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Effects of Stocking Densities and Illuminance Levels on Skin Conditions of Broilers in Winter

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ABSTRACT This study investigated the impact of stocking densities and illuminance levels on skin conditions in broilers during winter lairage. A total of 35-day-old 192 Ross 308 broilers were randomly assigned to a 3 × 2 factorial design, which included three stocking densities (low density (LD): 292.12 cm²/kg, normal density (ND): 233.70 cm²/kg, high density (HD): 194.75 cm²/kg) and two illuminance levels (0−5 lux (LX) and 5−10 lux (HX)). Following transportation in plastic crates (0.82 m × 0.57 m × 0.29 m), the birds were placed in lairage at temperatures below 10℃. Feather conditions and footpad dermatitis were evaluated after 1 hour of the lairage period as measures of skin conditions. The data were analyzed using a two-way ANOVA to investigate the effects of stocking densities, illuminance levels, and their interaction on feather conditions and footpad dermatitis. No significant differences were found in feather conditions and the incidence of footpad dermatitis concerning stocking densities, illumination levels, and their interaction during winter lairage (P>0.05). These findings suggest that broilers can effectively adapt to various lairage conditions in winter, including different stocking densities and illuminance levels, without significant effects on their skin conditions. Further study under more specific environmental conditions is necessary to identify proper lairage conditions for broilers during winter.

(Key words: broiler, density, illuminance, lairage, winter)

INTRODUCTION

As global interest in animal welfare intensifies, there is a growing focus on livestock production systems that prioritize the health and well-being of animals (Fernandes et al., 2021). This shift is particularly evident in the broiler industry (Saraiva et al., 2020), where establishing suitable lairage environments prior to slaughter has become a key concern. Lairage refers to the pre-slaughter period during which animals are held temporarily to reduce stress and maintain optimal health (Abidin et al., 2023). Inadequate lairage conditions can significantly affect post-slaughter meat quality and overall productivity (Pirompud et al., 2022). Higher stocking densities can lead to physical injuries due to close contact among birds (Vieira et al., 2020) and may also increase the risk of skin damage caused by stress and competition (Song et al., 2024), while illuminance levels may impact behavior and welfare in broilers (Kang et al., 2023).

In winter, however, low temperatures and the cold stress during lairage may compromise the welfare and health conditions of broilers. Winter lairage conditions can greatly influence broiler welfare, as cold stress from low ambient temperatures and the increased energy demands for thermoregulation can pose serious health risks (Hussnain et al., 2020). Broilers expend energy to maintain body temperature, which can destabilize their physiology and weaken immune function (Zhou et al., 2021). This stress may release hormones that disrupt metabolism, increasing vulnerability to illness and mortality during lairage (Moreira et al., 2024).

External factors such as low temperatures and high stocking densities may compromise health and skin conditions during lairage. Feather condition is often utilized as an indirect measure of broiler welfare and stress, as feather damage can result from high-density or suboptimal lairage environments (Benincasa et al., 2020). Additionally, footpad dermatitis, which is closely linked to litter conditions, may correlate with the overall quality of lairage (AMER, 2020). Despite these risks, limited studies have been conducted on winter lairage conditions, highlighting the need for studies that specifically address how stocking density and

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illuminance affect broiler health under low-temperature conditions.

This study aimed to assess the effects of stocking density, illuminance levels, and their interaction during winter lairage on feather conditions and footpad dermatitis in broilers. The findings are anticipated to provide baseline data to inform recommendations for sustainable, welfare-centered lairage conditions in broiler production.

MATERIALS AND METHODS

1. Experimental Design and Birds

This experiment was conducted in a commercial lairage facility with appropriate permissions and ethical approval. A total of 192 Ross 308 broilers, 35 days of age with an average weight of 1.6 kg to 1.8 kg, were utilized in a 3 × 2 factorial arrangement within a completely randomized design. After transport, the broilers were housed in plastic crates (0.82 m × 0.57 m × 0.29 m) in lairage, maintained at temperatures below 10℃. The study included three stocking densities (low density (LD): 292.12 cm²/kg, normal density (ND): 233.70 cm²/kg, high density (HD): 194.75 cm²/kg) and two illuminances levels (0−5 lux (LX) and 5−10 lux (HX)). The stocking density levels were set based on animal transportation regulations in the Republic of Korea, which recommend 160−210 cm²/kg for broilers weighing 1 to less than 2 kg. These density levels were slightly increased to account for welfare considerations during lairage in the study. Following a lairage period of 1 hour, evaluations were conducted on feather conditions and the incidence of footpad dermatitis in broilers. One bird per replicate from each of the six treatments was selected to evaluate feather conditions and footpad dermatitis scores.

