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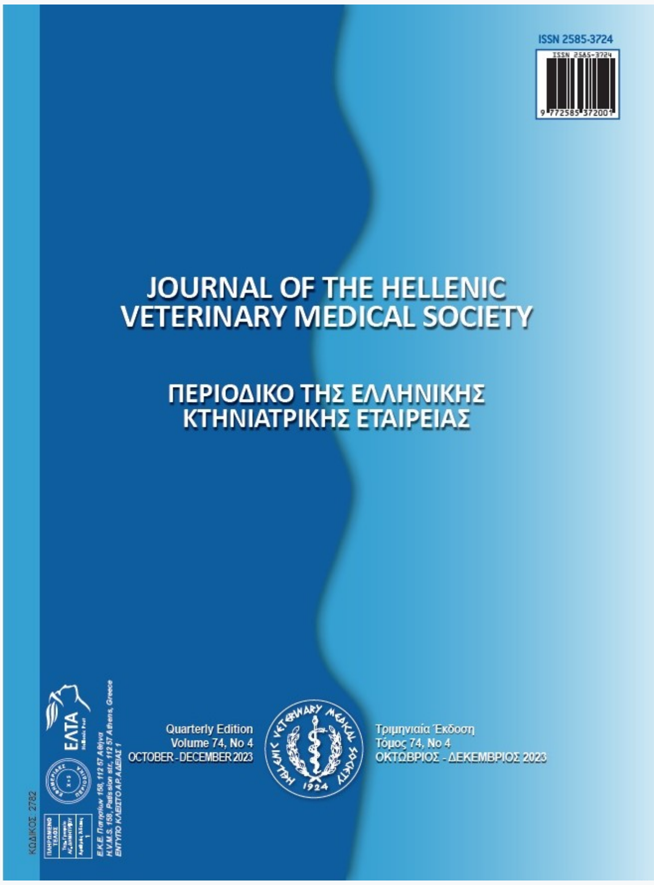

Later exposure to different perch material and design affects behaviour and performance of Leghorn hens

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Research article
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Later exposure to different perch material and design affects behaviour and performance of Leghorn hens

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ABSTRACT: In this experimental study, 540LSL lite laying hens were randomly distributed according to Complete Randomized Design in 6 treatments with6 replicates of 15 birds each. The experiment was set up asa 2 × 3 factorial arrangement of treatments; treatments consisted of 2 perch materials (wooden and plastic) and 3 perch shapes (square, round, and triangle). Effects of perch material and shape were evaluated on productive performance, behaviour and welfare traits, and egg characteristics. Egg weight was higher in wooden perch materials than plastic. Regarding perch design, egg weight, production percentage, and feed conversion ratio per kg of egg mass of commercial layers differed significantly. Moreover, wing flapping and perching behaviour were significant among different perch designs. Egg volume, egg weight, albumen height, Haugh unit score, and shell thickness differed significantly among perch designs. In conclusion, the provision of different perch designespecially wooden and triangular perches positively influences productivity, behaviour, and egg quality traits in laying birds.

Keywords: Perch material; Perch design; Productive performance; Egg quality

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INTRODUCTION

Poultry is the most vital and systematically developed part of the agriculture sector of Pakistan. It serves as the backbone in agriculture production and becoming the balancing force to keep a check in beef and mutton prices. Poultry reflects its inherent potential by contributing 34%, 12.7%, and 1.4 % respectively to total meat production, livestock sector, and GDP (Economic Survey, 2022). The layer sector is a cheaper source to provide animal protein in form of eggs (PPA, 2016).

Welfare is a major global concern nowadays concerning laying hens. Studies are underway in identifying reliable ways to provide the bird with proper welfare on poultry farms or experimental facilities (Botreau et al., 2009). Welfare, usually, relates to the expression of the natural behaviour of laying birds; however, less space and housing, limits the bird to express their full potential and natural behaviour that leads to emotional stress (Janczak and Riber, 2015). There has been significant research on altering conventional cages to minimize the threats to laying hen welfare. These altered modifications are the availability of perch, space, and litter which leads to increase bone health or bone density (Campbell et al., 2016),and substrate for dust bathing which is a strongly motivated natural behaviour respectively (Barnett et al., 2009).

