	10.0	3	15.0
7 weeks >	4	13.3	4	20.0
Total	30	100.0	20	100.0

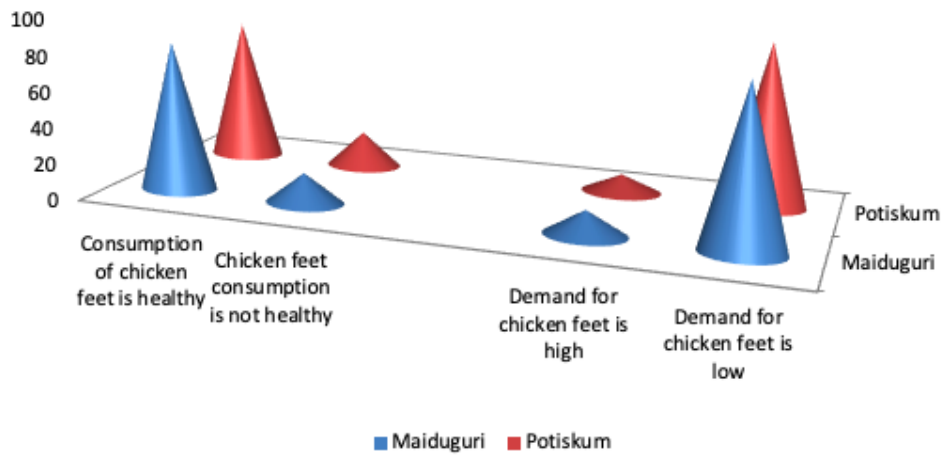


Figure 2: Farmers perception on the consumption of chicken feet and demand for chicken feet in Maiduguri and Potiskum



Plate I: pododermatitis at different stages of severity in some broiler farms in Maiduguri, Borno State.

Table 2: Distribution of cases of Pododermatitis in commercial broilers in Maiduguri Metropolis

Number of farms sampled	Flock size	Number of foot pads examined	Number of broilers with cases of pododermatis	Prevalence
1	80	13	5	38.5
2	50	13	0	0
3	30	13	0	0
4	130	13	3	23.1
5	100	13	4	30.8
6	40	13	0	0
7	46	13	0	0
8	94	13	5	38.5
9	30	13	4	30.8
10	25	13	7	53.8
11	20	13	6	46.2
12	42	13	7	53.8
13	89	13	6	46.2
14	20	13	0	0
15	94	13	0	0
16	23	13	0	0
17	40	13	1	7.7
18	47	13	0	0
19	48	13	8	61.5
20	95	13	5	38.5
21	48	13	8	61.5
22	146	13	0	0
23	27	13	8	61.5
24	75	13	2	15.4
25	93	13	9	69.2
26	24	13	4	30.8
27	23	13	8	61.5
28	27	13	2	15.4
29	29	13	0	0
30	23	13	3	23.1
Overall prevalence		390	100	25.6

Table 3: Distribution of cases of Pododermatitis in commercial broilers in Potiskum

Number of farms	Flock Size	Number Sampled	Number affected	Prevalence (%)
1	100	20	4	20
2	70	20	2	10
3	200	20	3	15
4	100	20	0	0
5	300	20	3	15
6	52	20	0	0
7	30	20	1	5
8	50	20	2	10
9	25	20	1	5
10	100	20	1	5
11	50	20	0	0
12	25	20	3	15
13	200	20	3	15
14	70	20	2	10
15	40	20	0	0
16	15	20	6	30
17	54	20	3	15
18	150	20	2	10
19	20	20	0	0
20	70	20	2	10
Overall prevalence	1721	400	38	9.5

Table 4: Distribution of the results of microbiological tests conducted on swabs taken from ulcerations on foot pads of broilers in Maiduguri Metropolis

Town	Test result	Coagulase Test	Catalase Test	Gram staining
Maiduguri	Positive	43	43	43
	Negative	57	57	57
	Total	100	100	100
Potiskum	Positive	12	12	12
	Negative	26	26	26
	Total	38	38	38

Table 5: A pooled comparison of cases and non cases of Pododermatitis with age of broilers, litter condition and floor types among 50 surveyed farms in Maiduguri and Potiskum

Variables	Pododermatitis			Chi squared test, DF	P value
	Cases	Non cases	Total		
Age of broilers	>4	9	14	9.46, 1	0.0021
	<4	22	5		
	Total	31	19		
Damp/wet litter		21	5	8.06, 1	0.0045
	Dry litter	7	11		
	Total	28	16		
Concrete floor		26	10	2.22, 1	0.1364
	other floor types	7	7		

substantial financial investment, experience and time and a strong work ethics which are more often found in older individuals than youth. Furthermore, the

capital for the construction, maintenance and daily poultry farm management and the purchasing of equipments are more likely to be accessed by adults

than youth due to their established careers, savings, family assets or even their ability to secure loans from banks. Adults are also likely to have more experience than youth in hiring and managing staff to run farm activities.

