

ORIGINAL ARTICLE

## Influence of housing systems on duck behavior and welfare

Shereen El. Abdel-Hamid, Al-Sadik Y. Saleem, Mohamed I. Youssef, Hesham H. Mohammed, Asmaa I. Abdelaty  
Department of Veterinary Public Health, Faculty of Veterinary Medicine, Zagazig University, Zagazig, Egypt

### ABSTRACT

**Objective:** This experiment was conducted to assess the effects of the housing system on the welfare and growth performance of the Muscovy duck.

**Materials and methods:** A total number of 48 Muscovy duck aged 3-week old were divided randomly into two groups (24 duck on each): deep litter system and cage system. Each group was subdivided into three replicates (8 birds on each) were identified with wing rings.

**Results:** The study showed that feeding and drinking behaviors significantly increased ( $p < 0.05$ ) in duck reared at the cage system. While there was no noticeable effect on lying and feather pecking, duck raised in the deep litter had better growth performance with a substantial difference, which achieve a higher feed conversion rate with lower feed efficiency. Physical conditions were significantly better at cage management. The level of stress indicating hormones indicating free Thyroxin was increased with the cage. Therefore, the litter system improves duck welfare and their performance.

**Conclusion:** It is concluded that the duck managed under the litter system has more opportunities that facilitate the expression of more natural behavior, and thus improve their health and performance, as a result of improved feed conversion rate and feed efficiency.

### ARTICLE HISTORY

Received February 27, 2020  
Revised April 15, 2020  
Accepted April 17, 2020  
Published July 10, 2020

### KEYWORDS

Muscovy duck; housing system; behavior; performance; welfare; duck hormones



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### Introduction

In Egypt, poultry is considered as one of the primary sources of animal protein supply [1]. Besides pure Egyptian breeds, some locally improved strains have been developed for both meat and egg production [2]; ducks are used for meat production, which partly compensates the demand for animal protein. To achieve profitability from duck production, some procedures are capable of modifying the management systems. The welfare of poultry and stress significantly affect poultry production [3]. There are many factors that can reduce production and increase the abnormal behavior of poultry, such as managerial factors as housing [4].

Although duck is waterfowl, they have been reared under indoor housing systems. In recent years, intensive production systems (deep litter system and cage systems) are required to increase the potential of the duck performance [5]; the housing system is known to be one of the important non-genetic factors that can influence poultry production and well-being [6]. Therefore, producers

tried to modulating the management of duck. Nowadays, a deep-litter system is the most common in raising poultry [7]. In this system, the management of bedding material is very critical to provide good litter quality. However, it is challenging to keep litter dry and in good condition in litter floors due to drinker type, bedding material, and high stocking density [8,9].

Wet and caked bedding material affects welfare and performance. Cage and slat floor housing have been used for many years for broilers and layers, but the cages are infrequently used for the duck. Although the cage system overcomes hygienic problems of the litter as a result of an accumulation of droppings under the cage and not be permitted to reach the birds, they have not been widely adopted because of poor leg health and reduced meat quality [10]. Thyroid hormones are known to be influenced by stress [11] and act on multiple metabolic processes, by a feedback mechanism, high level of plasma  $T_3$  and  $T_4$  inhibit the release of tonic releasing periods from hypothalamus and thyroid-stimulating hormone (TSH) from the pituitary gland. Other factors are also stimulating or

**Correspondence** Shereen El. Abdel-Hamid ✉ [shereen-mk@hotmail.com](mailto:shereen-mk@hotmail.com) 📧 Department of Veterinary Public Health, Faculty of Veterinary Medicine, Zagazig University, Zagazig, Egypt.

**How to cite:** Abdel-Hamid SE, Saleem ASY, Youssef MI, Mohammed HH, Abdelaty AI. Influence of housing systems on duck behavior and welfare. *J Adv Vet Anim Res* 2020; 7(3):407–413.

inhibiting the hypothalamus (e.g., drugs and stresses) [12]. This experiment was designed to estimate the effects of different floor housing systems on some welfare parameters of Muscovy ducks.

## Material and Methods

### Experimental birds used and management

A total number of 48 Muscovy duck aged 3 weeks were collected on one batch from the Faculty of Agriculture; the experiment was carried out on the farm of Faculty of Veterinary Medicine, Zagazig University. The research was conducted from the mid of June till the middle of August. The duck was divided randomly into two groups (24 duck on each) according to the housing system into a deep litter system and cage system. Each group was subdivided into three replicates (eight birds on each) were identified with wing rings of different colors.

