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Effects of Range Access on Behavioral-Based Welfare Indicators and Foot Health Condition of Slow- and Fast-Growing Broiler

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Abstract

This study was made to investigate outdoor range access on behavioral-based welfare parameters and post-mortem foot health conditions of slow- and fast-growing broilers in experimental conditions. There were four treatment groups (two genotypes as fast- and slow-growing birds × 2 indoor housing systems with or without range access) with five replicates. The behavior of 200 male chicks in the groups was observed at 8 weeks of age. The foot health condition was determined after slaughter. Fast-growing broilers spent more time with feeding, drinking, and dust bathing ($p \leq .001$, $p \leq .001$, and $p \leq .006$). The locomotion and standing behavior were found to be greater in slow-growing broilers than fast-growing broilers ($p \leq .001$ and $p \leq .001$). The birds in conventional deep litter spent more time with drinking ($p \leq .001$) and lying behavior ($p \leq .046$). The post-mortem incidence of the foot pad and hock joint dermatitis was found to be greater in fast-growing broilers in both housing groups ($p \leq .05$). The results have shown that the broilers with outdoor access exhibited more natural behavior such as preening and slow-growing birds spent more time performing locomotion and standing. Slow-growing broilers had also less post-mortem foot pad and hock joint lesions compared to fast-growing broilers.

Keywords: Behavior, foot pad dermatitis, free-range, hock joint arthritis, slow-growing broiler

Introduction

Genotype and housing conditions are considered critical factors that directly affect chicken health and welfare (Abo Ghanima et al., 2020; Çavuşoğlu & Petek, 2019a). Free-range broiler meat production has increased steadily in several countries because it is accepted that free-range condition is better for chicken welfare. The broiler chickens in well-managed free-range housing systems are active outdoors, range extensively, and can exhibit natural behaviors (Martínez-Pérez et al., 2017; Pichova et al., 2016; Sans et al., 2014; Zidane et al., 2018). The proportion of broilers produced under alternative indoors, free-range, and organic production represents 10% of total broiler production in the European Union (Better Chicken Commitment, 2021). Free-range broiler chickens have access to a range area where the environmental conditions can allow their foraging behavior, feed selection, and other activity (Da Ponte, 2008; Maciel et al., 2021). Access to the outdoor area provides the broiler to show direct sunbathing behavior (Pichova et al., 2016). The free-range housing systems may also provide special and alternative poultry products and improved meat quality (Ozbek et al., 2022).

The growth performance of fast-growing broilers is still increasing and it appears to be one of the main contributors to most of the poor welfare conditions in broiler meat production (Hartcher & Lum 2020; Phillips & Heins, 2021). Therefore, it has been discussed for many years whether fast-growing broilers would be reared at in all production systems with different management programs to reduce welfare issues as fed lower protein content or outdoor access (Singh et al., 2021; Wilhelmsson et al., 2019; Zaid et al., 2020). Many studies in recent years found that slow-growing broilers are more active and have lower levels of lameness, hock, and foot-pad lesions than fast-growing broiler chickens (Çavuşoğlu & Petek, 2019a; Dixon, 2020; Van der Eijk et al., 2022). However, they had longer slaughter age, often 56–80 days compared to 36–41 days in faster-growing birds (Van Horne, 2020) and consumes more feed to achieve the similar slaughter weight (Çavuşoğlu & Petek, 2019b). Despite all these, the market for slow-growing broiler chickens is getting increasing, and new strains of slow-growing broilers are being introduced to meet the consumer demand (Louton et al., 2019). Currently, 40% of Dutch production is slower-growing broilers while 24% of the production in France and 11% in the United Kingdom (Poultry World, 2019).

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In Türkiye, commercial broiler meat has been produced commonly in indoor deep-litter systems, and almost no fast-growing birds have been kept in free-range systems. There is limited research comparing the production, health, and behavioral-based welfare indicators of fast- and slow-growing broilers within the similar environment (Çavuşoğlu & Petek, 2019a), especially in free-range housing systems (Abdourhamane & Petek, 2020, 2022; Stadig et al., 2017; Zhao et al., 2014). This study was planned to investigate the range access on behavior-based welfare parameters and post-mortem foot health conditions of commercially available slow- and fast growing broilers under experimental free-range conditions.