Perching behaviour is natural and evident in Red Jungle fowl, from which modern-day chickens originated. In wild conditions, chickens used to perch at night on trees and bushes. Roosting during night time might be due to better survival from night-hunting ground predators (Olsson and Keeling, 2002). Perches are important and helpful for birds to approach the feeders and drinkers as well as night time roosting. In commercial poultry, perches are provided to improve hen's welfare in both enriched cages and non-caging systems. Perches allow the hens to express their perching behaviour and can be used to escape from the aggressive hens and active feather peckers (Cordiner and Savory, 2001). In commercial laying hens, perches are generally provided in non-cage and furnished cage systems to fulfil their behavioural needs (StruelensandTuyttens, 2009).

Another positive impact of perching is the improvement of the bird's physical condition i.e., to increase bone strength. However, some bone deformities and incidence of bumblefoot have also been noted in the laying hens when provided with perches (ESFA, 2015). The only concern about the perching by EU is that at least 15 cm perch length should be provided per hen in the furnished and non-cage system and perch don't have any sharp edges. The horizontal distance between perches must be 30 cm. These requirements stimulate the scientists to explore the design i.e., width, shape, and material of perches and their effects on hen health. The use of perches by laying hens in the non-cage system and furnished cage system are well documented, however, perch features in terms of material and shape are still limited and could contribute to variation in perch use and bird health. Therefore, the present study was hypothesized that the performance and welfare of laying hens may improve in later stages when exposed to different perch designs. From the above discussion, this study was conducted with the basic objective to evaluate the behaviour, productivity,and egg quality traits of commercial layers subjected to different perch designs and materials.

MATERIALS AND METHODS

The experimental trial was conducted at Indigenous Chicken Genetic Resource Centre, Department of Poultry Production, University of Veterinary and Animal Sciences, Ravi Campus, Pattoki, Pakistan.

Experimental Design:

The experimentation involved five hundred and forty Lohmann Selected Leghorns (LSL Ultra Lite) already maintained in the aviary system. Birds were not provided with any perches before 38 weeks of age, after that different perch designs (wood and plastic with square, round, and triangle) were added so that birds can easily be acclimatized with these perching designs. After the adjustment period of two weeks,540birdswere randomly distributed in 6 treatmentshaving6 replicates of 15 birds each. The experiment was set up ina 2 × 3 factorial arrangement of treatments under Complete Randomized Design. Treatments consisted of 2 perch materials (wooden and plastic) and 3 perch shapes (square, round, and triangle).The duration of this experiment was 14 weeks (40-54 weeks).

Housing and Management

Experimental birds were kept at an aviary system having floor pens (stocking density of 0.139 m^2 per bird;15 cm perch space (3.1 cm diameter for round and 3.2 cm diameter for triangle and square) was provided to each bird having 30 cm height. Birds were given 100 g per bird feed daily and ensured the availability of clean and fresh water by manual drinkers. Birds were provided with 16 hours of light with an intensity of 30 lux. The eggs collection data (weight of eggs and number of eggs) were noted on daily basis. Bodyweight was recorded at the start and the termination of the experiment.

Parameters Evaluated

Productive Performance

Bodyweight (g): Each bird was weighed at the start and the end of the experimental trial and their difference were determined.

Feed intake (g): Feed was offered daily and calculated by using the subsequent formula:

Feed Intake (g) = Feed Offered (g) - Feed Residues (g)

Egg weight (g): Eggs from every replicate were collected and weighed daily.

Production (%): Hen day egg production was calculated on daily basis.

FCR (per dozen of eggs): It is the ratio between the number of eggs produce and feed consumed. The following formula was used to check this ratio:

$$\text{FCR (per dozen of eggs)} = \frac{\text{KG of feed consumed}}{\text{Total egg produced}} \times 12$$

FCR (per kg of egg mass): It is a proportion between the egg mass and feed consumed and were determined by the following formula:

$$\text{FCR (per kg egg mass)} = \frac{\text{Feed consumed (g)}}{\text{Egg mass produced (g)}}$$

Mortality (%): Mortality and any other ailment were recorded on daily basis (if any).