1. The first system (deep litter), the duck, was kept in pen with a floor area of 1 m length × 2 m width × 2.5 m height (with 4 duck per m<sup>2</sup>). Each pen had provided with about 8–10 cm of sawdust was used as litter material.
2. The second system (cage), the duck, was kept in a cage with dimensions (2 m length, 80 cm width, and 60 cm height) with stocking density (eight birds per cage) [13]. Each cage was equipped with a feeder and a nipple drinker [14].

The duck was provided with *ad libitum* basic commercial duck's starter diet during the rearing stage that contained 22% crude protein and 3,015 metabolized energy until 5-week old which containing yellow corn 54%, Soybean 40, Vegetable oil 3%, Limestone 1%, Dicalciumphosphate 1%, DL-Methionine 0.10%, Salt 0.25%, and Vit.-Min. Premix 1 0.50%. After the first week of age, they were fed on a grower diet with 18% of crude protein and 3,125 metabolized energy which containing yellow corn 65%, Soybean 29.15%, Vegetable oil 3%, Limestone 1%, Dicalciumphosphate 1, DL-Methionine 0.10%, Salt 0.25%, Vit.-Min. Premix 1 0.50% until the end of the experiment [15].

### Behavioral observation

It was recorded at the duck pen to record different behavior for 5 h weekly from 6 am to 6 pm by focal sample technique. The observation was done by one person who is standing directly in front of each group and waiting 10 min for the acclimatization of ducks [4]. An observation sheet, a stopwatch, and photographing camera were used during the observation time for recording the behavioral pattern [16,17]. After observation, times, and frequencies

of normal and abnormal behavior were counted and calculated (Table 1).

Physical condition score was reported at the end of the study; the duck was captured and measured on a scale of 0 or 1 for (nostril and feather cleanliness) and 0–2 for (eyes, feather quality, footpad quality, and gait) [19]. As the welfare indicators, where zero was the best, and one or two was the worst.

### Tonic immobility

A sample of six birds from each group was examined at the end of the study (10 weeks age) for tonic immobility. Each bird was put on its back in a cradle and kept in this position for 10 sec before being released. The elapsed time was measured before the birds stood alone [20]. If the bird did not remain at least 10 sec after release, the tonic immobility (TI) attempt was considered as unsuccessful, and another attempt was performed. The number of TI attempts was noted.

### Growth performance parameters: according to Mohammed et al. [21]

1. Initial body weight (IBW) the weight of the duck at the beginning of the experiment (3rd week's age)
2. Final body weight (FBW) the weight of the duck at the end of the experiment (10 weeks age)
3. Average feed intake (FI) was recorded weekly.
4. Average body weight gain (ABWG) was calculated by subtracting the FBW and IBW.
5. The relative growth rate (RGR) was calculated by  $ABWG / (\text{initial BW} + \text{final BW}) * 0.5$ .
6. Feed conversion ratio (FCR) was calculated (average FI/average weight gain).

### Stress indicating hormones

Preliminary samples were randomly collected from the birds at morning to overcome the circadian variation and blood collection stressors after that samples were collected from six birds from each treatment twice (1st time at the age of 5-week old while the 2nd one at the end of the study (10-week old), respectively. Blood samples had been collected randomly for evaluating TSH and free thyroxin hormone (free T<sub>4</sub>) level on blood serum as one of the stress indicating hormones [22]. Samples were obtained from wing vein, clotted at room temperature, and centrifuged at 3,000 rpm for 10 min.

All statistical procedures were performed using SPSS, Inc [23]. Independent sample *T*-test of variance was performed. The analysis of data distribution suggested that all traits analyzed followed a normal distribution ( $p > 0.05$ ). While data of physical condition was analyzed by using the nonparametric Mann-Whitney test.

**Table 1.** Definition of recorded behaviors, adapted from [18].

Observed behavior	Definition
Feeding	Time: time of eating on troughs Frequency: Number of eating bouts on the troughs
Water-related preening behavior	Time: time of drinking on the drinker including with preening of their feather Frequency: Number of drinking bouts on the drinkers including with preening of their feather
Foraging	Time: time of pecking and scratching on the ground, floor or other parts of the pen Frequency: Number of pecking and scratching on the ground, floor or other parts of the pen
Standing	Time: time spend in Standing not engaged in any activity Frequency: Number of Standing not involved in any activity
Walking	Time: Time spent in walking Frequency: Number of walks
Resting	Time: time resting or sitting on the floor Frequency: Number of resting or sitting on the floor
Feather preening	Time: time spend to Clean and care about their plumage with their peak using short and repeated action while standing or sitting Frequency: Number of Clean and care about their plumage with their peak using short and repeated action while standing or sitting
Head shaking	The head is tilted to one side and shaken vigorously in a circular fashion
Wing flapping	Bird stretches its full height and flaps its wings repeatedly
Body shaking	Bird shakes its body vigorously
Feather pecking	Number of aggressive action followed immediately by submissive posture

## Results and Discussion

The housing system has a direct influence on the welfare of the birds and can affect their behavior [24].

