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Effects of Declawed Males on Laying Performances, Egg Quality Characteristics and Feather Cover of Layer Breeders in the Mating Cage

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Authors' Contribution
KZ conceived and designed the entire experimental plan. JL, WL, RM and SL participated in egg quality analysis and scoring of the plumage. HC and XZ provided essential experimental animals and site. YL performed the animal trails, finished the statistical analysis and drafted the manuscript.

Key words
Laying performance, Declawed male, Egg quality, Feather cover, Mating cage.

ABSTRACT

This study aimed to investigate the effects of declawed males on laying performances, egg quality characteristics and feather cover of layer breeders in the mating cage. Ninety-six 230-day-old Hy-line Brown roosters were randomly split into four groups. Group 1 chicks served as intact control. Trimming of claw of group 2 chicks was performed by the method of partial amputation of the third toe (along the distal phalanx) at day of hatch; the first and third toes were declawed in the group 3, while the second and fourth ones were trimming in group 4. They were caged with the same batch of non-declawed hens. Compared with intact control, laying rate was significantly increased in groups 3 and 4, while percentage of defective eggs was visibly decreased in group 3. Hatching experiment showed a considerable depression in egg fertility and hatchability of setting eggs in group 4. Egg quality analysis demonstrated the significant increases in shell thickness among declawed treatments and yolk color in group 2. Overall feather score of layer breeders was not a significant difference, but the neck region had the lowest feather score in all groups. Preferential trimming methods were the removal of the first and third or second and fourth toes of day-old chicks in Hy-Line strain.

INTRODUCTION

Chicken claw, a curved and pointed appendage at the end of a toe, can grow to be greater with the increase of age. Its excessive growth could cause many deleterious effects on chicken grown and production, including stress, physical injury (sores and scratches) or death of the bird, excoriation on the feeder's hands and inconvenience of feeding and management. One of the potential solutions is the prevention or restriction of claw growth.

Toe claw removal, alternately termed declawing, claw trimming or claw reduction, is usually done in combination with debeaking using a hotblade debeaker or microwave energy at one day of age. There is increasing evidence that effective declawing may be beneficial to chicken production performances. Hill (1975) and Hansen (1976) reported that claw trimming abated physical injury to the female during mating. Compton *et al.* (1981) and Gildersleeve *et al.* (1981) demonstrated that claw reduction ameliorated stress and reduced hysteria, and claw-trimmed birds had been found to be less fearful. Martin *et al.* (1976) and Compton *et al.* (1981) noted that claw reduction significantly increased rate of egg production, elevated feed conversion and enhanced livability. Moreover, other researchers also stated that claw removal promoted sexual maturity, ameliorated the feather condition (Compton *et al.*, 1981; Ruszler and Quisenberry, 1979) and decreased contamination of eggs (Tauson, 1986). From this body of data it appears that claw reduction has a positive influence on productive and other performances. However, few studies were reported on the effects of declawed male on laying performances, egg quality characteristics and feather cover of layer breeder in the mating cage. Accordingly, the purposes of the current study were to investigate the declawing effects on layer breeders to make an objective evaluation of the management practice.

MATERIALS AND METHODS

Animals and experimental design

A sufficient number of birds (Hy-Line Brown parent stock breeders) employed in this study were obtained from

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Jiangxi Huayu Poultry Breeding Co. Ltd. (Yichun, Jiangxi Province). All birds were debeaked and weighed at one day of age. The male chicks of similar body weight were divided equally into four groups. Group 1 chicks served as intact control. Trimming of claw of group 2 chicks was performed by the method of partial amputation of the third toe (along the distal phalanx) using a hotblade debeaker; in group 3 chicks, the first and third toes; in group 4, the second and fourth toes. Selection of toes for claw removal was based on those completely removed in male chicks. At 90 days (normal age for caging breeder), all roosters and the same batch of non-declawed hens were transferred to 3-tier mating cages (240 cm length × 120 cm width × 80 cm height) and each cage contained 52 breeders (male/female ratio, 1:12). 6 cages in each group were selected to measure performance parameters of the layers. Feed was supplied in mash form and dietary nutrient concentration was presented in Table I. The entire experiment was started at day 230 and lasted for 40 consecutive days. All birds were managed according to the guidelines in the Hy-Line parent stock Management Guide. Animal care protocols and experimental procedures in this study were approved by the Animal Care and Use Committee of the Anhui Academy of Agricultural Sciences (approval number A11-CS06; date of approval 21 September 2011).