Welfare and behaviour traits

Feather scoring: A total of 3 birds from each replicate were observed for scoring the plumage condition using a 4-point scoring system (Dereli Fidan andNazlıgül, 2013) and 6 different points of the body (Wing, Neck, Breast, Tail, Vent, Back) were observed.

Behavioural patterns: Three birds from each replicate were tagged and observed weekly for 20 minutes between 11:00 to 13:00 h, and the percent of time spent oneach behaviour was noted according to the general observer method in which three persons observes the behaviour of birds to avoid biasness (EFSA, 2015). Behaviour repertoire was included drinking, feeding, standing, sitting, jumping, walking, running, lying, dust bathing, aggressiveness, wing flapping, and scratching as adoptedby Rehman et al. (2018).

Egg characteristics

Egg geometry

A total of 20 eggs were collected from each replicate (60 per treatment group); after tagging the eggs, following egg morphometry was measured.

Shape index: Egg width and length were determined by using a Vernier calliper (least count =0.1mm). The following formula was used to calculate the egg shape index:

$$\text{Shape Index} = \frac{\text{Breadth}}{\text{Height}} \times 100$$

Egg Surface Area (cm^2): To calculate the egg surface area the following formula was used as adopted by Asghar et al. (2012).

Egg Volume (cm^3): Egg volume was determined by following the formula as adopted by Asghar et al. (2012).

Egg Quality

Twenty eggs from each replicate (60 per treatment group) were selected and subjected to egg quality traits.

Egg weight (g): Eggs were collected and weighed by using an electrical weighing balance.

Yolk index: For the calculation of the yolk index, the following formula was usedas adopted by Özbey and Esen (2007).

$$\text{Yolk index} = \frac{\text{yolk height}}{\text{yolk width}} \times 100$$

Haugh Unit Score: For the calculation of the Haugh Unit, the following model was followed as adopted by Wu et al. (2007).

Shell thickness (mm): Shell thickness is the average value of three-point at eggs that includes sharp end, equator, and air cell was calculated from the fresh shell without membranes using digital micrometre screw-gauge.

Shell breaking strength (N): Shell break strength was determined by using the Instron testing machine

(Shi et al., 2012). For this, 3 un-cracked eggs from each replicate were selected and gradually increasing load was applied till breakage and reading were noted.

Statistical Analysis

For behavioural data, it was analysed on a group level by averaging data values of hens from each replicate, residual was tested for the normal distribution applying the Shapiro-Wilk test.Data were transformed when necessary and subjected to further analysis. Data regarding behaviour, productive performance, egg quality traits, and feather scoring were subjected to two-way analysis of variance applying GLM procedures in SAS software (Version, 9.1). For the comparison of significant treatment means, Duncan's (1955) Multiple Range Test was applied.

RESULTS

Production Performance

In this experiment, egg weight, production percentage, and feed conversion ratio per kg egg mass of commercial layers differed ($P \leq 0.05$) among perch design and material (Table 1; Figure 1). Egg weight was higher in wooden perch material than plastic; regarding perch design, egg weight was higher in birds used square and triangle perches than round. The production percentage of commercial layers was higher in triangle perch than round and square design.

Behavioural and welfare traits

Walking and sitting behaviours were higher in plastic perches than wooden ($P \leq 0.05$). Standing behaviour was found higher ($P \leq 0.05$) in wooden perch than those of plastic (Table 2). Regarding perch design, birds spent most of their time wing-flapping near square perch as compared to round and triangle perches ($P \leq 0.05$). Furthermore, perching behaviour was more pronounced in square and round perches than in a triangle ($P \leq 0.05$). Wing flapping and perching were different among perch designs ($P \leq 0.05$). The frequencies of wing flapping were higher in square perch design than round and triangle; while perching behaviour was higher in square and round perch design than a triangle ($P \leq 0.05$). The interaction between perch material and design revealed that birds spent more of their time wing-flapping around wooden square perch than those of other perches ($P \leq 0.05$). Moreover, perching behaviour was more pronounced in birds around wooden square perches and plastic round perches. An interaction effect was significant in standing behaviour; birds revealed lower preference towards the rounds, square and triangle perches in termsof perch visit and the number of perching. In terms of feather scoring, perch material, design, and their interaction did not show any significant difference among treatment groups (Table 3).