2. Skin Condition Measurements

After the lairage period, feather conditions were assessed as indicators of skin conditions, using a scale that ranged from no damage (0) to severe skin damage (4) (Tauson et al., 2005). The assessment of feather condition involved examining the ear, tail, shoulder, and overall skin areas (Son et al., 2020). Fig. 1 presents the prevalence of footpad dermatitis assessed from damage (0) to severe footpad dermatitis (4).

3. Statistical Analysis

The effects of stocking densities, illuminance levels, and their interaction on feather condition and the incidence of footpad dermatitis were examined using the General Linear Model (GLM) procedure, specifically a two-way ANOVA, in SPSS 26.0 (SPSS Inc., Chicago, USA). The statistical unit analyzed was one broiler per crate used during lairage. Tukey's test was employed to conduct multiple comparisons across treatments. A significance level of 95% was established for statistical significance.

RESULTS AND DISCUSSION

1. Feather Condition

Table 1 presents the feather condition scores in response to stocking density and illuminance levels during the lairage period in winter. The feather condition analysis after lairage revealed no significant differences based on stocking density, illuminance levels, and their interactions (P>0.05). Feather condition scores for LD (292.12 cm²/kg), ND (233.70 cm²/kg), and HD (194.75 cm²/kg) were 1.33, 1.17, and 1.08,

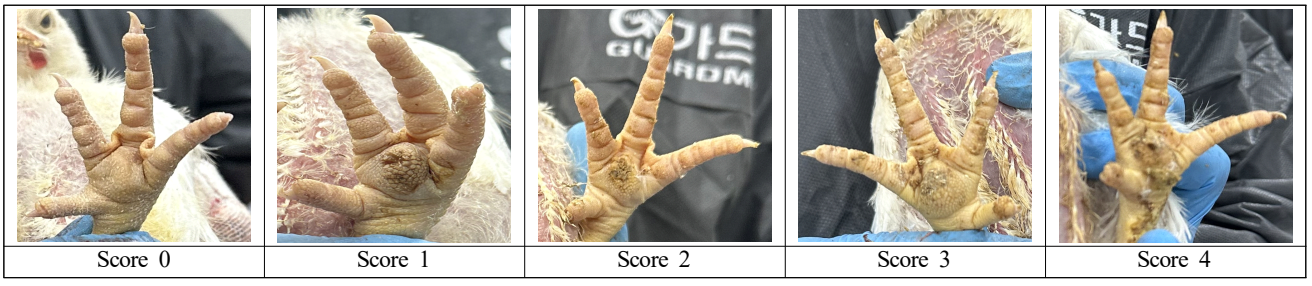

Fig. 1. Target birds for the footpad dermatitis scores of 0−4 on the footpad of broilers.

Table 1. Effect of stocking density and illuminance during winter lairage on feather condition in broilers

Items	Main effect					SEM	*P*-value		
	D[1]			IL[2]			D	IL	D × IL
	LD	ND	HD	LX	HX				
Feather condition	1.33	1.17	1.08	1.17	1.22	0.067	0.313	0.681	0.313

[1] D, density; LD (292.12 cm^2/kg); ND (233.70 cm^2/kg); HD (194.75 cm^2/kg).
[2] IL, illuminance; LX (0−5 lux); HX (5−10 lux).
SEM = standard error of the mean.

respectively, while scores for LX (0−5 lux) and HX (5−10 lux) were 1.17 and 1.22.

Feather condition is regarded as an essential welfare indicator in broilers (Saraiva et al., 2016). Lower stocking densities can reduce skin damage by minimizing physical contact among birds, whereas higher stocking densities may increase the likelihood of skin damage due to stress and competition (Song et al., 2024). In winter lairage conditions, skin damage may increase even at lower stocking densities due to competition for resources and space within the lairage environment, possibly intensifying competition-induced stress. Additionally, while previous studies indicate that higher illuminance (above 30 lux) may increase pecking behavior and lead to feather damage (Kjaer and Vestergaard, 1999), the low illuminance levels used in the study (0−5 lux and 5−10 lux) may have been insufficient to influence such behavior, resulting in no differences in feather conditions.

2. Footpad Dermatitis

Table 2 presents the footpad dermatitis scores in response to stocking density and illuminance levels during the lairage period in winter. The incidence of footpad dermatitis also showed no significant differences based on stocking density, illuminance levels, and their interactions (P>0.05). Footpad dermatitis scores were recorded as 0.42, 0.17, and 0.33 for LD (292.12 cm^2/kg), ND (233.70 cm^2/kg), and HD (194.75 cm^2/kg), respectively. Scores for illuminance levels were 0.22 in LX (0−5 lux) and 0.39 in HX (5−10 lux).