The housing system had a significant effect on ingestive behavior, including feeding, drinking, and foraging, as seen in (Table 2) as the time of feeding and drinking behavior were significantly higher of duck housed in the cage system in comparison to duck in litter system. These results may attribute to birds housed at litter more active and made greater use of resource than caged duck, which spend more time in feeding. These results agreed with Abdel-Hamid [25] found that restricted feeding space and filling of feeder lead to increase feeding time in case of caged birds. Also, Waitt et al. [26] found that time spends on water resources not only related to drinking but also included water-related preening behavior. On the other hand, Fouad et al. [27] documented that feeding and object pecking activities were higher in the floor system than in the cage system. Also, Jones and Dawkins [28] reported that the housing system does not affect the behavior of fowl. Foraging behavior was higher significant in the deep litter ( $80.5 \pm 18.12$  sec) than the cage system ( $5.8 \pm 2.2$  sec). These results agreed with several other authors [27,29,30], who found that birds were found in the floor system to be more dynamic and make greater usage of resources (scratching area, forging, walking, and running) than birds in cages. These results attributed to the availability of proper and healthy bedding. Duck reared in cage

show higher standing time with less significant bouts, also walking behavior (time and frequency) was significantly higher in the litter. This may be due to birds in-floor system have further freedom than do birds in cages, as supported by several other authors [31–34], who stated that the increases in density had a suppressive effect on walking behavior. The results (Table 3) showed that resting behavior was insignificantly higher in the litter system. This result may be attributed to the lack of a convenient area for relaxing at cage management. These results agreed with Jones and Dawkins [28]. On the other hand, Carrière et al. [35] documented that duck housed in a cage spent more time lying down. This difference may be due to the breed difference.

Concerning with feather preening, it was increased with a litter system. This result may be due to the duck more comfort on these floors, and the presence of bell drinkers permit perfect preening. This result was agreed with [26,36], who found that water lines do not allow effective preening. The head shaking, wing flapping and body shaking were significantly higher in a deep litter ( $0.88 \pm 0.90$  bouts,  $1.59 \pm 0.18$  bouts, and  $1.57 \pm 0.18$  bouts, respectively) than cage system ( $0.58 \pm 0.90$  bouts,  $0.92 \pm 0.18$  bouts, and  $0.80 \pm 0.18$  bouts, respectively), as supported by others [33,37]. Feather pecking was a higher increase in the cage than deep litter, as reported in other reports [29,30]. These results suggested that the presence of the extra stimuli provided by deep litter such as forging, walking, and scratching lead to partially successful in directing

**Table 2.** Mean  $\pm$  SE time and frequency of ingestive and kinetic behavior of muscovy duck in relation to the housing system.

Behavioral patterns	Litter	Cage	Sig.
Feeding time (sec/h)	415.1 $\pm$ 54.8	580.7 $\pm$ 45.8	*
Feeding frequency/h	7.3 $\pm$ 0.93	6.4 $\pm$ 0.75	N.S
Water-related preening time (sec/h)	376.1 $\pm$ 58.9	821.9 $\pm$ 86.03	**
Water-related preening frequency/h	9.65 $\pm$ 1.26	13.85 $\pm$ 1.4	**
Foraging and pecking in objects time (sec/h)	80.5 $\pm$ 18.12	5.8 $\pm$ 2.2	**
Foraging frequency/h	3.275 $\pm$ 0.29	0.45 $\pm$ 0.29	**
Standing time (sec/h)	281.35 $\pm$ 25.71	290.88 $\pm$ 99.71	NS
Standing frequency/h	10.60 $\pm$ 0.95	7.70 $\pm$ 1.36	*
Walking time (sec/h)	93.70 $\pm$ 14.0	42.0 $\pm$ 21.21	*
Walking frequency/h	16.83 $\pm$ 2.14	8.83 $\pm$ 1.85	**

N.S = non-significant, \*Significance difference at level  $p \leq 0.05$ , \*\*Highly significant difference at level  $p \leq 0.01$ .

**Table 3.** Mean  $\pm$  SE time and frequency of comfort and abnormal behavior of Muscovy duck in relation to the housing system.

