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Slatted floor reduces the welfare and increases the foot pad dermatitis and growth performance of Turkeys under Egyptian conditions

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Abstract
Background: When Turkeys' legscome in contact with their dropping during the growing stage results in footpad dermatitis condition which affects the poult's welfare and productivity.
Aim: Our experiment aimed to detect the impact of various bedding substrates on the wellbeing, and performance of growing Turkey under Egyptian conditions.
Methods: 180-day-old Turkey poults were allocated into three treatments. In treatment I, the poults [60 each with three replicates (n = 20 birds)] were kept on wood shavings (WS); in the second treatment, the poults were housed on chopped wheat straw (CWS). However, in the third treatment, they kept on a plastic slatted floor (PSF).
Results: The greater feed intake and body weight were recorded in poults reared in PSF compared with those kept in other treatments (WS and CWS). Feed conversion ratio did not show any significant difference. The mortality percentage was higher in the PSF group than in the WS one. The frequency of feeding and drinking behavior was higher in poults reared on WS treatment compared with other treatments CWS and PSF. On the other hand, resting behavior showed the highest frequency in poults kept in PSF. Contrary, the lowest frequency of walking behavior was recorded in poults reared in PSF treatment. In addition, the poults kept in WS had a longer tonic immobility reaction period followed by those kept in PSF and CWS. Concerning foot-pad dermatitis, the highest score of 0 was observed in the CWS group, while the highest score of 1 was recorded among poults kept in the WS group. On the other side, the highest score 2, 3, and 4 was observed in the poults reared in the PSF group. Heterophil/Lymphocyte ratio of Turkey poults was higher in PSF. While T3 and T4 concentrations in blood were not affected by using different bedding materials.
Conclusion: It is concluded that the slatted floor was good for Turkey producers from the point of performance but, it is the worst from the point of welfare.
Keywords: Behavior, Bedding materials, Footpad dermatitis, Turkey, Welfare.

Introduction

Seven million tons of Turkey meat will be expected to be consumed in 2025 (Johnson, 2018) because Turkey meat follows chicken meat in importance (USDA, 2022). Poultry welfare and soundness are affected significantly by housing factors. The common poultry-keeping system is deep litter in Egypt (Youssef *et al.*, 2011). Some behaviors are essential for the bird's well-being like; litter scratching, dust bathing, and pecking (Bessei, 2006; Sandilands and Hocking, 2011). After the fattening stage, dropping and feed residues constitute about 80% of the major part of the bedding dry matter (Kamphues *et al.*, 2011). Subsequently, Turkeys are continuously in contact with its excreta in the bedding. If litter conditions become suboptimal due to the drying properties are poor, the poult leg will develop ulcerations and contact dermatitis (Haslam *et al.*, 2007; Youssef *et al.*, 2010).

Footpad contact dermatitis (FPD) is a vital indicator for Turkey wellbeing. FPD is characterized by poor walking and sometimes irritable and painful (Weber Wyneken *et al.*, 2015). When birds have poor walking, they cannot access feed and water resulting in a lower growth rate (de Jong *et al.*, 2012; Jankowski *et*

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al., 2015). Many researchers mentioned that FPD is linked to poor litter conditions (Meluzzi *et al.*, 2008). The percent of Turkeys' FPD is increased if the litter moisture is high (Hocking and Wu, 2013). Absent of excreta in wet litter was enough to induce FPD in Turkey (Mayne *et al.*, 2007; Youssef, 2011).

The incidence of FPD is high and widespread in intensive Turkey (*Meleagris gallopavo*) farms in Europe and represents a potential welfare and economic issue in the production sectors (Yahav, 2000). In Germany, Krautwald-Junghanns *et al.* (2011) recorded that the percentage of FPD is about 34% in males and 60% in females' Turkey at 4 months of age. However, in French, Allain *et al.* (2009) found that the percentage of FPD was 41% among Turkey flocks. In addition, in Swedish, Berg (1998) recorded that the ratio of severe and mild FPD is 20%–78%, also, investigated the Swedish broiler sector and found the ratio of severe and mild FPD is 10%–35%, respectively. Deep footpad lesions cause stress and are very painful for birds (de Jong *et al.*, 2014), resulting in bad health conditions if other infections occur. Finally, low performance occurred (Mayne *et al.*, 2007).

