Influence of raised plastic floors compared with pine shaving litter on environment and Pekin duck condition

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ABSTRACT Commercial poultry production management practices have been under increased public scrutiny driven by concerns for food safety and animal welfare. Within the United States, wood shavings and raised plastic floors are common flooring systems used in duck production. It is intuitive that each flooring type would present different management challenges influencing physical characteristics of growing ducks. This study evaluated the relationship between flooring type and duck condition during the winter. Random samples of 20 ducks from 5 predetermined areas (n = 100) were examined in commercial duck houses (n = 9, litter; n = 11, raised plastic slats). Ducks were assessed at 7, 21, and 32 d of age for eye, nostril, and feather cleanliness, feather and foot pad quality, and gait. The data were analyzed to determine the proportion of ducks with a given score. In both housing types, the proportion of 0 scores for foot pad quality improved during the production cycle ($P < 0.0001$). Feather hygiene declined with age in ducks reared on litter flooring, whereas ducks reared on slatted flooring had cleaner feathers at d 32 ($P < 0.011$). With the exception of foot pad scores, the majority of ducks had no detectable problems for any single trait. The only main effect due to flooring pertained to feather quality with the proportion of ducks having a 0 or 1 score greater in litter flooring systems than slats ($P < 0.05$). Overall, the condition of ducks reared, regardless of flooring system, was considered to be good.

Key words: duck, health, litter flooring, slat, welfare

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INTRODUCTION

Within the realm of poultry production, increased scrutiny of how poultry are managed has been driven by many factors including increased consumer awareness about the commercial production environment, food safety, and animal welfare. The challenge for the current generation of poultry scientists will be to bridge a perceived ethics gap between poultry producers and consumer perceptions of poultry welfare (Te Velde et al., 2002; Dawkins et al., 2004; Bessei, 2006).

With respect to poultry welfare, the discussion often encompasses multiple scientific disciplines and common management practices. The positive biological responses and economic returns associated with genetic selection for productivity (e.g., growth, egg production) have also contributed to an increased incidence of negatively correlated traits, especially skeletal development (broilers, turkeys) and skeletal integrity (layers; Decuypere et al., 2010; Quinton et al., 2011; Wolc et al., 2011). It is important to note that these negative correlations often result from interactions between genotype, rearing environment, and management practices and are not necessarily the direct result of selection. There have been numerous reports over the last 30 yr that have demonstrated these types of interactions with laying hens and broilers (e.g., Craig and Adams, 1984; Wilson et al., 1984; Craig and Lee, 1989; Webster and Hurnt, 1990; Lay et al., 2011).

There have been few reports in the literature that have addressed commercial duck management practices and the effect on the welfare of commercial Pekin ducks with most of these conducted in Europe (Rodenburg et al., 2005; Jones and Dawkins, 2010a,b). The study by Jones and Dawkins (2010b) was conducted in commercial facilities in the United Kingdom (n = 46) and included differing ventilation, water, and feeding systems. The authors developed an evaluation system that they used to visually assess individual ducks with quality scores for the eyes and nostrils, feather cleanliness and quality, locomotion and foot pad status. It is important to note that in the United Kingdom, solid flooring with straw as bedding is the predominant commercial

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flooring system, whereas in the United States, farms typically have solid floors with litter (wood shavings), raised wire/plastic floors, or a combination of the two. It is intuitive that the type of flooring system could influence, either positively or negatively, both the environment and physical characteristics of commercial ducks. For example, it could be hypothesized that frequent removal of manure in a slatted floor system would improve ammonia management and improve foot pad scores. The litter environment and the inherent dust associated with the microenvironment created by the normal rooting behavior of ducks housed on wood shavings could be hypothesized to have a negative effect on nostril and eye scores. The objective of the current study was to determine the influence of raised plastic floors (slats) versus solid floors with pine shavings (litter) on the physical characteristics of commercial Pekin ducks throughout the production cycle.

