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Original Research Article

EFFECT OF BEDDING MATERIALS ON DUCK'S WELFARE AND GROWTH PERFORMANCE

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Abstract: Ducks spend their entire life in contact with the litter material, thus the management strategies should focus on what is the best for ducks welfare and growth performance. Herein, the main object of the present study was assessing the effects of different litter materials on the ducks' welfare and growth performance. Four groups of ducks (24 duckling for each) were kept on four types of bedding materials, sawdust, plastic slatted floor, sand and without. The present study revealed several changes in duck's behaviors due to different bedding materials, where the most frequencies of maintenance behaviors (feeding, drinking, idling, preening) were significantly ($P<0.05$) higher in plastic slatted in comparing to other materials the highest significantly in plastic slatted litter and the lowest in non-bedding litter. Moreover, the ducks reared under sawdust floor revealed the highest frequency of foraging behavior (11.48 bouts/hour). While, feather pecking and aggression were the highest in non-bedding material (74.4, 5.51 bouts/hour, respectively). The hygienic conditions inside the non-bedding floor was the worst due to increase levels of ammonia and carbon dioxide (12, 0.97 Cm^3/Litter, respectively). The ducks reared in plastic slatted floor were the best in growth performance with good signs of soundness. In non-bedding floor, the environmental stress revealed in the increase the level of plasma corticosterone hormone with bad signs of soundness. This study confirms importance of bedding materials in rearing of ducks, especially under plastic slatted floor.

Key words: duck; bedding material; behavior; performance; welfare

Introduction

Poultry has an important role amongst agricultural industries in many countries. Poultry sector in Egypt is one of the major sources of animal protein supply (1). Duck production is an aspect of the poultry industry, which is very popular in many parts of the world. Ducks represent the second largest poultry production in Africa after chicken, beside pure Egyptian breeds there were some local developed strains that established for both meat and egg production (2). Duck used for meat production, which may partly compensate the increasing demand for animal protein, where duck meat is highly appreciated as it combines the characteristics of a red meat and the dietetic characteristics of poultry meat (3). From an economic standpoint, management strategies should focus on what is

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the best for poultry welfare and growth performance (4). To increase the income from ducks rearing, producers are capable of modulating the management of ducks. The well-being of poultry and stress largely influence the poultry production (5). There are many factors which can decrease the performance and increase abnormal behavior of poultry such as management and housing (6). Deep-litter floor housing is most common when raising birds used for meat production (7).In this system, better litter management is crucial for providing good litter quality and for controlling the ammonia level inside the poultry houses. Distinct mixtures of different materials have been proposed as bedding for poultry (8). Duck litter is a mixture of duck excreta, spilled feed, spontaneously fallen feathers and farm bedding material (9). Wood sawdust is the most common used bedding material, however, there were many alternative materials that may be used such as rice and wheat straw (10), soya bean straw (11) and other dry, absorbent, low-cost organic materials. Moreover, the sand is occasionally used as a bedding material (12). The ducks spend their entire life in contact with the litter material. Therefore, its quality is considered a crucial factor of poultry welfare (13), where the good litter should be characterized by good absorption property with a reasonable drying time (14), fast drought, low price and acceptable as a fertilizer. Litter quality may play an important role in the activity levels of broilers through encouraging normal behaviors that require energetic movements such as leg exercise (walking, foraging and dusting bathing) (15, 16). Moreover, behavior is a part of an animal's interaction with its environment. Poor litter quality is considered a welfare problem in modern poultry production. For that reason, the objective of this study was to assess the effect of different bedding material on duck welfare.

Material and methods

This experiment was done after the approval by Ethics and Animal welfare committee of the poultry Research Unit, Faculty of Veterinary Medicine, Zagazig University, Egypt (ANWD-206).

Experimental animals and management

A total of ninety six one day old of Moulard duckling was collected on one batch from Faculty of Agriculture, Zagazig University. The ducks were divided randomly after one week of the brooding period into four groups (each of 24 ducklings) as according to bedding materials (17) into saw dust, plastic slatted, sand and without floor. Each group was subdivided into three replicates (each 8 birds) following identifying with wing rings and kept in brooder house in the same home pen.

Each group was kept in a pen with a floor area of 3.5 m length X 3 m width X 3 m height. Each pen had provided with one incandescent lamp of 100 watts at height 2.5 m above the level of ducks. During the experimental period, ducks were provided with full light for 1st week, then decrease gradually until reach 8h /day. Newly hatched duckling should have a proper brooding temperature, where it was measured by thermometer at the level of a bird's back and maintained at about 32-34 °C in 1st week, then decreased 3-5 °C per week until it reached 19-20 °C at 4 weeks (fully feathered ducks) (18).