Footpad dermatitis is another welfare indicator potentially influenced by stocking density and illuminance. Higher stocking densities can increase litter moisture due to manure accumulation, potentially worsening footpad dermatitis (Petek et al., 2014; Saraiva et al., 2016). However, since the lairage period in the study was relatively short, it likely did not affect litter humidity to an extent that could impact footpad dermatitis incidence. Furthermore, lower stocking densities may allow more significant activity, potentially reducing footpad dermatitis incidence (Ferrante et al., 2006). Still, this effect may not have been significant within the limited lairage duration of this study. Lower illuminance levels can also increase resting time, potentially prolonging contact between footpads and feces, which could elevate the risk of footpad dermatitis (Blatchford et al., 2009; Deep et al., 2010). On the other hand, the duration of lairage in the study (1 hour) may have been insufficient for illuminance levels to impact footpad dermatitis occurrence significantly, as the

Table 2. Effect of stocking density and illuminance during winter lairage on footpad dermatitis in broilers

Items	Main effect					SEM	*P*-value		
	D[1]			IL[2]			D	IL	D × IL
	LD	ND	HD	LX	HX				
Footpad dermatitis	0.42	0.17	0.33	0.22	0.39	0.080	0.436	0.303	0.697

[1] D, density; LD (292.12 cm^2/kg); ND (233.70 cm^2/kg); HD (194.75 cm^2/kg).
[2] IL, illuminance; LX (0−5 lux); HX (5−10 lux).
SEM = standard error of the mean.

time spent in contact with manure was likely too short to affect the occurrence of footpad dermatitis.

CONCLUSION

This study evaluated the effects of stocking density and illuminance levels during the lairage period in winter on feather conditions and the incidence of footpad dermatitis in broilers. The results showed that stocking densities, illuminance levels, and their interaction did not significantly affect feather condition or footpad dermatitis occurrence. These findings suggest that broilers can generally adapt to different lairage conditions during winter without significant effects on skin conditions. However, additional research is warranted to refine and identify optimal lairage conditions in winter, considering more specific environmental variables.

SUMMARY

본 연구는 겨울철 계류 중 밀도와 조도가 육계의 피부 상태에 미치는 영향을 평가하고자 실시하였다. 총 192수의 35일령 Ross 308 육계를 3 × 2 요인 배치법으로 무작위 배치하여 실험을 수행하였다. 육계는 10℃ 이하의 온도에서 플라스틱 케이지(0.82 m × 0.57 m × 0.29 m)에 배치하여 계류하였다. 밀도는 LD(292.12 cm^2/kg), ND(233.70 cm^2/kg), HD(194.75 cm^2/kg)으로, 조도는 LX(0−5 lux)와 HX (5−10 lux)으로 설정하였다. 계류 이후 피부 손상 지표로서 깃털 상태와 발바닥 피부염 발생을 평가하였다. 본 실험 결과, 계류 중 밀도, 조도, 그리고 상호 작용에 따른 깃털 상태 및 발바닥 피부염 발생은 차이가 나타나지 않았다(P>0.05). 본 연구 결과는 겨울철 계류 과정 중 밀도와 조도의 차이가 육계의 피부 상태에 미치는 영향이 크지 않음을 시사한다. 이후, 겨울철 적절한 계류 조건을 구명하기 위해 보다 구체적인 환경 조건 하 추가적인 연구가 필요한 것으로 판단된다.

(색인어 : 육계, 밀도, 광도, 계류, 겨울)

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REFERENCES

Abidin Z, Idris F, Ramiah S, Awad E, Zakaria Z, Idrus Z 2023 The effects of feed withdrawal, transport and lairage on intestinal microflora in broiler chickens. Egypt J Anim Health Prod 11(1):68-72.

Alvino GM, Archer GS, Mench JA 2009 Behavioural time budgets of broiler chickens reared in varying light intensities. Appl Anim Behav Sci 118(1-2):54-61.

AMER MM 2020 Footpad dermatitis (FPD) in chickens. KJFHC 6(4):11-16.

Benincasa NC, Sakamoto KS, da Silva IJO, Lobos CMV 2020 Animal welfare: impacts of pre-slaughter operations on the current poultry industry. J Anim Behav Biometeorol 8(2):104-110.

Blatchford R, Klasing K, Shivaprasad H, Wakenell P, Archer G, Mench J 2009 The effect of light intensity on the behavior, eye and leg health, and immune function of broiler chickens. Poult Sci 88(1):20-28.

Deep A, Schwean-Lardner K, Crowe T, Fancher B, Classen H 2010 Effect of light intensity on broiler production, processing characteristics, and welfare. Poult Sci 89(11):2326-2333.