MATERIALS AND METHODS

When this experiment was designed, particular attention was paid to equalizing normal production variables across experimental flocks, i.e., breeder flock age, density, brooding schedule, nipple drinkers. This was done to better delineate the effects of flooring type on the characteristics of the growing ducks. It is well recognized within the poultry industry that mid-winter poultry management is problematic, particularly in northern states. It is a continual balancing act between conserving heat while at the same time allowing for sufficient ventilation to maintain air quality. The process is even more tenuous in facilities without power ventilation systems, which would include a large proportion of the duck houses under contract to Maple Leaf Farms Inc. (Leesburg, IN). For the reasons outlined above, we purposely chose flocks placed in January through March to control for seasonal influence and to maximize potential differences due to the rearing/flooring environment.

Housing and Birds

The study was conducted from January to March (2011) in commercial duck farms (Maple Leaf Farms Inc.) located in distinct geographical locations in northeastern Indiana (location A), northern Indiana (location B), and southern Wisconsin (location C). The barns used in this study differed primarily in flooring type (litter, n = 9; slats, n = 11). The houses with slats all used charcoal stoves for supplemental heat during brooding, and this was not the case for those houses with litter floors. Flock density was standardized across barns to 0.16 m^2 per duck, which corresponds to the recommendations of the Guide for the Care and Use of Agricultural Animals in Research and Teaching (Federation of Animal Science Societies, 2010). Because of differences in the sizes of individual barns, this resulted in 6,350 to 9,550 ducks per house on litter flooring and 10,000 to 10,300 ducks per house on slats. The ducks used throughout the experiment were from the commercial Pekin strain developed and used by Maple Leaf Farms. Placement was at day of age, and all ducks were brooded in approximately one-third of the house through 10 d of age and then given access to the entire house. All ducks were processed at commercial target weights (~3.5 kg) and ages (32 to 36 d) at a Maple Leaf Farms processing facility. The Michigan State University Institutional Animal Care and Use Committee approved an exemption because the project was conducted in commercial facilities.

Duck Physical Condition Scores

The physical condition of the ducks was evaluated at 3 ages: 7 to 8 (7 d), 21 to 24 (21 d), and 30 to 33 (32 d) posthatch. The day in parentheses represents the day reported for scoring; the actual date varied as indicated due to inclement weather and availability of researcher travel days. One hundred ducks per flock were included in each evaluation; 20 ducks were randomly sampled at each of 5 predetermined barn locations (4 corners and middle of the house). Groups of ducks (n = 20) were penned at each location through the use of hinged catching frames, and individual ducks within each group were scored by a team of 3 trained individuals using the scoring rubric shown in Table 1. Prior to the start of the study, all individuals involved in scoring the ducks attended an on-farm training session, which involved scoring ducks and modifying scoring definitions until consensus was reached. Additionally, team membership was scrambled as much as possible to minimize the possibility of interrater reliability issues. After being scored, the ducks were placed on the flooring system and gait was assessed as the ducks walked away from the researchers, sometimes after a short period of running, to rejoin the flock.

The individual duck physical condition scores used in this study were modified from the scoring system reported by Jones and Dawkins (2010b). Modifications to the scoring system were made in conjunction with Maple Leaf Farms Inc. requiring all ducks to be individually handled when scored. Additionally, this scoring rubric included verbal descriptions and pictures of each trait and score, respectively (Table 1). The individual traits scored were identified on a scale of 0 to 1 (nostril and feather cleanliness) or 0 to 2 (eyes, feather quality, foot pad quality, and gait) where 0 was the best or ideal condition or situation and a 1 or 2 indicates a worse condition for that specific quality.

Environmental Data

Barn temperature was recorded each scoring day using a Kestrel 3000 Wind Meter (QC Supply, Schuyler, NE) handheld thermometer at both ends and the center of each barn. Handheld instruments were used to record CO (Industrial Scientific T40 CO Rattler,

Table 1. Duck condition criteria scores and definitions[1]