Ducks were provided with *ad libitum* basic commercial duck's starter diet throughout the rearing phase that contained 22% crude protein until 5 weeks old. Then, they were fed on a grower diet with 18% of crude protein until the end of experiment (19).

Behavioral observation

It was conducted in the home pen to record different behavior for 5hrs weekly from 6 am to 6 pm by focal sample technique. Observation was done by one person standing directly in front of each group and waiting 10 minutes for acclimation of ducks (6). An observation sheet, a stop watch and photographing camera were used during the observation time for recording the behavioral pattern (20, 21). After observation, the total frequencies of normal and abnormal behavior were counted and calculated, as mentioned in Table (1) in all bedding materials.

Other welfare indicator

At the end of the study, the ducks were captured and measured the physical condition (22).

The condition of eye, nostril, feather, foot and gait was scored as the welfare indicators. The other welfare score was ranged from zero to two, where zero was the best and one was the worst.

Growth performance parameters

It was recorded previously (23), where, initial body weight (IBW) of ducks was weighed at the beginning of experiment (2^{nd} weeks age) and weekly until 10^{th} weeks age, also feed residues and thus average feed intake (FI) were recorded weekly. Average body weight gain (ABWG) was calculated by subtracting body weight between two successive weeks. Relative growth rate (RGR) was calculated by ABWG/ (initial BW+final BW) *0.5. Furthermore, feed conversion ratio (FCR) was calculated (feed intake/weight gain) over a period of experiment.

Blood sampling and cortisol level

At the end of the experimental period, blood samples had been collected randomly from 15 ducks/group, at morning to overcome the circadian variation in hormone level (23). Blood samples were obtained from wing vein into heparinized tubes, centrifuged at 4000 rpm for 15 min to obtain blood plasma, which stored on -80°C for evaluating the cortisol level, as one of stress indicating hormones (24).

Air quality hygiene

Carbon dioxide and total ammonia levels in air of each group were detected (25) to determine the hygienic level inside all experimental groups.

Statistical analysis

All statistical procedures were performed using the SAS statistical system Package V9.2 (26). One-factorial analysis of variance (ANOVA) was performed. The analysis of data distribution suggested that all traits analyzed followed a normal distribution ($P>0.05$). Pearson correlations were performed to compute the relationship of the abnormal behavior and performance parameters.

Results

The results as shown in Table (2) revealed a significant differences in the most of the duck's behaviors, where the most of normal behaviors were the highest in plastic slatted and wood shaving, respectively. While, the abnormal behaviors (feather pecking and aggression) were significantly higher ($P<0.05$) in the non- bedding floor than other groups. Likewise, the growth parameters in Table (3) had notable differences among experimental groups with significant differences, where final body weight, body weight gain, growth rate were higher in plastic slatted floor than other groups. The hygienic conditions inside the non-bedding floor was the worst due to increase levels of ammonia and carbon dioxide, as shown in Table (4). The results in Table (5) showed that ducks reared in non-bedding floor bedding materials had the worst signs of health with significant increase in the level of plasma corticosterone hormone.

Table 1: Definition of recorded behaviors

Observed behavior	Definition
Eating	Number of eating bouts on the troughs
Drinking	Number of eating bouts on the drinkers
Foraging	Number of pecking and scratching on ground, floor or other parts of pen
Idling	Standing not engaged in any activity
Activity	Either walk or run
Laying	Laying or sitting on the floor
Feather preening	Clean and care about their plumage with their peak using short and repeated action while standing or sitting
Feather pecking	Number of pecks at the feathered parts
Aggression	The ducks make hostile acts toward other birds

Table 2: Impact of different bedding material on behavior (mean±SE) of ducks

Behavioral patterns	Different bedding material			
	wood shaving	Plastic slatted	Sand	No bedding
Feeding frequency /hour	10.1±0.54 [ab]	11.97±0.99 [a]	8.74±0.79 [b]	8.37±0.45 [b]
Drinking frequency/hour	14.4±4.80[b]	29.31±6.37 [a]	9±1.58[c]	5.41±.98 [c]
Foraging frequency/hour	11.48 ±0.35 [a]	2.45±0.75 [c]	4.80±0.97 [b]	1.54±0.75 [c]
Idling frequency/hour	20.54±0.71 [a]	23.22±1.57 [a]	20.45±0.81 [a]	17±1.27 [b]
laying frequency/hour	7.62±2.39	8.60±2.48	6.97±1.18	6.42±2.18
Activity frequency/hour	23.37±1.80	19.71±1.81	23.02±1.79	20.62±1.28
Feather preening frequency/hour	11.87±2.25 [a]	12.20±1.16 [a]	10.62±0.96 [ab]	8.17±0.61 [b]
Feather pecking frequency/hour	49±13.58 [b]	21.03±2.44 [c]	56.41±19.8[b]	74.40±14.82 [a]
Aggression frequency/hour	2.60±1.14 [b]	1.98±0.91 [b]	3.68±1.73 [ab]	5.51±2.04 [a]