Table I.- Dietary nutrient concentration for production period.

Ingredients	Nutrient concentration
Metabolizable energy (MJ/kg)	12.14
Crude protein (%)	17.48
Lysine (%)	0.87
Methionine (%)	0.43
Methionine+cystine (%)	0.71
Isoleucine (%)	0.67
Threonine (%)	0.66
Tryptophan (%)	0.20
Arginine (%)	0.89
Valine (%)	0.77
Linoleic acid (%)	0.97
Calcium (%)	3.98
Phosphorus (%)	0.45
Sodium (%)	0.17
Chloride (%)	0.17

Measurements of laying performances and mortality

The performances of laying hens including hen-day egg production, defective eggs (misshapen eggs, grosscracked, broken, softshell and shell-less eggs, excessively small or large eggs) and the number of dead birds were recorded by cage daily. Laying rate, percentage of defective eggs and mortality were calculated by recorded performance parameters. Afterwards, freshly qualified eggs were collected and incubated in commercial layer hatcheries under the same incubation conditions. Qualified eggs were accepted with the criteria as: similar in size and shape, clean and smooth surface, oval shape with a small end and a big end. The number of fertilized eggs and live chicks and day-old weight were counted for calculation of hatchability of fertile eggs, percentage of healthy pullets, male-to-female ratio, rate of water loss and average chick hatching weight.

Egg quality analysis

Given the nutritional and economic importance of egg quality, major quality parameters of eggs were measured in 30 eggs per group at the end of the experiment: egg weight, egg shape index, shell color, shell strength, shell thickness, shell weight, albumen height, Haugh units, percentage of yolk, yolk color. Egg weight, albumen height, yolk color and Haugh units were measured using automatic egg multitester equipment (EMT-5200, Robotmation Co. Ltd., Tokyo, Japan) according to the manufacturer's instructions. Shell color was determined on the large end, equatorial region, and small end, respectively, using a reflectometer (PRS-Evans Electroselenium Ltd., Halstead, Essex) on a scale of 0 (black) to 79.9 (white). The average of the 3 measurements was used as an eggshell color. Length and width (mm of each egg were gauged with a digital vernier caliper (LRY1202, Shanghai LiangRen Tools Co., Ltd., Shanghai, China) and egg shape index were calculated as a percentage according to the formula: [(egg width / egg length × 100]. Shell strength was measured using an Eggshell Force Gauge (EGG-0503, Robotmation CO., Ltd, Tokyo, Japan) and shell thickness using a shell thickness meter (ESTG-1, ORKA Food Technology Co. Ltd. Ramat Hasharon, Israel) with three measurements made from locations at the bottom, top and middle of each egg. Yolk was separated and weighed for calculation of percentage of yolk.

Feather score

Feather score was evaluated using an established 4-point scale (Tauson, 1986). The best feather score was defined as 4 and the nearly denuded skin as 1. The scoring system was applied to the neck, breast, back, wings and tail as follows; score 4, for a part of the body with smooth and perfect plumage; score 3, for a part of the body where feathers have slightly damaged, but with no or only very small denuded spots; score 2, for a part of the body that displayed larger denuded spots or with serious deterioration; score 1, for a part of the body having heavily destroyed

feathers with denuded spots with injury to skin. At the end of the experiment, a total of 30 (15 male and 15 female) birds per group were randomly scored. Finally, the average feather score for each individual part of the body and an overall average score were calculated.