Condition	Score	Definition
Eyes	0	Best: eyes clear, clean, and bright
	1	Moderate: dirt or staining around the eye area or any evidence of wet eye ring
	2	Worst: Inflamed eye lids, conjunctivitis, eyes sealed shut or blind
Nostril cleanliness	0	Best: Nostrils with clean and clear air passage ways
	1	Worst: Nostril air passageways blocked with dust or mucus
Feather cleanliness	0	Best: Clean and unstained down or feathers
	1	Worst: Adhering manure or staining on down or feathers
Feather quality	0	Best: Good coverage of down or feathers
	1	Moderate: Some evidence of down/feather picking or damaged area (as evident by short and stubby down/feathers) less than 1 cm^2 (5/32 $inch^2$)
	2	Worst: Severe feather picking (as evidenced by blood) or damaged areas (as evident by short and stubbly down/feathers) of greater than 2 cm^2 (5/16 $inch^2$)
Heel and toe pads	0	Best: Heel and toe pads free of any lesions or ingrained dirt
	1	Moderate: Pads are callused or cracked but lesions cover less than 50% of the pad area and are free of blood
	2	Worst: Lesions or callouses cover 50% or more of pads or any bloody lesions
Gait	0	Best: Duck waddles and walks freely
	1	Moderate: Duck walks with slight limp, or walking is labored due to crossed feet, bowlegs resulting in a awkward gait
	2	Worst: Ducks reluctant to walk, will only walk short distances when encouraged, typically due to obvious leg problems (synovitis, severely crossed feet or extreme bowing of the legs)

[1]The full scoring rubric with photographs can be requested from Maple Leaf Farms Inc. (Milford, IN).

Grainger Industrial Supply Inc., Indianapolis, IN), RH (EXTECH USB Data logger, model RHT10, Cole Parmer Inc., Vernon Hills, IL), and NH_3 (TOXIRAE II, QC Supply, Schuyler, NE) levels in the center of each barn on scoring days. All measurements were made at the human level.

Production Data

Production measures included live weight, mortality, and condemnation at the processing plant. A final live weight was determined for each flock at the processing plant, and gain per day was subsequently calculated. Although there was individual variability in scoring days, average days to processing were similar between locations. Individual producers reported daily mortality and the number of culls due to lameness. Processing plant condemnations were recorded on a per flock basis.

Statistical Analyses

The assessment data were binomial (or converted to binomial when 0 to 2 scores were used), not transformed, and analyzed using SAS PROC GLIMMIX. Data were organized by characteristic with total number of ducks per barn earning a particular score divided by total number of ducks observed (100) per location and age. Model was the response variable explained by age and flooring type and their interaction. A solution could not be found when location was tested as an interaction with the other variables resulting in location as a main effect separate from age and flooring type. The model was run once for characteristics measured on a binomial scale 0 to 1. Because the prevalence of 0 scores (perfect condition) and 2 scores (poorest condition) may both have implications for welfare, the model was run twice for characteristics measured on a 0 to 2 scale to evaluate 0 versus 1 scores and 0 versus 2 scores. However, in some instances there were a very small number of 2 scores that would not allow for a solution to be found. Therefore, in some cases the scales had to be collapsed for analysis for characteristics originally measured on a 0 to 2 scale with the model evaluating 0 versus 1 and 2 scores. Data were expressed as a proportion of ducks exhibiting a specific score at each age by flooring type. The production and environmental data were analyzed using PROC MIXED with the same model as described above. Statistical difference was considered at $P \leq 0.05$.

RESULTS

Environmental and Production Data

The environmental variables indicated a single difference existed between flooring types (Table 2). The RH was lower in houses with slats compared with litter flooring at 32 d ($P < 0.05$). There were no effects of flooring type on the production parameters measured (Table 3), except a higher percentage of ducks were condemned at the processing plant from slats compared with litter flooring ($P < 0.001$).

Duck Physical Condition Scores

There are very few differences observed between the ducks reared on slats versus litter flooring. Eye scores of 0, 1, or 2 were different among locations (Table 4 and 5; $P < 0.05$). Ducks at location B were different from location C for all scores ($P < 0.05$). However, location A was different from location C for eye score 1 ($P < 0.05$) and between locations A and B for eye score 2 ($P \leq 0.05$; Table 5).