Table 1. Effect of different perch material, design, and their interaction on productive performance of commercial layers (40-54 weeks).[1]

Trait	Perch Material		P-value	Perch Design			P-value
	Wooden	Plastic		Square	Round	Triangle	
FI, Kg	10.08 ± 0.02	10.09 ± 0.02	0.530	10.10 ± 0.02	10.08 ± 0.02	10.08 ± 0.03	0.793
EW, g	63.13^{a} ± *0.08*	62.85^{b} ± *0.08*	0.001	63.10^{b} ± *0.06*	62.83^{a} ± *0.04*	63.05^{b} ± *0.17*	0.001
PP, %	93.21 ± 1.03	91.24 ± 1.46	0.241	90.29^{b} ± *1.70*	91.11^{b} ± *1.24*	95.29^{a} ± *1.33*	0.044
EM, Kg	5.77 ± 0.07	5.62 ± 0.09	0.160	5.58^{b} ± 0.11	5.61^{a} ± 0.08	5.89^{a} ± 0.08	0.045
FCRdz	1.35 ± 0.02	1.40 ± 0.03	0.116	1.41 ± 0.03	1.39 ± 0.02	1.32 ± 0.02	0.563
FCRem	1.78 ± 0.03	1.86 ± 0.04	0.085	1.86^{a} ± *0.05*	1.85^{a} ± *0.03*	1.74^{b} ± *0.03*	0.050
LIV %	98.86 ± 0.64	97.24 ± 1.48	0.302	100.00 ± 0.00	95.43 ± 1.84	98.71 ± 1.29	0.061

Trait	Wooden			Plastic			P-value
	Square	Round	Triangle	Square	Round	Triangle	
FI, Kg	10.09 ± 0.03	10.06 ± 0.03	10.08 ± 0.05	10.10 ± 0.03	10.09 ± 0.03	10.08 ± 0.02	0.957
EW, g	62.96^{c} ± *0.07*	62.89^{c} ± *0.05*	63.55^{a} ± *0.03*	63.24^{b} ± *0.03*	62.77^{d} ± *0.06*	62.54^{e} ± *0.04*	0.0001
PP, %	92.29 ± 2.15	92.79 ± 1.65	94.57 ± 1.77	88.29 ± 2.53	89.43 ± 1.67	96.00 ± 2.14	0.093
EM, kg	5.69 ± 0.14	5.72 ± 0.10	5.89 ± 0.11	5.47 ± 0.16	5.50 ± 0.11	5.88 ± 0.13	0.111
FCRdz	1.37 ± 0.03	1.36 ± 0.03	1.32 ± 0.03	1.46 ± 0.06	1.43 ± 0.03	1.32 ± 0.04	0.092
FCRem	1.81 ± 0.05	1.81 ± 0.04	1.73 ± 0.04	1.92 ± 0.07	1.90 ± 0.04	1.75 ± 0.06	0.096
LIV %	100.00 ± 0.00	96.57 ± 1.54	100.00 ± 0.00	100.00 ± 0.00	94.29 ± 3.50	97.43 ± 2.57	0.200

[a-e] Superscripts on different means within a row represent significant difference among treatment means at $P \leq 0.05$.
[1]Values are presented as least-square means ± standard errors, the average of each parameter from 40-54 weeks.
FI= Feed intake, EW= Egg weight, PP=Production percentage, EM=Egg mass, FCRdz=Feed conversion ratio per dozens of eggs, FCRem=Feed conversion ratio per Kg of egg mass, LIV=Livability