Statistical analysis

Statistical analysis was carried out using Origin Pro 8.0 software (OriginLab Corporation, Northampton, USA). All data were analyzed with one-way analysis of variance (ANOVA) followed by the Tukey' s post hoc test for multiple comparisons. The results were presented as mean ± standard error of the mean (SEM). Means with different superscript letter are significantly different ($P<0.05$).

RESULTS

Laying performances and mortality

Laying performances and mortality in all four groups were presented in Table II. Compared with intact control, laying rate was significantly increased in groups 3 and 4, while the percentage of defective eggs was visibly decreased in group 3 ($P < 0.05$). However, no remarkable differences were found in mortality ($P > 0.05$). Moreover, hatching experiment showed a considerable depression in egg fertility and hatchability of setting eggs in group 4 ($P < 0.05$), but other parameters did not change substantially in terms of hatchability of fertile eggs, percentage of healthy pullets, male-to-female ratio, rate of water loss and average chick hatching weight ($P > 0.05$).

Table II.- Effects of declawed males on laying performances and mortality of Hy-Line Brown layers in the mating cage.

Parameters	Group 1	Group 2	Group 3	Group 4
Laying performances				
Laying rate (%)	83.32±0.62^a	85.12±0.52^a	87.62±0.60^b	89.92±0.68^c
Defective eggs (%)	1.36±0.13^a	1.13±0.11^a	0.95±0.09^b	1.40±0.12^a
Mortality				
Rooster (%)	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
Hen (%)	0.35±0.35^a	0.35±0.35^a	0.69±0.44^a	1.04±0.71^a
Hatchability performances				
Fertility (%)	95.11±0.29^a	94.38±0.22^a	95.27±0.22^a	92.47±0.32^b
Hatchability of setting eggs (%)	91.35±0.35^a	90.09±0.37^a	91.10±0.35^a	88.65±0.40^b
Hatchability of fertile eggs (%)	96.04±0.22^a	95.47±0.32^a	95.62±0.23^a	95.87±0.25^a
Percentage of healthy pullets (%)	95.94±0.50^a	96.96±0.45^a	96.55±0.50^a	95.87±0.51^a
Male-to-female ratio (%)	103.03±3.06^a	100.99±3.47^a	102.00±3.24^a	99.57±2.62^a
Rate of water loss (%)	12.15±0.19^a	12.12±0.2^a	12.01±0.27^a	12.42±0.55^a
Average chick hatching weight (g)	41.99±0.17^a	41.80±0.18^a	41.35±0.28^a	41.88±0.22^a

All roosters and the same batch of non-declawed hens were reared to 3-tier mating cages and each cage contained 52 breeders (male/female ratio, 1:12). 6 cages in each group were selected to measure laying performances and mortality of the layers. The entire experiment was started at day 230 and lasted for 40 consecutive days. Means with different superscript letters are significantly different ($P < 0.05$).

Table III.- Effects of declawed males on egg quality characteristics of Hy-Line Brown layers in the mating cage.

Egg quality	Group 1	Group 2	Group 3	Group 4
Shell strength (kg/cm^2)	4.31±0.17^a	4.30±0.14^a	3.96±0.21^a	3.91±0.19^a
Shell color	25.77±0.60^a	26.31±0.60^a	26.01±0.49^a	25.72±0.75^a
Egg shape index	1.27±0.01^a	1.29±0.01^a	1.28±0.01^a	1.27±0.01^a
Shell weight (g)	7.60±0.11^a	7.85±0.12^a	7.42±0.14^a	7.63±0.11^a
Egg weight (g)	60.81±0.62^a	63.01±0.89^a	61.05±0.95^a	61.30±0.64^a
Shell thickness (mm)	0.35±0.01^a	0.39±0.01^b	0.38±0.01^b	0.38±0.01^b
Percentage of yolk (%)	25.84±0.28^a	25.83±0.29^a	26.24±0.33^a	25.95±0.28^a
Albumen height (mm)	7.66±0.12^a	7.72±0.21^a	7.89±0.18^a	7.83±0.17^a
Yolk color	7.22±0.16^a	7.98±0.15^b	7.47±0.12^{ab}	7.47±0.16^{ab}
Haugh units	87.53±0.80^a	86.74±1.35^a	88.41±1.06^a	88.01±1.02^a