That the study found males to dominate broiler chicken production in both Maiduguri (56%) and Potiskum (70%) was also observed by Sambo *et al.* (2015) and seems to contrast the finding in village chicken production where females were the dominant gender (Sule *et al.*, 2014) The ability of men to access capital to finance commercial broiler chicken production is also likely to be higher among men than that of women. The finding that full-time farmers in both Maiduguri (6.7%) and Potiskum (15%) were less involved in broiler production when compared to civil servants and business people in both Maiduguri and Potiskum is worrying. Factors like risk, marketing, and high cost of feed, as highlighted by Adeyonu *et al.* (2021), may perhaps play a role in discouraging full time farmer from active participation in Broiler production.

That most of the farmers in Maiduguri (76%) and in Potiskum (75%) had less than 5 Years of experience appears to highlight the potential for growth of the broiler industry in these geographic areas.

The perception that the consumption of chicken legs was healthy by farmers agrees with the findings of Sanusi *et al.* (2017) and tends to suggest a cultural acceptance of chicken legs as meat among the people living in these communities. It would, perhaps, require an increase in the knowledge of the nutrient composition, like the collagen content of the chicken feet and its effect on the skin and beauty, to boost the specific demand for chicken paw especially among the youth.

The reasons why farmers do not think that pododermatitis affects the price of their broilers might be related to the common practice of selling whole live chickens rather than by their parts or weight. Sales of chicken by parts and weight have the potential to change the prices of chicken parts based on their specific demands. Wherever the export of chicken paws to countries like China is considered, the prices of chicken paws are likely to change.

The fact that farmers in both the study areas appear not to be aware of the negative effect of pododermatitis on food and water consumption, nor its indirect economic effect on the prices of their broilers, highlights the paucity of knowledge of this disease among broiler farmers. Extension services are needed to provide such vital information to farmers.

The finding that broilers were commonly reared under the deep litter system (100%) in both Maiduguri and Potiskum was similar to that in Jos, Plateau State (Maduka *et al.*, 2016) and tends to highlight the need for good litter management to reduce the incidence of pododermatitis, as suggested by Alabi *et al.* (2023). The occurrence of pododermatitis in 20/30 and 15/20 farms in Maiduguri and Potiskum points to major welfare and economic issues associated with the ways these birds are being raised. The prevalence of 25.6% (100/390 birds) and 9.5% (9.5%) in Maiduguri and Potiskum town, respectively, seems to highlight the need for enlightenment of farmers on the importance of this disease. That severe case of pododermatitis was also seen among broilers in the study areas seem to serve as a wake-up call for veterinarians in these areas to set up guidelines and mechanisms for the regulation of practices that compromise broiler welfare in their respective jurisdictions.

That 43% of swab samples from Maiduguri Metropolis and of 12 of the swab samples from Potiskum town were positive for *Staphylococcus aureus* are suggestive of an association of this bacterium with pododermatitis in these communities. The occurrence of *S. aureus* might be of public health concern if these organisms are Methicillin-Resistant *Staphylococcus aureus*.

That some samples were not positive for *Staphylococcus* could either mean that other organisms might be involved in the occurrence of pododermatitis in this locality or that the use of antibiotics, which was a common practice in all but one of the farms, could be suppressing the infection in affected birds.

The prevalence of detection of *S. aureus* of 43% found in this study was lower than the prevalence of 89.28% found in Jammu, India was perhaps due to variations in climatic conditions and variation in litter material, and the conditions of litter materials.

Though, broilers were mostly raised on concrete floors in most of the farms, we found no association between the floor and the incidence of pododermatitis. However, we found wet litter was associated with pododermatitis, which tends to agree with the works of Alabi *et al.* (2023) and Terra *et al.* (2014) who found an association between litter and pododermatitis. Such birds should be moved to a dry litter, which was observed to delay or suppress the occurrence of pododermatitis (Taira *et al.*, 2014). This finding might probably be related to the types of drinkers used in broiler production in the study areas which commonly seem to leak water on the

surrounding litter. Improvements in these drinkers or adoption of nipple drinkers, which might be costly to the small-scale broiler farmers, might likely play a role in reducing the occurrence of pododermatitis and other diseases like coccidiosis.

The association between the age of broilers and pododermatitis in this study might be related to the weight broilers were gaining, which exerts their weight (Shepherd & Fairchild, 2010) on the foot against poor litter material.

Keeping broilers beyond 35-42 days, as observed in this study, carries the likelihood of increasing the incidence and severity of pododermatitis. Such practice needs to be changed in order to reduce the incidence of pododermatitis, as well as cull the birds when the feed conversion efficiency is at its optimal level.

The occurrence of pododermatitis among broilers in both Maiduguri metropolis and Potiskum seems to highlight the need for improvements in the management of broilers in these farms.

The practice of raising broilers on wet litters could predispose birds to pododermatitis.

The study was able to find *Staphylococcus aureus* in swab samples taken from the lesions found in broilers affected with pododermatitis in Maiduguri metropolis and Potiskum, respectively.

The study recommends that farmers be educated on the importance of pododermatitis on the productivity and welfare of their birds by their respective State Veterinary Office.

The Directors and Staff of the Department of Veterinary Services, in Borno and Yobe States, should enlighten Broiler farmers on the importance of maintenance of a dry litter with high quality.

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Conflict of Interest

The authors declare no conflict of interest.

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