Table 2. Environmental house means and SE from commercial ducks reared on 2 types of flooring systems[1]

Age (d)	CO (ppm)		NH_3 (ppm)		Temperature[2] (°C)						RH (%)	
					Zone 1		Zone 2		Zone 3			
	Litter	Slats	Litter	Slats	Litter	Slats	Litter	Slats	Litter	Slats	Litter	Slats
7	5.9 ± 2.1	7.1 ± 2.3	5.8 ± 1.6	6.6 ± 1.5	21.9 ± 1.4	20.1 ± 1.5	22.9 ± 1.3	20.1 ± 1.6	23.4 ± 2.8	22.2 ± 1.9	63.7 ± 3.7	68.1 ± 4.0
21	1.6 ± 1.8	2.8 ± 2.6	6.5 ± 1.4	9.0 ± 1.8	14.2 ± 1.3	16.7 ± 1.5	14.4 ± 1.5	16.6 ± 1.4	15.6 ± 1.7	16.2 ± 1.5	71.8 ± 3.1	72.9 ± 3.6
32	1.3 ± 2.4	1.6 ± 2.6	5.5 ± 1.8	9.9 ± 1.9	12.7 ± 1.6	17.1 ± 1.6	13.0 ± 1.5	17.0 ± 2.0	14.2 ± 1.5	15.4 ± 2.3	76.9 ± 3.4	62.4 ± 3.8*

[1]Means represent n = 9 litter houses, n = 11 raised plastic (slat) floor houses.

[2]Zone 1 = front of house; zone 2 = center of house; zone 3 = back of house.

*Statistical significance at $P \leq 0.05$ compared with litter flooring at the same age.

Main effects of age and location were important when evaluating nostril cleanliness (Table 4). Ducks on both slats and litter flooring had a higher proportion of ducks with 0 scores at 7 d compared with 21, and at 32 d versus 21 d ($P \leq 0.002$; Table 5). All nostril cleanliness scores were different between location A and B, and location B and C ($P \leq 0.05$; Table 5).

The age × floor interaction had an effect when evaluating feather cleanliness (Table 4). A larger percentage of 7-d-old ducks scored 0 on litter compared with slats ($P < 0.01$). However, the proportion of 0 scores was reversed by d 32, with a greater proportion of ducks on slats than ducks on litter flooring scoring 0 ($P < 0.01$). Differences also existed between locations with both A and B different from location C for all duck scores ($P < 0.04$, Table 5).

No location effect was observed when feather quality was evaluated (Table 4). The main effect of flooring type influenced the proportion of ducks with 0 or 1 scores ($P \leq 0.05$). Ducks reared on litter had a higher proportion of 0 scores compared with ducks on slats at all ages. A greater proportion of 32-d-old ducks had a score of 2 compared with 7-d-old ducks, resulting in an age main effect ($P < 0.01$, Table 5).

Foot pad quality scores were influenced by age (Table 4). The proportion of ducks scored as 0 or 1 was different between d 7 and 21, d 21 and 32, and d 7 and 32 ($P \leq 0.006$, Table 5). Ducks foot pad scores of 2 were notably different between d 7 and 21 and d 21 and 32 ($P \leq 0.008$). An effect of location existed when foot pad quality was scored 2 with differences between all locations ($P < 0.001$, Table 4,5).

The proportion of ducks with gait scores of 0 or 1 were influenced by location ($P \leq 0.002$, Table 4). Differences were found between locations A and B and B and C ($P < 0.01$, Table 5).

DISCUSSION

Regional poultry production decisions necessarily include the availability and cost of local resources that can subsequently influence management decisions and challenges. For example, fresh shavings litter is continually added to commercial duck houses over the course of a production cycle, placing considerable importance on the availability of fresh litter in areas of concentrated duck production [M. Turk (retired), vice president of production, Maple Leaf Farms, personal communication]. Rearing ducks on raised wire or plastic floors alleviates the litter source concerns, but may present a different set of challenges with respect to optimizing duck performance and welfare.

Within the past decade, several papers have addressed various aspects of commercial duck welfare (Rodenburg et al., 2005; Waitt et al., 2009; Jones and Dawkins, 2010a,b). As alluded to earlier in the paper, the interpretation of studies on the welfare of commercial poultry is often difficult because environmental effects may preclude or predispose birds to particular

Table 3. Production numbers (means and SE) from commercial ducks reared on 2 types of flooring systems[1]

Flooring type	Mortality (%)	Culls[2] (%)	Plant condemned (%)	Gain per day (kg)
Litter	2.74 ± 0.35	0.42 ± 0.13	2.0 ± 0.57	0.19 ± 0.002
Slats	3.83 ± 0.41	0.77 ± 0.15	6.3 ± 0.66*	0.19 ± 0.003

[1]Means represent n = 9 litter houses, n = 11 raised plastic (slat) floor houses.