Major quality parameters of eggs (shell strength, shell color, egg shape index, shell weight, egg weight, shell thickness, percentage of yolk, albumen height, yolk color and Haugh units) were measured in 30 eggs per group at the end of the experiment. Means with different superscript letters are significantly different ($P < 0.05$).

Egg quality

Table III summarizes the effects of claw removal on egg quality characteristics. The results obtained here demonstrated the significant increases in shell thickness among declawed treatments and yolk color in group 2 compared with intact control, but no differences were detected in shell strength, shell color, egg shape index, shell weight, egg weights, percentage of yolk, albumen height and Haugh units.

Feather condition

The effects of claw removal on feather condition of layer breeders were examined in the current study. As illustrated in Table IV, overall feather score of hens was not significantly different among declawed treatments and intact control. Interestingly, the feather score of the neck was significantly lower than that of any body part. Likewise, an overall feather score of roosters was largely similar to that of hens. The neck region on roosters had the lowest feather score around 3.3 points in the studied groups.

Table IV.- The average feather score for each individual part of the body and an overall average score of birds in the mating cage.

Parameters	Group 1	Group 2	Group 3	Group 4
Laying hens				
Neck	2.94±0.11^{c}	2.75±0.11^{b}	3.01±0.12^{b}	2.81±0.12^{b}
Breast	3.68±0.04^{ab}	3.55±0.06^{a}	3.62±0.03^{a}	3.55±0.06^{a}
Back	3.77±0.03^{a}	3.64±0.03^{a}	3.68±0.02^{a}	3.77±0.03^{a}
Wing	3.70±0.05^{ab}	3.56±0.05^{a}	3.68±0.03^{a}	3.73±0.03^{a}
Tail	3.48±0.04^{b}	3.53±0.07^{a}	3.54±0.04^{a}	3.61±0.07^{a}
Overall feather	17.57± 0.16^{A}	17.03± 0.18^{A}	17.52± 0.13^{A}	17.47± 0.18^{A}
Roosters				
Neck	3.36±0.11^{b}	3.51±0.06^{b}	3.39±0.06^{b}	3.39±0.11^{c}
Breast	3.65±0.03^{a}	3.66±0.02^{ab}	3.56±0.03^{ab}	3.63±0.02^{ab}
Back	3.73±0.03^{a}	3.74±0.03^{a}	3.73±0.03^{a}	3.73±0.03^{a}
Wing	3.70±0.03^{a}	3.69±0.04^{ab}	3.74±0.03^{a}	3.65±0.05^{ab}
Tail	3.61±0.04^{a}	3.54±0.06^{b}	3.59±0.06^{a}	3.46±0.05^{b}
Overall feather	18.05± 0.19^{A}	18.14± 0.14^{A}	18.00± 0.12^{A}	17.85± 0.12^{A}

A total of 30 (15 male and 15 female) birds per group were randomly scored in the current study. Finally, the average feather score for each individual part of the body and an overall average score were calculated. Means with different superscript letter are significantly different ($P < 0.05$). Lowercase letters are for columns and capital letters are for rows.