Method

This study was carried out at the Poultry Research and Experimental Farm of Faculty of Veterinary Medicine of Bursa Uludag University in Türkiye. The ethical permission for this study was obtained from Local Ethical Committee for Animal Experiments of Bursa Uludag University (Bursa Uludag University, approval date and number; 01.09.2015, 91).

Care and Management of the Birds

In the study, there were four interactive treatment groups (indoor deep litter floor housing with or without range access; free-range or conventional deep litter × slower- and faster-growing broiler) with five replicates/pens. The indoor space was 1 m^2 for all replicate/pens (for ten birds) and 5 m^2 outdoor space was allocated for each replicate of free-range access. In this way, each main treatment group consisted of 50 male broilers (ten birds in each replicate). Each main treatment group consisted of 50 male broiler (10 birds in each replicate). One-hundred slow-growing (Hubbard JA 57) and one-hundred fast-growing (Ross PM3), day-old chicks were studied, in total. In range access groups, 31%–41% of the outdoor condition was covered by natural grass such as *Portulaca oleracea* and *Xanthium spinosum*. In the study, 7 kg/m^2 rice hull was provided for the indoor part of all experimental groups as litter material.

The birds in all groups were raised in standard management conditions for broiler meat production until the end of the experiment (Ross Broiler Management Handbook, 2018). Free-range chickens were housed indoors during the first 4 weeks of growing periods, and then the broilers were allowed to access the range from 8:00 a.m. to 6:00 p.m. during the day (Sainsburry, 1992). A 24-hour continuous lighting regime consisting of daylight and artificial light was used in the first week of the experiment. Then, daylight and an intermittent night lighting program (2 hours of dark and 2 hours of light) were applied until the end of the experiment. The light intensity was 20 lux for all birds in the treatment groups throughout the experiment as indicated in Turkish legislation for the welfare of broiler chickens (Anonymous, 2018). All chicks in the study received a commercial multiphase broiler feed (i.e., starter feed for first 10 days, 23% protein and 2950 kcal/kg ME; grower feed I for days from 11 to 23, 21% protein and 3000 kcal/kg ME, grower feed II for days from 24 to 36, and finisher feed for days from days 37 to 56, 19% protein, 3100 kcal/kg ME).

Data

All behavioral measures were assessed with the direct live observation by an experienced person during the last week of the experiment (at 8 weeks of age). The foot health condition was determined after slaughter from the affected legs.

Behavioral-based Welfare Indicators

The behavioral observations were conducted on a number of focal selected chickens by continuous visual observation (Graml et al., 2008). The definitions of the behaviors measured in the study are given in Table 1. To measure the behavior of the birds in the groups; three animals from each replicate group (15 focal birds for each group) were marked with non-toxic color markers to provide unique combinations. Behavioral data were collected using the continuous sampling method, and each replicate was observed for 30 minutes at a distance of 1 m for three focal animals (10 minutes for each focal bird). The behavior of the focal birds in all groups was recorded over a 5-hour period from 10 a.m. to 3 p.m. by one observer on 2 consecutive days. The behaviors of the birds in four treatment groups were expressed as states (lying, walking, dust bathing, and standing) and events (feeding, drinking, wing flapping, fighting, and preening) according to the occurrence of status or number (Fortomaris et al., 2006; Ferreira et al., 2021, 2022; Martin & Bateson, 2007). State behaviors, those that occur for some length of time, were lasting

Table 1.