To decrease FPD, rearing Turkeys on bedding materials other than straw as well as reducing litter moisture scores should be practiced for managerial and economic reasons in commercial poultry farms. The plastic slatted flooring is already used in layers, (Heerkens *et al.*, 2015) and broiler poultry farms in Asia (Bilal *et al.*, 2014) to lower the contact time between dropping and Turkey legs. Rearing the birds on the ground without litter affected the behavior and welfare of birds (Bergmann *et al.*, 2013). Also, understanding birds' specific behaviors can help in welfare assessment (Anonymus, 2015; Special Eurobarometer, 2015).

The main objective of our experiment was to assess the effects of using various bedding substrates on behavior, productivity, and leg health.

Material and Methods

Study period and location

This experiment was performed from March to May 2022, at the Poultry Centre, Faculty of Veterinary Medicine, Kafrelsheikh University, Egypt. 180 1-day-old Turkey poults and removed from the trusted hatchery. Their initial body weight (IBW) was 60 ± 2.3 g and kept under ideal management conditions.

Housing and experimental design

Three treatments were performed (60 poults in each with three replicates, n = 20 birds) according to the floor bedding materials used in the pen. At the end of the experiment, Turkey stocking densities were about 25 kg/m^2. The poults were raised in pens littered with wood shavings (WS) (5 cm depth) for the first 7 days of the brooding period. During this period, the bedding material was kept dry and clean. After the adaptation period, the poults were prepared in a randomized sequence of three groups and each treatment was started.

In treatment I, the poults (60 poults) were kept on dry WS; poults in the second treatment, were housed completely on dry chopped wheat straw (CWS). During the experimental period, the poults in WS and CWS kept in contact with droppings. However, the poults in the third treatment, they kept on a plastic slatted floor (PSF) where there is a low contact with dropping due to the excreta passing through the PSF holes (15–10 mm in diameter) to store under it. The distance between PSF and the ground is approximately 30 cm (Chuppava *et al.*, 2018).

All poults fed on a commercial standard diet (broiler starter; crude protein = 23%, metabolizable energy = 3,000 kcal/kg) (Almagd Company, Quesina city, Menufiya Governorate, Egypt) ad libitum. Bell drinkers were used. All poults were raised in controlled environmental pens. LED lamps were used for lighting. Light intensity in the first week is 40 lux, and from the second week to the final day length is 5 lux (Mousa-Balabel *et al.*, 2023). Continuous lighting was used in the first 3 days then changed to 16 hours light: 8 hours darkness. The pen temperature began at 33°C and then reduced weekly to 21°C by day 35.

Performance measurement

The patient's body weight (BW) was taken weekly. At day 60, the final poult body weight was recorded. Feed (FI) water intakes, and feed conversion ratio (FCR) were calculated based on feed fed along the experimental duration by dividing the total feed intake (TFI) by the final body weight gain (BWG). Mortality percent was recorded at the end of the study according to El-Husseiny *et al.* (2000).

Score of FPD

Signs of footpad lesions were examined externally for poults (five randomly selected birds/group). In the beginning, all poults were checked for footpads and then checked weekly until day 60. The leg pads were carefully cleaned with lukewarm water and a sponge to remove dirtiness and dried with tissue paper, to enable the score and severity of FPD. The middle plantar was scored according to Stracke *et al.* (2021) by two trained observers. The scoring system ranges from 0 to 4 according scale taken by Hocking *et al.* (2008); the scores are; 0 (Intact foot with no obvious signs of FPD); 1 (Small area about % of foot, covered with necrotic cells); 2 (The area which covered with necrotic cells reached 25% of foot); 3 (The area which covered with necrotic cells reached 50% of foot) and 4 (The area which covered with necrotic cells more than 50% of foot). Tonic immobility (TI): A total of 45 ducks (15 poultsper group) were tested individually for the duration of TI duration according to Ghareeb *et al.* (2008).