Fernandes JN, Hemsworth PH, Coleman GJ, Tilbrook AJ 2021 Costs and benefits of improving farm animal welfare. Agriculture 11(2):104.

Ferrante V, Lolli S, Marelli S, Vezzoli G, Sirri F, Cavalchini L 2006 Effect of light programmes, bird densities and litter types on broilers welfare. Pages 216-221 In: EPC 2006 - 12th European Poultry Conference, Verona, Italy.

Gaglo-Disse A, Tona K, Aliou S, Debonne M, Aklikokou K, Gbeassor M, Decuypere E 2010 Effect of delayed feed access on production and blood parameters of layer-type chicks. Acta Vet Hung 58(2):211-219.

Hussnain F, Mahmud A, Mehmood S, Jaspal M 2020 Effect of broiler crating density and transportation distance on

preslaughter losses and physiological response during the winter season in Punjab, Pakistan. Braz J Poult Sci 22(02):eRBCA-2019-1169.

Kang SW, Christensen KD, Kidd Jr MT, Orlowski SK, Clark J 2023 Effects of a variable light intensity lighting program on the welfare and performance of commercial broiler chickens. Front Physiol 14:1059055.

Karthiayini K, Philomina P 2015 Effect of stocking density on blood biochemical and leukocyte profile of broiler chicken in summer season. Indian J Poultry Sci 50(2):218-221.

Kim HJ, Son J, Jeon JJ, Kim HS, You AS, Kang HK, Kang BS, Hong EC 2021 Effects of light intensity on the growth performance, blood parameter and immune status of broiler chicks. Korean J Poult Sci 48(3):143-150.

Kjaer JB, Vestergaard K 1999 Development of feather pecking in relation to light intensity. Appl Anim Behav Sci 62(2-3):243-254.

Liu W, Zhao J 2014 Insights into the molecular mechanism of glucose metabolism regulation under stress in chicken skeletal muscle tissues. Saudi J Biol Sci 21(3):197-203.

Moreira LM, Sousa LS, Guamán CAG, Vieira MC, Santini MB, Cardoso AR, Leme FdOP, Lara LJC, Araújo ICS 2024 Effects of cold stress on physiologic metabolism in the initial phase and performance of broiler rearing. J Therm Biol 119:103773.

Petek M, ÜSTÜNER H, YEŞİLBAĞ D 2014 Effects of stocking density and litter type on litter quality and growth performance of broiler chicken. Kafkas Univ Vet Fak Derg 20(5):743-748.

Pirompud P, Sivapirunthep P, Chaosap C 2022 Factors influencing dead on arrival and condemnation of broilers during catching, transport, lairage and slaughter. Int J Agric Technol 18(6):2535-2544.

Saraiva S, Esteves A, Oliveira I, Mitchell M, Stilwell G 2020 Impact of pre-slaughter factors on welfare of broilers. Vet Anim Sci 10:100146.

Saraiva S, Saraiva C, Stilwell G 2016 Feather conditions and clinical scores as indicators of broilers welfare at the slaughterhouse. Res Vet Sci 107:75-79.

Son JS, Kim CH, Kang HK, Kim HS, Jeon JJ, Hong EC, Kang BS 2020 Effect of stocking density on the feather condition, egg quality, blood parameters and corticosterone concentration of laying hens in conventional cage. Korean J Poult Sci 47(2):83-93.

Song DC, Lee JH, Yun W, Chang SY, Park SH, Jeon KH, Kim H, Cho JH 2024 Effects of stocking density and illuminance in lairage of fattening pigs in different temperatures. Animals 14(15):2145.

Tauson R, Kjaer J, Maria G, Cepero R, Holm K 2005 Applied scoring of integument and health in laying hens. Anim Sci Pap Rep 23(1):153-159.

Vieira FMC, da Silva IJO, Barbosa Filho JAD, Vieira AMC 2020 Reducing poultry preslaughter losses: crating density effects under different lairage periods at slaughterhouse. J Anim Behav Biometeorol 1(1):1-6.

Yu M, Oketch EO, Chathuranga NC, Nawarathne SR, Hong JS, Maniraguha V, Seo E, Lee J, Park H, Heo JM 2023 Effect of crating density and weather conditions during transit on preslaughter losses, physiological characteristics, and meat quality in broilers. J Anim Sci Technol. https://doi.org/10.5187/jast.2023.e132.

Zhou H, Kong L, Zhu L, Hu X, Busye J, Song Z 2021 Effects of cold stress on growth performance, serum biochemistry, intestinal barrier molecules, and adenosine monophosphate-activated protein kinase in broilers. Animal 15(3):100138.

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