Ethogram Used for the Evaluation of Broiler Behavior With Direct Visual Observation (Ferreira et al., 2022; Wilutzky, 2015; Zhao et al., 2014)

Lying/resting	Bird lies in the litter and contacts with the floor with their sternum and abdomen, both legs are twisted under their body.
Walking/Locomotion	Walking with normal steps or quick steps after when the bird takes two or more steps forward without pecking or scratching
Feeding	The bird is taking in food once, actively or repeatedly
Drinking	Bird is actively consuming water from drinker
Dust bathing	Bathing the dust, combined with some other behavior such as preening and scratching, bird pecks and scratches at the litter material
Standing	Standing without any other activity, with no other body parts touching the ground, without foot movements
Fighting	Two birds standing facing each other, heads and necks raised to the same level, head pecking, jumping or kicking at another bird in an aggressive manner
Preening	Bird directs its beak to its own plumage of several body parts and carries on pecking, nibbling, combing, rotating movements, once or repeatedly, while standing or sitting
Wing flapping	Bird spreads the wings and moves them up and down at least twice

more than 1 second, and event behaviors, those that are often sudden, were lasting less than 1 second (Ferreira et al., 2021; Lehner, 1992). The observer recorded the length of the state behaviors of each focal animal with a stopwatch. The length of each behavioral parameter was represented as a percentage of the total observation time.

Post-mortem Clinical Measures

The samples for clinical measures were collected from the equal number of legs of the birds from each group after the slaughter at 56 days of age. The leg samples were selected primarily from affected legs with superficial or minor superficial lesions on the foot pad or hock joint after slaughter (Butterworth, 2013; Welfare Quality Project, 2009). The gross images were obtained from the legs, and histopathological examinations were done routinely to assess the occurrence of leg and joint problems such as foot pad dermatitis, hock joint arthritis, tibial dyschondroplasia, etc. by microscopic examinations. Tissue samples were fixed in 10% buffered neutral formalin solution; after completion of the fixation, tissues (48 hours) were passed through graded alcohol and xylene solutions, 5-µm sections were taken by embedding in paraffin, and the slides were stained with hematoxylin–eosin. The sole of the feet, knee joint-synovial, and joint tissues prepared in this way were examined microscopically (Michel et al., 2012).

Statistical Analysis

The statistical test for the examined traits was done using Statistical Package for Social Sciences computer software 13.00 (SPSS Inc, Chicago, IL, USA, 2009). Analysis of variance test was used to analyze the effects of the broiler's housing system and genotype (Snedecor & Cochran, 1989). The general form of the model was the following: $Y_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$, where *a*: range access and *b*: genotype; $a \times b$: an interaction; *i*: 1, 2 (1: deep litter without range access, 2: deep litter with range access), $j = 1, 2$ (1: fast-growing broiler, 2: slow-growing broiler). μ is a constant, and *e* is an error term. The results are presented as mean ± SEM.

Results

The effects of range access and genotype on event behavior scores in the groups are shown in Table 2. There were significant differences for genotype × range access interaction for feeding, drinking, and wing flapping behavior of the chickens ($p \leq .007$, $p \leq .044$, $p \leq .001$). The fast-growing birds spent more time for feeding and drinking behavior ($p \leq .001$ and $p \leq .001$). The free-range birds had greater preening behavior and less drinking behavior than those in deep litter ($p \leq .003$ and $p \leq .001$).

The state behavior score values observed in the groups are shown in Table 3. There was a significant genotype × range access interaction for the standing behavior of the birds ($p \leq .001$). The locomotion, standing, and dust-bathing behavior of the faster- and slower-growing chickens were significantly different ($p \leq .001$, $p \leq .001$, $p \leq .006$). Lying or resting duration of broilers raised on conventional deep litter was found significantly greater ($p \leq .046$).

The level of foot pad dermatitis, hock joint dermatitis, hock joint arthritis, and tibial dyschondroplasia in fast-growing and slow-growing broiler housed in both indoor deep litter housing systems with free-range access or without range access is presented in Figure 1. According to Figure 1, the incidence of footpad and hock joint dermatitis was greater in faster-growing broilers in deep litter with range access and without range access. The level of hock joint arthritis was slightly greater in fast-growing broilers in free-range birds. No

Table 2.