Behavior observation

Video cameras (Panasonic WV-CF224FX; Panasonic Corporation of North America, Secaucus, NJ) hinged on the ceiling of each pen were used to record additional measurements about the behavior

of the poults. From week 2 and every week, video recordings were made in each pen over 24 hours for all trials. A solitary observer conducted field-of-view observations using an instantaneous scan sampling technique at 20-minute intervals, each group was monitored 3 days a week (twice a day; each of 30 minutes) for the duration of the entire experimental period at 7 am and 4 pm for reporting the different behavioral patterns (Torrey *et al.*, 2013). The behavioral Ethogram utilized includes feeding, drinking, resting (laying down), standing without engaging in any other action, and walking. Birds that walk or run for 2 or more minutes are considered to be active.

Blood sampling

Blood samples were taken from five randomly chosen chickens. Blood samples were then collected every week. Five milliliters of blood were extracted from the wing vein and placed in two sterile microtubes, one of which contained the anticoagulant ethylenediaminetetra-acetic acid (EDTA). The sera were extracted from the coagulated blood samples by centrifuging them at 3,000 rpm. The sera were then put into clean and sterile microtubes and kept at −20°C until they were tested for plasma T3 and T4 (Xie *et al.*, 2011).

The complete blood counts (CBCs) and differential white blood cell analyses of the uncoagulated blood samples were performed (Chung *et al.*, 2020). As described by Kaab *et al.* (2018), blood smears were made on the same day that blood was collected. Heterophil/lymphocyte (H/L) ratios were calculated by counting H/L numbers in a field of vision at 100× oil magnification until a total of 100 cells were counted (Beaulac and Schwean-Lardner, 2018).

Statistical analysis

The distributional normality and homogeneity of variance of the data were examined. It was reported as a means and examined using Graph Pad Prism 5's one-way ANOVA. The significance of the differences between the various groups was examined using the Duncan post hoc multiple comparisons test. At p 0.05, the significance level was established.

Ethical approval

The experimental designs performed in this study were approved by the Research Policy Committee of the Faculty of Veterinary Medicine, Kafrelsheikh University, Egypt.

Results

The performance results for Turkey are mentioned in Table 1. Final poults FI and BW (5,876 ± 0.624 and 2,856 ± 5.446 g, respectively) were greater ($p < 0.05$) in poults reared on the slatted floor (PSF) compared with those kept in other treatments (WS and CWS). FCR did not show any significant difference. The highest mortality percentage (11.7%) was observed in the PSF group while the lowest percentage (5%) was observed in the control group (WS).

Table 2 displays the varied behaviors of young Turkeys (the proportion of birds performing dependent on the bird numbers in a field of view). The regularity with which birds visit the feeder washing her in poults reared on CWS treatment (9.98 ± 1.155) compared with other treatments WS and PSF (7.01 ± 1.155 and 6.68 ±

Table 1. Effect of different floor materials on growing Turkey performance.

	WS	CWS	PSF	Significant	*p*-value
IBW (g)	60.00 ± 2.309	60.00 ± 1.155	60.00 ± 1.165	ns	0.4319
Final BW (g)	2,587 ± 5.937	2,806 ± 2.726	2,856 ± 5.446	*	0.0168
BWG (g)	2,527 ± 1.764	2,746 ± 3.786	2,796 ± 2.028	*	0.0432
Total FI (g)	5,798 ± 0.290	5,638 ± 0.328	5,876 ± 0.624	*	0.0322
FCR	2.29 ± 0.115	2.05 ± 0.088	2.10 ± 0.057	ns	0.6390
Mortality %	5	8.3	11.7	*	0.0321

(WS): Wood shaving; (CWS): Chopped wheat straw; (PSF): Plastic slatted floor; (ns): not significant.

Table 2. The frequencies of some growing Turkey behaviors are raised under different floor materials.