Behavioral patterns	Litter	Cage	Sig.
Resting time (sec/h)	1335 $\pm$ 171.37	1206 $\pm$ 134.0	N.S
Resting frequency/h	16.15 $\pm$ 1.47	12.45 $\pm$ 1.49	N.S
Feather preening time (sec/h)	531.109 $\pm$ 97.26	487.75 $\pm$ 97.99	NS
Feather preening frequency/h	8.90 $\pm$ 0.85	6.10 $\pm$ 1.2	*
Head shaking frequency/h	0.88 $\pm$ 0.90	0.58 $\pm$ 0.90	*
Wing flapping frequency/h	1.59 $\pm$ 0.18	0.92 $\pm$ 0.18	*
Body shaking frequency/h	1.57 $\pm$ 0.18	0.80 $\pm$ 0.18	**
Pecking frequency/h	1.25 $\pm$ 0.52	1.58 $\pm$ 0.43	N.S

N.S = non-significant, \*Significance difference at level  $p \leq 0.05$ , \*\*Highly significant difference at level  $p \leq 0.01$ .

**Table 4.** Mean  $\pm$  SE of growth performance of Muscovy duck concerning the housing system.

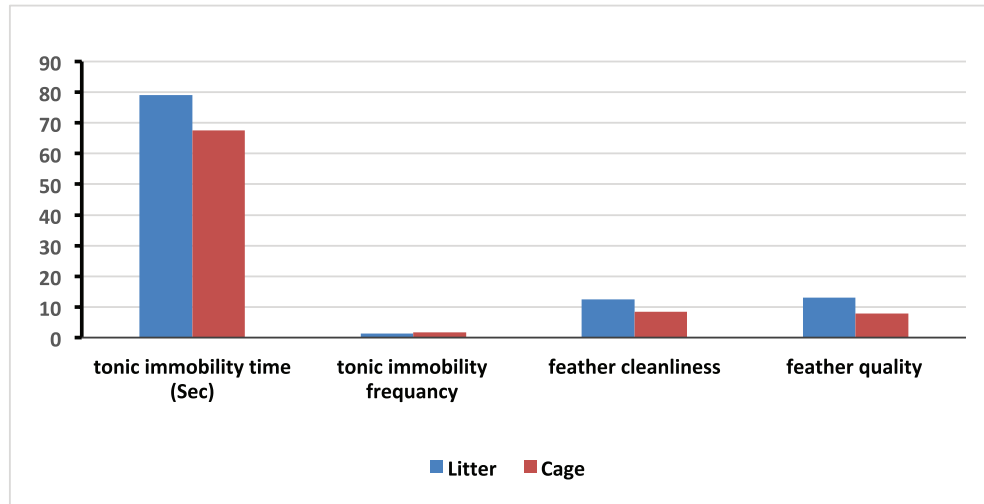
Performance	Litter	Cage	Sig
IBW (gm)	478.0 $\pm$ 32.52	474.82 $\pm$ 20.41	N.S
Final body weight (gm)	2839 $\pm$ 98.49	2715 $\pm$ 85.93	N.S
Weight gain (gm)	2419 $\pm$ 79.82	2224 $\pm$ 79.82	N.S
FI (gm)	9310 $\pm$ 817	10714.2 $\pm$ 1225	N.S
RGR	1.45 $\pm$ 0.3	1.39 $\pm$ 0.3	*
Feed conversion rate	3.89 $\pm$ 0.13	4.95 $\pm$ 0.24	**
Feed efficiency	0.25 $\pm$ 0.01	0.31 $\pm$ 0.01	**

N.S = non-significant, \*Significance difference at level  $p \leq 0.05$ , \*\*Highly significant difference at level  $p \leq 0.01$ .