DISCUSSION

Laying performances, a major productive and economic indicators in the layer industry, were investigated in the current study. Our results displayed that laying rate was significantly increased in groups 3 and 4 compared with intact control, which agreed with Kolokol'nikova *et al*. (2009) and Ruszler and Kiker (1975), but contradicted the conclusions that overall hen-day egg production was unaffected by claw reduction (Compton *et al*., 1981). This inconsistency might be caused by gender and strain differences of declawed birds used for study. Percentage of defective eggs was significantly lower in group 3 than in the control group, since percentage of defective eggs is considered to be regulated by various factors, our study may not be able to explain the phenomenon. But conceivably an indication that claw reduction apparently affected percentage of defective eggs in a group-specific manner, mortality remained unchanged for all groups of birds. These results were in conflict with the findings of Compton *et al*. (1981). Conversely, our findings were mostly parallel to those of Ingram and Wilson (1981) and Compton *et al*. (1981), who found that hen mortality was not affected by claw trimming. Hatching experiment showing that egg fertility exhibited a significant depression in group 4 was nearly identical to previously published results (Ingram and Wilson, 1981). This phenomenon was probably because roosters with the second and fourth toes declawed were not as capable of keeping their balance during the mating period. In comparison to egg fertility, we also observed a similar trend in hatchability of setting eggs in group 4. It is not surprising that hatchability of setting eggs is positively correlated with egg fertility under a fixed total number of setting eggs. Little variations were found in terms of hatchability of fertile eggs, percentage of healthy pullets, male-to-female ratio, rate of water loss and average chick hatching weight, suggesting that they were unaffected by claw reduction.

Egg quality is composed of those characteristics of an egg that is a crucial fact in the poultry industry for its reproductive and economic values (Dudusola, 2009; Onbasilar *et al*., 2011). Although it is well documented, there is a lack of such knowledge in the mating cage. In our study, we first measured the egg quality characteristics of laying hens mated with the declawed roosters. Statistical analysis displayed that claw trimming significantly increased shell thickness among declawed treatments and yolk color in group 2 than the control. Admittedly, calcium is the major component of eggshell and the pigment content of feed is an important factor for yolk color (Shen and Chen, 2003; Faitarone *et al*., 2016). Thus, the marked exaltations in shell thickness and yolk

color might be associated with the absorption of dietary calcium and pigment from the gut. But, both were not readily measured in our current experiment. There were no significant differences between treatment and control groups for shell strength, shell color, egg shape index, shell weight, egg weights, percentage of yolk, albumen height and Haugh units. Egg quality may be affected by various factors such as bird strain and age, nutrition, disease, storage, stress etc. (Rroberts, 2004). The current results should be carefully guarded and extensive investigations are needed to verify the effects of claw trimming on egg quality characteristics.

Feathers are epidermal outgrowths that form distinctive external covering of the body of birds. They not only aid in thermal insulation, waterproofing and flight, but feather condition is used as a phenotypic indicator of welfare level. Feather cover of all birds was evaluated in the present work. The results demonstrated that toe amputation did not alter overall feather score in all four groups. These findings largely agreed with the results of Compton *et al*. (1981), Glatz (2004), Tauson (1986) and Vanskike and Adams (1983) but contradicted the conclusions proposed by Hill (1975) and Fickenwirth *et al*. (1986) that the reduced claw length apparently ameliorated the influence of the claws on feathers during trampling. Given that relatively young birds were selected in this study, cumulative trampling period of claw on feather may be too short to cause a severe feather loss. Thence, further studies are warranted by extension of experimental period. Additionally, the neck region on birds on all groups had the poorest plumage condition of any body part, which makes distinct contacts with the cage door while eating can explain the neck feather conditions.

CONCLUSIONS

We investigated the effects of declawed roosters on laying performances, egg quality characteristics and feather cover of the mated hens in a natural mating system. It could be concluded from overall results that claw reduction has significant effects on some laying performances and egg quality characteristics of layer breeders in a group-specific manner. Preferential trimming methods were the removal of the first and third or second and fourth claws of day-old chicks in Hy-Line strain. The rationality of declawing as a management practice must be verified by more extensive investigations in other strains.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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