[2]Due to lameness; thus a gait score of 2.

*Statistical significance at $P < 0.001$ compared with litter flooring.

habits or behaviors that may or may not be indicative of the overall welfare of the animal. The current study was conducted in commercial facilities during the winter with an attempt to equalize as many production factors across experimental flocks (i.e., density, brooding schedule, nipple drinkers, trough feeders) to better delineate the effects of flooring type on the characteristics of the growing ducks. The only difference in the environmental variables measured was RH at 32 d with slats lower than litter ($P \leq 0.05$, Table 2). Although not all possible environmental measurements were assessed (e.g., dust level), this suggests that similar management programs, regardless of flooring type, may result in similar environmental conditions. In addition to the lack of environmental differences due to flooring type, all CO and NH_3 values were well below

Table 4. Proportion of ducks with scores (means and SE) from commercial ducks reared on 2 types of flooring systems[1]

Trait	Flooring type	Day	Score 0 (%)	Score 1 (%)	Score 2 (%)	Source of variation	P-value: 0 score	P-value: 1 score	P-value: 2 score
Eyes									
	Litter	7	88.3 ± 5.9	11.5 ± 5.7	N/A[2]	Age	NS	NS	NS
		21	93.0 ± 4.1	6.1 ± 3.6	0.5 ± 0.3	Floor	NS	NS	NS
		32	98.7 ± 1.6	1.2 ± 1.5	0.06 ± 0.1	Age × floor	NS	NS	NS
	Slats	7	94.1 ± 3.6	5.4 ± 3.2	0.1 ± 0.2	Location	0.04	<0.05	<0.001
		21	97.4 ± 2.0	2.3 ± 1.7	0.2 ± 0.2				
		32	91.3 ± 4.6	7.2 ± 3.8	1.3 ± 0.7				
Nostril cleanliness									
	Litter	7	85.3 ± 5.3	14.6 ± 5.3		Age	<0.001	<0.001	
		21	69.1 ± 6.6	31.0 ± 6.7		Floor	NS	NS	
		32	88.5 ± 4.6	11.5 ± 4.6		Age × floor	NS	NS	
	Slats	7	95.1 ± 2.9	4.9 ± 2.9		Location	0.009	0.009	
		21	59.1 ± 7.9	40.8 ± 7.9					
		32	80.7 ± 5.7	19.2 ± 5.7					
Feather cleanliness									
	Litter	7	99.0 ± 0.9	1.0 ± 0.9		Age	NS	NS	
		21	92.6 ± 2.2	7.5 ± 2.2		Floor	NS	NS	
		32	91.2 ± 2.5	8.8 ± 2.5		Age × floor	0.01	0.01	
	Slats	7	94.2 ± 2.1	5.8 ± 2.1		Location	0.009	0.009	
		21	93.4 ± 2.1	6.6 ± 2.1					
		32	98.1 ± 1.0	1.9 ± 1.0					
Feather quality									
	Litter	7	99.1 ± 1.2	0.7 ± 0.1	0.15 ± 0.2	Age	NS	NS	0.02
		21	97.7 ± 2.0	2.0 ± 1.7	0.27 ± 0.3	Floor	0.04	<0.05	NS
		32	92.8 ± 3.7	5.2 ± 2.8	1.7 ± 1.0	Age × floor	NS	NS	NS
	Slats	7	92.1 ± 4.0	8.7 ± 4.1	0.04 ± 0.1	Location	NS	NS	NS
		21	92.9 ± 3.6	4.1 ± 2.3	2.2 ± 1.3				
		32	87.2 ± 5.5	10.4 ± 4.5	2.1 ± 1.2				
Foot pad quality									
	Litter	7	6.5 ± 4.1	88.3 ± 5.3	2.7 ± 1.6	Age	<0.001	<0.001	0.005
		21	32.9 ± 7.8	43.9 ± 7.6	17.8 ± 4.8	Floor	0.02	NS	NS
		32	70.5 ± 7.8	19.6 ± 6.0	4.5 ± 2.2	Age × floor	NS	NS	NS
	Slats	7	25.3 ± 8.3	70.5 ± 8.0	3.7 ± 1.8	Location	NS	NS	<0.001
		21	58.0 ± 9.2	35.5 ± 8.3	5.4 ± 2.2				
		32	80.8 ± 6.8	17.5 ± 6.4	2.1 ± 1.2				
Gait									
	Litter	7	99.3 ± 0.5	0.7 ± 0.4	N/A	Age	NS	NS	
		21	99.7 ± 0.3	0.3 ± 0.3		Floor	NS	NS	
		32	98.9 ± 0.6	1.1 ± 0.6		Age × floor	NS	NS	
	Slats	7	99.1 ± 0.5	0.9 ± 0.5		Location	0.002	0.002	
		21	99.2 ± 0.4	0.7 ± 0.4					
		32	99.2 ± 0.4	0.7 ± 0.4					