Effects of Genotype and Range Access on Event Behavior of the Broiler Chickens (% of Total Time)

Groups	Feeding	Drinking	Wing Flapping	Fighting	Preening
Genotype					
Fast growing	24.02 ± 1.45	14.07 ± 1.12	2.03 ± 0.49	0	14.25 ± 1.30
Slow growing	14.79 ± 1.22	8.29 ± 0.95	1.71 ± 0.41	2.31 ± 1.21	11.23 ± 1.10
Range access					
With (free range)	18.60 ± 1.43	8.932 ± 1.10	1.84 ± 0.48	0.19 ± 1.41	16.40 ± 1.29
Without (deep litter)	20.22 ± 1.25	13.42 ± 0.96	1.90 ± 0.42	2.12 ± 1.23	9.08 ± 1.12
Genotype × range access					
Fast × with (free range)	20.60 ± 2.21^{B}	10.33 ± 1.71^{B}	3.11 ± 0.74^{A}	0	19.16 ± 1.20
Fast × without (deep litter)	27.45 ± 1.87^{A}	17.80 ± 1.44^{A}	0.96 ± 0.63^{B}	0	9.33 ± 1.68
Slow × with (free range)	16.60 ± 1.81^{a}	7.54 ± 1.40^{a}	0.58 ± 0.61^{b}	0.38 ± 1.783	13.63 ± 1.63
Slow × without (deep litter)	12.98 ± 1.65^{a}	9.03 ± 1.274^{a}	2.85 ± 0.55^{a}	4.23 ± 1.628	8.82 ± 1.48
ANOVA					
Genotype	.001	.001	.612	.220	.080
Range access	.395	.003	.928	.306	.001
Genotype × range access	.007	.044	.001	.306	.144

Note: ^{A,B}Significant differences between free range and deep litter for fast-growing broilers.
^{a,b}Significant differences between free range and deep litter for slow-growing broilers.
ANOVA, analysis of variance.

Table 3.

State Behavior Values of Fast- and Slow-Growing Broiler Housed on Deep Litter With or Without Range Access (% of Total Time)

Groups	Locomotion (%)	Lying/ Resting (%)	Standing (%)	Dust Bathing (%)
Genotype				
Fast growing	5.04 ± 1.12	27.90 ± 1.45	6.71 ± 1.41	5.98 ± 0.78
Slow growing	11.36 ± 0.94	26.22 ± 1.22	13.68 ± 1.19	3.13 ± 0.66
Range access				
With (free range)	7.77 ± 1.10	25.15 ± 1.43	9.15 ± 1.39	4.69 ± 0.77
Without (deep litter)	8.63 ± 0.96	28.97 ± 1.25	11.24 ± 1.21	4.43 ± 0.67
Genotype × range access				
Fast × with (free range)	5.26 ± 1.71	25.57 ± 2.21	9.81^{A} ± 2.16	6.17 ± 1.19
Fast × without (deep litter)	4.82 ± 1.44	30.23 ± 1.87	3.61^{B} ± 1.82	5.80 ± 1.00
Slow × with (free range)	10.29 ± 1.39	24.72 ± 1.81	8.49^{b} ± 1.76	3.20 ± 0.97
Slow × without (deep litter)	12.44 ± 1.27	27.72 ± 1.65	18.87^{a} ± 1.60	3.06 ± 0.88
ANOVA				
Genotype	.001	.376	.001	.006
Range access	.506	.046	.260	.801
Genotype × range access	.377	.661	.001	.909

Note: ^{A,B}Significant differences between free range and deep litter for fast-growing broilers.
^{a,b}Significant differences between free range and deep litter for slow-growing broilers.
ANOVA, analysis of variance.

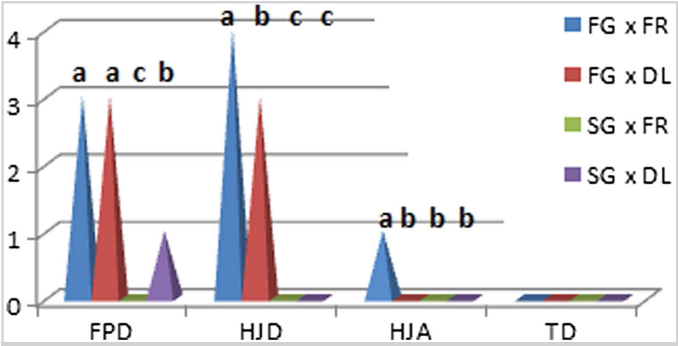

Figure 1.