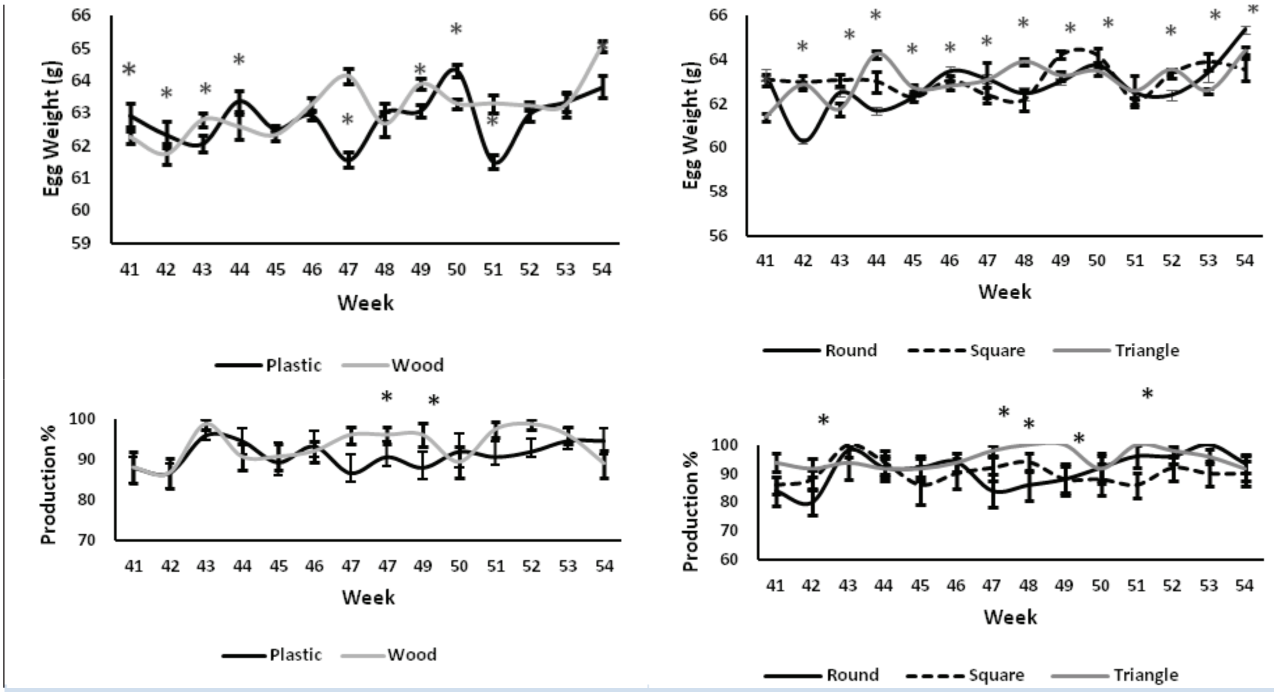

Figure 1. The trend of weekly egg weight and production percentage among different treatment groups; * Significant difference at P ≤ 0.05

Table 2. Effect of different perch material, design and their interaction on the behavioral response of commercial layers.[1, 2]

Trait	Perch Material		P-value	Perch Design			P-value
	Wooden	Plastic		Square	Round	Triangle	
DRK	10.92 ± 4.29	6.13 ± 0.42	0.289	5.94 ± 0.74	12.52 ± 6.54	7.08 ± 1.07	0.242
FED	4.52 ± 0.82	4.38 ± 0.39	0.887	4.68 ± 0.33	4.98 ± 1.18	3.70 ± 0.51	0.979
STA	10.33^{b} ± 1.14	19.61^{a} ± 1.55	0.008	13.24 ± 2.10	14.84 ± 2.89	16.83 ± 2.75	0.071
STI	11.68^{a} ± 1.33	11.26^{b} ± 1.23	0.005	12.24 ± 0.90	9.53 ± 1.57	12.59 ± 1.81	0.830
JUM	11.89 ± 0.92	7.99 ± 0.94	0.845	10.24 ± 1.70	9.03 ± 1.18	10.51 ± 1.38	0.337
WAL	16.07^{a} ± 1.42	10.03^{b} ± 1.67	0.020	1.16 ± 0.30	10.13 ± 1.46	12.59 ± 1.13	0.102
LA	0.96 ± 0.23	0.93 ± 0.22	0.930	10.70 ± 0.81	0.73 ± 0.38	0.75 ± 0.19	0.865
DB	10.73 ± 1.23	11.42 ± 0.98	0.677	0.83 ± 1.66	7.46 ± 1.28	12.40 ± 1.64	0.959
AGR	0.35 ± 0.26	0.32 ± 0.17	0.940	0.13 ± 0.13	6.18 ± 1.59	0.27 ± 0.18	0.480
WF	8.55 ± 1.42	9.77 ± 0.92	0.380	10.99^{a} ± *1.03*	9.11^{b} ± *1.41*	7.65^{b} ± *0.98*	0.004
SC	5.78 ± 1.19	8.87 ± 1.10	0.070	7.56 ± 1.55	7.87 ± 1.21	8.83 ± 1.46	0.749
PER	8.22 ± 0.82	9.29 ± 0.93	0.150	10.34^{a} ± *0.52*	10.70^{a} ± *1.07*	6.85^{b} ± *0.60*	0.004