[1]Means represent n = 9 litter houses, n = 11 raised plastic floor (slat) houses.

[2]N/A = model could not estimate as a result of too few 2 scores. As a result, 2 scores were added to 1 scores.

Table 5. Probability of main effects for age and location on duck scores from commercial ducks reared on 2 types of flooring systems[1,2]

		P-value			*P*-value		
Trait	Score	7 vs. 21 d of age	21 vs. 32 d of age	7 vs. 32 d of age	Location A vs. B	Location A vs. C	Location B vs. C
Eyes							
	0	NS	NS	NS	NS	NS	0.018
	1	NS	NS	NS	NS	<0.05	0.018
	2	NS	NS	NS	0.0005	NS	0.047
Nostril cleanliness							
	0	0.0001	0.002	NS	<0.05	NS	0.004
	1	0.0001	0.002	NS	<0.05	NS	0.004
Feather cleanliness							
	0	NS	NS	NS	NS	0.04	0.002
	1	NS	NS	NS	NS	0.04	0.002
Feather quality							
	0	NS	NS	NS	NS	NS	NS
	1	NS	NS	NS	NS	NS	NS
	2	NS	NS	0.012	NS	NS	NS
Foot pad quality							
	0	0.0005	0.0004	<0.0001	NS	NS	NS
	1	<0.0001	0.003	<0.0001	NS	NS	NS
	2	0.008	0.006	NS	0.002	0.005	<0.0001
Gait							
	0	NS	NS	NS	0.007	NS	0.01
	1	NS	NS	NS	0.007	NS	0.009

[1]n = 9 litter houses; n = 11 raised plastic floor (slat) houses.

[2]Location of commercial duck houses: location A in northeastern Indiana, location B in northern Indiana, location C in southern Wisconsin.

accepted industry standards, and below the 11 ppm NH_3 values reported by Carlile (1984), DEFRA (2009), FASS (2010), and Jones and Dawkins (2010b).

Table 3 reports average mortality across housing types, finding 1.4 to 2.5% less than the 5.2% reported by Jones and Dawkins (2010b); this is most likely due to the reduction in days needed to reach a similar BW (32 vs. 41 d). In the scope of animal production, this reduction in days to market could also potentially minimize a host of negative, age-related effects on animal well-being.

The current study found main effect differences in eyes, nostril cleanliness, feather cleanliness, feather quality, foot pad quality, and gait. With the exception of feather quality, an effect of location was found with each variable measured (Table 4). Although the experimental design tried to minimize differences, the data suggests that management practices still vary and could account for some of the differences observed. Therefore, no specific explanation can be used to comment on why these differences existed.

The greatest proportion of ducks in both flooring systems had 0 scores for all traits at all ages with the exception of foot pad quality (Table 4). Although the stated objective was to identify potential differences due to flooring system, the data also targeted selected ages that could be used in future studies to model the development or amelioration of a particular trait [e.g., the high proportion of foot pads with a score of 1 in 7-d-old ducklings in both flooring systems compared with older ages ($P \leq 0.0005$; Tables 4 and 5)].