Foot Health (FPD, HJD, HJA, and TD level) in FG × FR, FG × DL, SG × FR, and SG × DL Groups.
$^{a\text{-}b\text{-}c}$Any Bar Within a Particular Point not Sharing a Common Letter Differ Significantly ($p \leq .05$).
DL, deep litter housing systems without range access; FG, fast growing; FPD, foot pad dermatitis; FR, deep litter housing systems with free-range access; HJA, hock joint arthritis; HJD, hock joint dermatitis; SG, slow growing; TD, tibial dyschondroplasia.

clinical data were observed in slow-growing birds, except a low level of footpad dermatitis in free-range birds.

Discussion, Conclusion, and Recommendations

The welfare problems of poultry are a very complex issue and most often caused by the genotype, housing system, equipment design, or improper use (Çavuşoğlu & Petek, 2019a; Rayner et al., 2020; Relić et al., 2019). The results of this study showed that the slower-growing broilers spent significantly less time for feeding, drinking, and dust-bathing ($p \leq .001$, $p \leq .001$, $p \leq .006$) and significantly more active with more time for locomotion and standing ($p \leq .001$, $p \leq .001$) than the faster-growing broiler chickens (Dixon, 2020). As a result of spending more time eating and drinking, the fast-growing broiler probably consumed more feed than slow-growing birds (Çavuşoğlu & Petek, 2019b). Genotype × range access interactions for feeding and drinking behavior revealed that fast-growing birds in conventional indoor deep litter in closed barns statistically consumed more feed and water while there were no significant differences for slow-growing birds between both housing systems. The birds in closed barns without range access spent significantly more time with drinking due to probably living in a limited area and there was nothing to do as walking freely, catching a fly or insect, etc.

In this study, dust bathing behavior was significantly affected by genotype and fast-growing broilers spent more time for dustbathing. The less dustbathing behavior of slower-growing birds might be explained by decreased and insufficient litter material over time because more locomotor activity of slower-growing birds may have led to thinning litter. Actually, dust bathing and preening are common behaviors for healthy feather and skincare of poultry (Ekesbo, 2011). Reduced dustbathing behavior in a flock may indicate problems with litter or range quality without a dustbathing substrate (Chen et al., 2013; OIE, 2019). Dustbathing helps to keep the feathers in good condition, which in turn helps to maintain body temperature and protect against skin injury. In general, the free-range birds and slow-growing broilers spent significantly more time with preening behavior. Similar to our results for preening activity, Zhao et al.(2014) reported more natural behaviors such as preening, dustbathing and walking for the broilers with outdoor access than the indoor birds. Although slow-growing broilers tend to fight each other, there was generally no difference between all groups as genotype or range access for fighting behavior. Concurrent with this study, Zhao et al. (2014) showed that the housing system did not significantly affect broiler fighting activities.

In the current study, the locomotion and standing behavior of fast-growing birds was found to be significantly different from the slow-growing birds ($p \leq .001$). The main explanation for the lower activity of fast-growing broilers can be their heavy body weight and conformation which is limiting their mobility (Petek et al., 2018; Wallenbeck et al., 2017). Consistent with our results we found (Figure 1), lower activity may also be associated with foot lesions of fast-growing broilers. Increasing eating behavior of fast-growing broilers can also decrease the duration of the other behavior. Based on previously reported findings (Çavuşoğlu & Petek, 2019a, 2019b), it is clear that the greater activity of slower-growing broilers also contributes to lower gait, hock, and breast cleanliness scores compared to faster-growing birds. Similar to the result of this study, Bergmann et al. (2017) showed that Cobb Sasso slow-growing broilers were

more active than conventional Ross 308 broiler chicken. Sanchez-Casanova et al. (2019) also reported that there were welfare benefits of outdoor access, principally in terms of increased activity. Wallenbeck et al. (2017) reported that both slow- and fast-growing broilers show decreasing activity with increasing age, while spent eating and sleeping time was approximately similar over the entire rearing period.