Behavior	WS	CWS	PSF	Significant	*p*-value
Feeding	7.01 ± 1.155	9.98 ± 1.155	6.68 ± 0.881	**	0.0034
Drinking	6.10 ± 0.547	9.47 ± 0.574	5.14 ± 0.577	**	0.0011
Resting	8.34 ± 1.202	11.31 ± 1.453	18.51 ± 0.577	***	0.0070
Walking	4.43 ± 0.819	3.86 ± 0.881	2.32 ± 1.155	*	0.0326
TI (second)	111.38 ± 21.50	42.32 ± 21.86	74.56 ± 22.41	**	0.007

(WS): Wood shaving; (CWS): Chopped wheat straw; (PSF): Plastic slatted floor.

0.881, respectively). The same results were observed in drinking behavior. On the other hand, resting behavior showed the highest frequency in poults kept in PSF. Contrary, the lowest frequency of walking behavior was recorded in poults reared in PSF treatment. In addition, the poults kept in WS had a longer TI reaction period (111.38 ± 21.50 seconds) followed by those kept in CWS and PSF (42.32 ± 21.86 and 74.56 ± 22.41 seconds, respectively).

This study showed a significant difference in scores of FPD among poults reared on different flooring systems. The highest score 0 of for FPD was observed in the group of WS, while the biggest score was observed among poults kept in the second group (CWS). On the other side, the highest scores 2,3, and 4 were observed in the poults reared on the slatted floor (PSF) as shown in Table 3.

Data on blood parameters are presented in Table 4. The H/L ratio of Turkey poults was higher in PSF (0.88 ± 0.016) treatment in comparison to those kept in WS and CWS (0.76 ± 0.014 and 0.80 ± 0.026, respectively; $p < 0.01$). Turkey poultsT_3 and T_4 concentration in blood was not affected by using different flooring materials.

Discussion

To maximize the growth performances of Turkeys, they should be managed well and raised in good environmental conditions especially litter traits and housing design. Litter quality in poultry farms is crucial to ensure the continuity of excellent and sustainable contributions to a stable human food supply (Alders *et al.*, 2018).

Table 3. Scores of footpad dermatitis in growing Turkey raised under different floor materials.

Flooring type		WS	CWS	PSF	Significant	*p*-value
Scores	0	60	43.3	25	**	0.0021
	1	10	20	15	**	0.0014
	2	8.3	15	15	*	0.0260
	3	6.7	5	10	*	0.0341
	4	15	16.7	35	**	0.0072

(WS): Wood shaving; (CWS): Chopped wheat straw; (PSF): Plastic slatted floor.

The records of this study proved that Turkeys reared on plastic slatted flooring systems had a significantly higher final BW in comparison with those housed in WS and CWS systems. Similar results were obtained from de Almeida *et al.* (2017); Cavusoglu *et al.* (2018). In addition, poults reared in PSF treatment had relatively higher TFI and BWG and an economic FCR than observed for poults reared in WS and CWS treatments. Birds preferred to peck and search in dry WS as compared to straw and slatted floors (Baxter *et al.*, 2018).

Slatted flooring would possibly offer almost no possibilities for the birds to forage (peck and manipulate particles) when no litter particles are available on the floor; therefore, feed pecking is preferable to pecking at the slatted floor (de Almeida *et al.*, 2017) resulting in better feed consumption. Pereira *et al.* (2007) found that in the slatted flooring device, there was air motion inside the plenum among the manure and the perforated floor, and the increased air motion reduced heat stress in birds (subsequently improving the FI) which negatively impacts the welfare and performance of broilers (Lara and Rostagno, 2013). The higher mortality rate on slatted floors may be related to bad immune status, lower walking behavior, and severe FPD recorded in this group.

Deciding the flooring material is very important to encourage the birds to perform their natural behavior. This study proved the effect of pen bedding materials on the behavioral repertoire of Turkey poults. There has been a big distinction between the bedding materials and Turkey behaviors. Resting behavior became higher in poults raised on the slatted ground than for those kept in WS and CWS treatments. Some of those differences in behavioral repertoire will be because of the severity and possibility of painful footpad lesions (Gentle *et al.*, 2001; Michel *et al.*, 2012). Moreover, poor walking ability in birds kept on the slatted floor indicates potential pain and behavioral restriction (Bessei, 2006; Baracho *et al.*, 2012). The causes of negative walking potential have many factors, but the main risk factors are obesity and poor litter conditions in broiler houses (de Jong *et al.*, 2014). Behavioral modifications proved the hypothesis that footpad lesions are severe and painful (Sinclair *et al.*, 2015).