Shepherd and Fairchild (2010) reviewed the literature associated with foot pad dermatitis and associated causes. The type of litter, moisture level, and season of the year were cited as important factors predisposing broilers to foot pad dermatitis. In the current study, the foot pad scores were better in both flooring systems with age (Tables 4 and 5). In the ducklings brooded on slatted floors, there was a higher proportion of 0 scores at 7 d old compared with litter (Table 4). However, irrespective of flooring type, the proportion of ducks with 2 scores increased from 7 to 21 d old and then decreased from 21 to 32 d old. The increased presence of number 2 observations at 21 d old may be due to the sticky nature of excreta in young ducks, in that it sticks to the foot pad and does not fall through the slats as easily when ducks are younger, and management of the litter may influence the issue as well. Jensen et al. (1970) reported on the effects of diet on the incidence of foot pad dermatitis in turkey poults at 10 d of age. Their initial studies were carried out in brooders with a quarter-inch wire mesh screen covering the brooder. When the wire mesh screen was removed, the incidence of foot pad dermatitis was reduced and their conclusion was that mesh predisposed the poults to prolonged contact with the excreta, resulting in the onset of dermatitis. Therefore, management options designed to reduce prolonged excreta contact with the web of young ducklings in either system should be explored during the brooding phase because they may help improve the foot pad quality in older ducks.

Knierim et al. (2004) previously reported that an open water source is important for maintaining good eye quality, nostril cleanliness, and plumage condition. Meanwhile, O'Driscoll and Broom (2011) found no difference in eye quality when nipple waterers, bell waterers, and open trough waterers were used in duck rearing. However, ducks on nipple waterers had more dirty and blocked nostrils compared with those housed with the other watering systems. Only nipple waterers were available to ducks in the current study. The differences between eye and nostril cleanliness scores between ducks housed on slats versus litter flooring therefore indicate that multiple management practices such as drinkers, flooring, and air quality may interact to affect these outcomes (Table 4). Eye condition was not affected in this study statistically. However, the nostril cleanliness was affected by age with 21-d-old scores being statistically different from 7 and 32 d old (Table 5). Therefore, without measuring the dust and particulate matter within the houses, it is hard to determine the exact contributions to the nostril cleanliness at different ages.

The overall incidence of dirty feathers was very low at all ages in both flooring systems but the only age × floor interaction was found (Table 4). Ducks on litter at 7 d had more 0 scores compared with slats; however, this observation switched at 32 d old with more ducks on slats having 0 scores ($P \leq 0.05$). Although it was not quantified, authors observed more staining of the feathers on ducks reared on litter and speculate it is likely due to oils and tannins released from the wood shavings due to moisture.

Similar to feather cleanliness, feather quality scores for the largest portion of ducks were 0 (Table 4). The ducks on litter had overall more 0 scores compared with slats. Regardless, the 2 scores increased with age (Table 5). Although the incidence of feather picking was not measured, authors subjectively observed an increased incidence of dried blood on the tips of the primary wing feathers, which may account for the increased scores. Rodenburg et al. (2005) cited work by Leipoldt (1992) in which the incidence of feather picking was increased in ducks reared on a 100% slatted floor compared with those reared on 100% litter or a mix of 50:50 slats:litter. The authors hypothesize that this may be an indication of the ducks inability to forage or perform other seeking behaviors on slats that could be expressed in a litter floor environment. However, this remains to be tested further.

Because there have been no refined or empirical description of normal gait in any duck species, we recognized that gait scoring or walking ability may not be accurately determined in ducks that were handled and released following individual assessment. Although efforts were made to score the ducks as they walked, not ran, the ducks' natural fear response and attempt to increase the distance between themselves and the human observers may have overridden any minor or moderate lameness due to pain. Therefore, we recognize the gait data are quite subjective (Table 4).

In summary, this study is the first to document environmental parameters in commercial duck facilities related strictly to flooring type as well as to assess the physical characteristics of the ducks reared in these facilities within the United States. This initial study was conducted during the winter months in 3 locations throughout Indiana and Wisconsin when it was accepted that natural ventilation would be reduced to conserve heat. Given that our feather quality data agrees with other, older reports in the literature, further studies are warranted to investigate environmental modifiers or enrichment approaches that might serve to mitigate the behaviors contributing to the observed negative effects on feather quality, such as methods provision of foraging substrates. With respect to the traits measured, although a predominant scoring of 0 (indicating no detectable problems) was given to the majority of ducks on both flooring systems, further evaluations of flooring type and other management practices need to be conducted to target and reduce the incidence of those ducks scoring 1 and 2. Finally, further research is necessary to evaluate the relationships between the scoring system with respect to well-being and productivity outcomes.

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