[abc] Means in the same row with different superscripts are significantly different at ($P < 0.05$)

Table 3: The means (±SE) of growth parameters in ducks reared under different bedding materials

Growth parameters	Different bedding material			
	wood shaving	Plastic slatted	Sand	No bedding
Initial body weight (g)	449.62±18.71	435.88±15.91	438.12±20.85	438.88±14.05
Final body weight	3175.4±74.89 [b]	3260.6±65.97 [a]	3044.3±71.17 [b]	2785.5±76.03 [c]
Total body weight gain (g)	2725.75±62.94 [ab]	2824.75±57.87 [a]	2606.18±61.91 [b]	2346.62±67.12 [c]
Weekly body weight gain (g/bird/week)	340.72±7.87 [ab]	353.09±7.23 [a]	325.77±7.74 [b]	293.33±8.39 [c]
Feed intake (g/bird/week)	968.75±78.12	964.84±73.86	955.5±71.12	861.72±68.05
Relative growth rate	1.503±0.01 [a]	1.529±0.01 [a]	1.497±0.02 [a]	1.455±0.01 [b]
Feed conversion rate	2.84±0.82	2.73±0.83	2.93±0.69	2.94±1.63

[abc] Means in the same row with different superscripts are significantly different at ($P < 0.05$). g= gram

Table 4: Levels of ammonia and carbon dioxide in air of different bedding materials groups

Environmental indicators	Different bedding material			
	wood shaving	Plastic slatted	Sand	No bedding
Total ammonia (Cm^3)	7.76±.43[b]	10±1.15 [ab]	8.40±.23 [b]	12±1.15 [a]
Carbon dioxide (Cm^3)	0.05±.005 [d]	0.13±.005 [b]	0.10±.011 [c]	0.97±.005 [a]

[abcd] Means in the same row with different superscripts are significantly different at ($P < 0.05$)

Table 5: The level of corticosterone hormone (µg/dl) and mean rank of physical condition of duck under different bedding material

	Different bedding material			
	wood shaving	Plastic slatted	Sand	No bedding
Eye	1.25	1.25	1.25	1.66
Nostril	1.16	1.16	1.33	1.66
Feather cleanliness	1.04	0.87	1.29	1.91
Feather quality	1.08	1.08	1.25	1.83
Foot pad	1.21	1.21	1.45	1.54
Gait	1.21	1.21	1.21	1.70
Corticosterone level (µg/dl)	8.475±1.90[bc]	4.82±.58 [c]	13.17±.2.52 [ab]	14.55±1.16 [a]

[ab] Means in the same row with different superscripts are significantly different at ($P < 0.05$)

Discussion

The concerning on how to manage duck's dropping under the intensive system, leading to the discovery several absorbents that were generally referred to bedding material (27). Behavioral study is considered the chief indicator to assess poultry welfare and poultry's response to the surrounding environment (17). In this study, there were several changes in duck's behaviors due to different bedding materials, as mentioned before in previous studies (17, 28-31).The bedding materials had significant effects on inestive behavior including eating,