Despite significant differences in the standing behavior of slower- and faster-growing birds ($p \leq .001$), there were no significant differences in time for lying or resting behavior of both genotypes. Prolonged lying and resting time may be an indicator of negative chicken behavior signals (Rayner et al., 2020). Zupan et al. (2003) showed that the resting behavior of broilers in intensive systems was highest, whereas the lowest was found in the free-range systems. Similar to the findings of that researcher, the birds without range access had significantly more time with lying/resting behavior ($p \leq .046$). Although there was no difference in this study, genetic differences may be a reason for the higher percentage of resting behavior of the birds among the groups. In this study, as expected, slow-growing broilers stayed up longer than fast-growing broilers. Especially slow-growing broilers in conventional deep litter without range access spent more time with standing behavior. The effects of both genotype and range access on the wing flapping behavior of the birds were found to be not significant.

Contact dermatitis is characterized by ulceration and necrotic lesions on the plantar surface of the footpads and hock joints of broilers (Çavuşoğlu, 2018). These lesions and inflammation have been considered to be painful for birds (Flecknell, 2008; Young, 2007). In this present study, the prevalence of post-mortem foot pad and hock joint dermatitis determined clinically were highest in fast-growing broilers raised on both indoor housing with or without range access. Fast-growing birds from free-range access also had minimal levels of hock joint arthritis compared to other birds with no arthritis (Figure 1). The presence of tibial dyschondroplasia, which is a plug of cartilage in the proximal end, distal and proximal of tibia, was not observed in slow- and fast-growing birds raised on both housing systems. Similar to the result of this study, Hanh et al. (2019) reported that the fast-growing broilers in conventional indoor closed systems without range access suffered from some welfare issues such as lameness, severe hock burn, and footpad dermatitis. In the same study, it was found that the crossbred of Ho × Luong Phuong chickens, which is a slow-growing chick, in the outdoor access system had better welfare than that of the indoor housing system.

Some factors might have affected the results of this study, although their effects were very limited. In commercial conditions, the faster-growing birds are slaughtered at 6 weeks of age while slower-growing broilers are slaughtered after 11–12 weeks of age depending on their performance or husbandry conditions (Anonymous, 2019; Rayner et al., 2020). For a comparative study with the similar conditions as possible, we planned to slaughter the animals at the same age. The longer, more frequent, and greater range access from the inside to outside in a free-range housing system is associated with improved bird welfare (Taylor et al., 2018). But the number of chickens in the range area was generally very low (Rodriguez-Aurrekoetxea et al., 2014; Stadig et al., 2017; Taylor et al., 2017) due to free-range chickens usually reluctant to use outdoor areas, especially in hot hours of the day (Ferreira et al., 2021). The present study was carried out at the beginning of the hot season of the year (in June and July) and fast-growing birds spend almost all of their time indoors. Therefore, we did not measure the range-related behavior of the birds due to some shortage of the birds observed in the range area.

In this study, the incidence of post-mortem footpad dermatitis and hock joint arthritis was higher in fast-growing broilers compared to slow-growing broilers regardless of the housing system. Accordingly, locomotion and standing behaviors were less in fast-growing broilers. Slow-growing broilers spent less time for feeding and drinking. The free-range broilers had a significantly higher preening activity with less drinking behavior. The provision of range access for broilers should be beneficial to have better welfare by spending less time on indoor litter.

Ethics Committee Approval: This study was approved by the Bursa Uludağ University Animal Experiments Local Ethics Committee (01.09.2015, 91).

Peer-review: Externally peer-reviewed.

Author Contributions: MP conceived the idea of this research, designed and performed the experiment, supervised the study, and wrote the article. IMA performed the experiment.

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