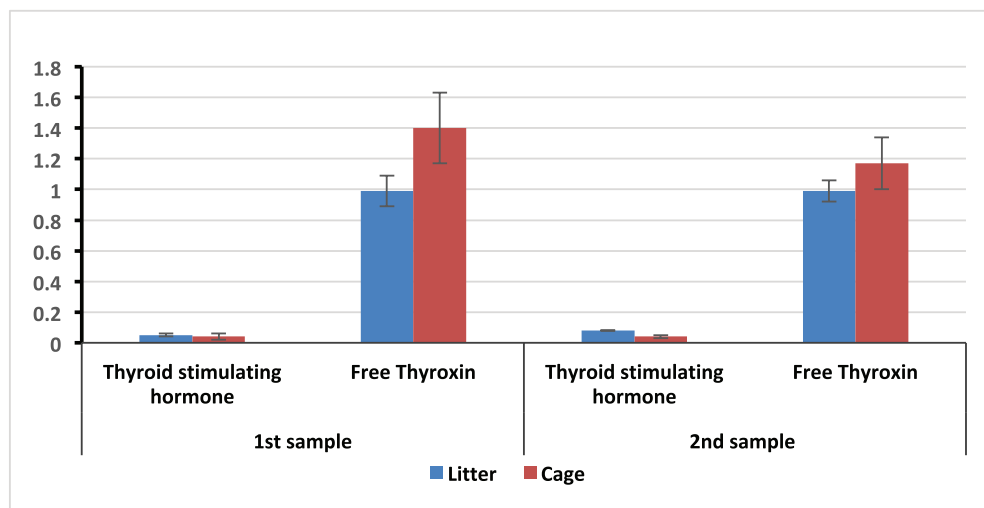
behavior away from non-feeding pecks at food and feather pecking. The reverse trend was recorded by Sherwin et al. [38], who noted the lowest incidence of pecking happened in birds reared in cages. This difference may be due to species differences.

The duck reared in the litter system revealed a slight rise in FBW, total weight gain, weekly body weight gain than those in the cage system. As seen in Table 4, but the

difference did not reach the significance, as found in several other reports [37,39–42]. This difference may be due to the behaviors, such as running, walking, wing flapping, preening, and well-being of duck reared in deep litter systems, were better than those of duck raised in cage system, which improves performance. At the same time, the reverse trend was observed in several other reports [10,43–46], who cited that caged birds showed higher body weight



**Figure 1.** Mean  $\pm$  SE of Tonic immobility and mean rank of the physical condition of Muscovy under in relation to the housing system.



**Figure 2.** Mean  $\pm$  SE of serum TSH (uIU/ml) and free T<sub>4</sub> (ng/ml) of Muscovy duck in relation to the housing system.

than those of birds reared in the floor system. While meaning the feed consumption was higher in the cage than litter. This may be attributed to birds in the cage have no enough space, which assists the birds for normal physiological and metabolic responses, eventually resulted in increased feed consumption as compared to the floor system. This result agreed with several other reports [10,45,46], as they cited that the cage system promotes FI in duck while disagreed with two statements [37,39]. This difference may be due to the effect of several environmental factors. The growth rate was highly significant in litter also feed conversion rate and feed efficiency were significantly better in litter than the cage. This attributed to the higher body

in deep litter duck in this experiment in which there is a negative relationship between growth rate and FCR. These results agreed by Sari et al. [47] as they stated that FCRs were worse in the cage system than the deep litter floor system. The reverse trend was obtained by Shields and Greger [10], as they that the cages provide the most economical use of land, increasing efficiency for every poultry house and reducing production cost by making better use of fixed expenditure. This difference may be attributed to species differences. These results depicted in Figure 1 shows that the duration of tonic immobility for measuring fear of duck was longer at deep litter housed duck although the difference not significant. These results may

be attributed to increased environmental complexity that may decrease the fearfulness of birds [48]. These results were agreed with Campo et al. [49] as they reported that the housing system design did not influence the duration of the tonic immobility response. The signs of soundness that measured in this study feather cleanness and feature quality were better in the cage than a result of the accumulation of droppings under the cage and not be permitted to reach the birds also; the occurrence of footpad dermatitis was significantly increased in the cage. This result due to direct contact of footpad with wire slat of cage leading to pododermatitis lesions, which characterized by inflammation and necrosis. However, the housed duck cage has a steel or plastic mesh floor that may increase contact dermatitis (foot, toe, hock, and breast lesions) [50,51]. As seen in Figure 2, it showed that free  $T_4$  was raised in the cage housing system at the two blood samples this result attributed to the capture of duck in cages increase stress leading to increase thyroid hormones [12]. However, reduced concentrations of  $T_3$  and  $T_4$  in stressed birds were also reported [3,22].

## Conclusion

In this study, the housing system had no significant effect on the duck. Still, duck housed under the litter system showed better conditions that assist birds in expressing better normal behavior also improves their well-being and performance, which improves feed conversion rate and feed efficiency, which becomes more economical.

## Acknowledgments

The authors would like to thank the staff at the Department of Veterinary Public Health, Faculty of Veterinary Medicine, Zagazig University, Egypt, for providing materials used in this study. Also, the authors would like to thank the anonymous referees for their helpful comments on the manuscript.

## Conflict of interests

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

## Authors' contribution

Shereen El. Abdel-Hamid and Asmaa I. Abdelaty did the practical part while Al-Sadik Y. Saleem, Mohamed I. Youssef, Hesham H. Mohammed did the reviewer part

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