Fear levels in birds can be assessed by the duration of TI (Ghareeb *et al.*, 2014). In this work, the reaction times of TI had been longer in poults kept on WS

Table 4. H/L ratio, T_3 and T_4 of growing Turkey raised under different floor materials.

	WS	CWS	PSF	Significant	*p*-value
H/L	0.76 ± 0.014	0.80 ± 0.026	0.88 ± 0.016	*	0.0123
T_3 (ng/dl)	6.67 ± 0.236	6.68 ± 0.235	6.73 ± 0.146	ns	0.1457
T_4 (ng/dl)	7.21 ± 0.863	7.10 ± 0.623	7.11 ± 0.870	ns	0.1213

(WS): Wood shaving; (CWS): Chopped wheat straw; (PSF): Plastic slatted floor; (ns): not significant.

treatment than those raised on slatted floors and CWS treatments. This result may be attributed to poults kept on WS being more active than other treatments.

FPD or contact dermatitis is a common inflammatory method in poultry species with maximum occurrence in broiler fowl and Turkey flocks. This is a disorder that may cause foot pad alternations, from the upper surface to the deepest skin layer, and according to the conditions of the circumstance, it indirectly induces more losses in production (PiéOrpí, 2020). Numerous elements affect the footpad conditions (Shepherd and Fairchild, 2010). Incorrect or anxious litter and flooring substances are considered the most vital risk factor for FPD (Haslam *et al.*, 2007), and it could be painful and have an effect on walking capability (Zikic *et al.*, 2017).

In this study, in Turkey, there was a relationship between flooring materials and the prevalence of FPD. The percent of all FPD scores were higher (worse) in poults reared on PSF except for the scores 0 and 1 in comparison with other treatments. Similar data were obtained by Bogosavljevic-Boskovic *et al.* (2012). Contrary, Li *et al.* (2017) confirmed that performance was not changed by using the plastic slatted flooring as a litter system in broiler production.

On the grounds that foot-pad dermatitis causes pain and pain prevents birds from reaching the feed. Moreover, foot-pad dermatitis reduces the profitability.

FPD negatively impacts the birds' welfare and overall performance data (Grandin, 2017). FPD is not only critical for fowl wellbeing but also for economic productivity (Bokkers and de Boer, 2009) because footpad lesions are painful and pain prevents birds from attaining the feeders. Finally, FPD reduces the farm benefit (de Jong *et al.*, 2014).

The response of H/L reaction to slight and moderate stressors leads to increase heterophils, whereas the response to intense or severe stressors results in basophilia (increasing in basophils number) and heteropenia (lowering in heterophils number), thus, the H/L ratio may become a reliable indicator on the degree of the stressor (Maxwell and Robertson, 1998). There was a tendency for increasing H/L ratios in poults reared on PSF in comparison to other treatments (WS and CWS). No differences were observed concerning T_3 and T_4 concentration.

Conclusion

From the received outcomes, it can be concluded that the FPD in growing Turkeys did not negatively affect the performance parameters. Also, raising poults on the slatted ground reduces the Turkey poults' welfare as they cannot express highly motivated behaviors. Finally, our results suggest that rearing the Turkey poults clean with regularly replaced WS litter is important from a welfare point.

Conflicts of interest

The authors declare no conflict of interest.

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Author contributions

TMM-B supplied the design and concept of the work. Preparing materials, collection of data, and analytical evaluation were done by all authors. The primary draft of the manuscript was written by TMM-B, and each author corrected the manuscript. Each author read and accepted the final manuscript.

Data availability

All information supporting the findings of this work is available within the manuscript. Any extra information needed can be requested from the corresponding author.

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