drinking and foraging, where the frequencies of eating and drinking behaviors were significantly higher in plastic slatted in comparing to other bedding materials. While foraging bouts were the highest significance in the bedding from sawdust material. These results agreed with Mohammed et al. (17), who found significant correlation between ingestive behavior and different bedding materials. While, the present study did not agree with Karousa et al. (31), who cited that litter types had no significant effect on feeding and drinking behaviors. As mentioned before in Table (2), the frequencies of ingestive behavior (eating, drinking and foraging) were the lowest significantly in no bedding materials, which confirm the importance of bedding materials to improve the ingstive behavior. The observed differences in ingestive behavior may be due to the properties of the bedding materials affected the quality of the ration and water (30).Furthermore, Toghyani et al., (32) mentioned that there were significant difference in ingestive behavior among different bedding materials. In this study, the laying frequency was the highest in plastic slatted and the lowest in non- bedding floor, but the difference did not reach the significance. This result may be attributed to the absence of comfortable media for the resting in no bedding group. These results agree with Anisuzzaman and Chowdhury (33) and disagreed with Stub and Vestergaard (34). The ducks reared in on non-bedding material was standing less significantly without any activities in comparison to other groups. This result was agreed with Mohammed et al., (17), while was disagreed with Toghyani et al., (32), who found that standing behavior was slatted but the differences did not reach the significance. Those changes in idling and laying behaviors, as comfortable behavior (5) may be due to the variations in cleanliness, odor and other characters of different litters (35). The bouts of activity (walking and running) were higher in sawdust and sand bedding than plastic slatted and non-bedding material which may be attributed to the changes in particle size of the litter (17). The difference in duck's activity in the present study was supported by Oliveira and Carvalho (36), who cited that the locomotion of birds was affected by different type of litter. The activity in plastic slatted was the lowest which may be due to the negative correlation between activity and the rate of food consumption (37). Regarding to feather preening, the ducks reared under plastic slatted floor and sawdust were more performance of feather preening with significant difference in comparing to other groups. This result may be due to the ducks more comfort on these floors. This result was agreed with Mohammed et al. (17), and disagreed with Waitt et al. (38) and Rice et al. (39), who found that the floor types hadno significance difference on preening behaviour of ducks. Sameh et al., (40) did not record any significant differences in preening behavior among different litter materials. Moreover, the abnormal behaviors representing in feather pecking and aggressive were significantly affected by the bedding, where it was the highest in non-bedding material and the lowest in plastic slatted floor. These results agreed with Mohammed et al. (17) and disagreed with Sameh et al. (40). Likewise, the bedding materials had significant effects on the most parameters of growth performance, where the plastic slatted was the highest and non-bedding group was the lowest. The improvement in growth performance in a plastic slatted litter may be attributed to the increase of all maintenance behaviors in this litter. The ducks reared in plastic slatted group revealed a significant increase in final body weight, total body weight gain, weekly body weight gain and growth rate by comparing to other experimental groups. These results were comparable to other studies, who mention that litter materials had a significant effect in growth parameters (29, 32, 41). While, other researchers did not find a significant effect of bedding materials on growth performance (17). The feed consumption and feed conversion ratio did not reveal significant differences among the experimental group. Likewise, Davis et al., (42) and Mendes at el., (43) stated that different litters did not influence growth performance. While, other previous studies mention that bedding materials has a significant effect on feed consumption (44) and

feed conversion ratio (45). The date as mentioned before in Table (4) revealed the hygienic conditions in the study, where the levels of ammonia and carbon dioxide were significantly higher in non-bedding litter in compare to others. These results may attributed to accumulation of fecal matter and increase the humidity in non-bedding litter (46). These results go hand by hand with results obtained by Tasistro et al. (47), who stated that there was a significant interaction between bedding materials and level of ammonia. Also, Almeida et al. (28) found that the use of perforated plastic flooring can improve the air quality (less CO2 and NH3 concentration) and bird cleanliness. Nevertheless, Fraley et al. (48) mentioned that there were no differences for any of the environmental data between flooring systems. Lien et al., (49) reported that the litter absorbs moisture, reduces ammonia production and finally may affect the total body weight gain. The signs of soundness in eye, nostril, feather, feet and gait were better in presence of bedding materials, especially in plastic slatted and sawdust, respectively. While the non- bedding litter was the worst in the previous signs. These results may attributed to ability of bedding materials to absorb moisture and may reflect the good managerial conditions (49). These results were comparable to Buhr et al. (50); Waitt et al. (38); Fraley et al. (48); Karcher et al. (22). Garcia et al. (30) cited that litter material had no effect on the physical condition of birds.

The level of plasma corticosterone was the highest significance in the non-bedding group, while the ducks reared in plastic slatted group revealed the lowest level of plasma cortisol. This result may be due to the ducks in plastic slatted floor had good signs of soundness. This result disagreed with that obtained by Asaniyan et al (27) and Sameh and El-Khloya (51), who noted that litter depth and litter type had no significant influence on hematological values and welfare indices.

Conclusion

In the present study, there were several changes in duck's behaviors due to different bedding materials, where the most of maintenance behaviors were the highest significantly in plastic slatted litter and the lowest in the non-bedding litter. Furthermore, growth parameters were the better in plastic slatted and sawdust floor, respectively, while the lowest growth parameters were in non-bedding floor. The hygienic conditions inside the non-bedding floor was the worst due to increased levels of ammonia and carbon dioxide. The ducks reared under non-bedding floor revealed the worst signs of soundness, while it was the best in plastic slatted floor. The plasma corticosterone is a useful indicator for acute and environmental stress, which was the highest in non-bedding litter. This study confirms importance of bedding materials in rearing of ducks, especially under plastic slatted floor.

Conflict of interests

None of the authors have any conflict of interest of declare.

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