Trait	Wooden			Plastic			P-value
	Square	Round	Triangle	Square	Round	Triangle	
DRK	5.74 ± 0.66	6.70 ± 1.01	8.41 ± 1.66	5.15 ± 1.33	5.94 ± 0.34	5.74 ± 1.04	0.448
FED	4.00 ± 0.72	4.38 ± 0.62	3.39 ± 1.36	4.95 ± 1.20	4.75 ± 0.91	5.21 ± 2.31	0.896
STA	22.55^{b} ± *1.92*	16.36^{b} ± *2.53*	11.08^{b} ± *2.56*	10.14^{ab} ± *2.68*	19.92^{a} ± *1.85*	9.77^{a} ± *2.59*	0.008
STI	9.89 ± 2.22	13.36 ± 2.53	15.29 ± 2.57	11.20 ± 2.48	10.52 ± 3.57	8.55 ± 2.04	0.262
JUM	7.93 ± 0.97	8.38 ± 1.94	13.10 ± 1.98	12.10 ± 4.01	7.67 ± 1.40	10.46 ± 3.31	0.210
WAL	11.40 ± 1.24	7.47 ± 1.13	13.77 ± 2.25	16.72 ± 3.22	11.23 ± 3.38	17.71 ± 4.89	0.184
LA	0.65 ± 0.42	1.43 ± 0.49	0.85 ± 0.42	0.93 ± 0.60	0.70 ± 0.46	1.09 ± 0.70	0.769
DB	11.34 ± 1.68	11.07 ± 1.64	13.46 ± 1.99	10.32 ± 3.04	11.85 ± 3.10	8.42 ± 2.13	0.765
AGR	0.00 ± 0.00	0.76 ± 0.76	0.28±0.28	0.00 ± 0.00	0.71 ± 0.36	0.26 ± 0.26	0.582
WF	8.90^{a} ± *1.22*	11.64^{b} ± *1.53*	6.39^{b} ± *1.31*	13.08^{ab} ± *1.20*	8.78^{ab} ± *1.16*	6.19^{ab} ±*1.78*	0.006
SC	10.87 ± 1.77	9.68 ± 1.24	6.80 ± 1.66	13.08 ± 1.20	6.06 ± 1.88	6.31 ± 2.33	0.241
PER	6.46^{a} ± *1.35*	9.52^{b} ± *1.45*	7.17^{bc} ± *1.31*	4.24^{ab} ± *1.76*	11.88^{a} ± *1.54*	6.33^{b} ± *1.68*	0.001

[a-c] Superscripts on different means within a row represent significant difference among treatment means at P ≤ 0.05.
[1]Values are least-square means ± standard errors, the average of each behavior from 40-54 weeks.
[2]Traits are presented as the percentage of time spent in different behavioral activities.
DRK=drinking, FED=Feeding, STA=Standing, STI=Sitting, JUM=Jumping, WAL=Walking, LA=Laying, DB=Dust Bathing, AGR=Aggressiveness, WF=Wing Flapping, SC=Scratching, PER=Perching

Table 3. Effect of different perch material, design, and their interaction on feather scoring of commercial layers.[1]

Trait	Perch Material		P-value	Perch Design			P-value
	Wooden	Plastic		Square	Round	Triangle	
Neck	2.89 ± 0.26	3.33± 0 .24	0.182	3.00 ± 0.26	3.33 ± 0.33	3.00 ± 0.37	0.618
Wing	3.33 ± 0.24	3.56 ± 0.18	0.464	3.50 ± 0.22	3.17 ± 0.31	3.67 ± 0.21	0.396
Breast	3.44 ± 0.24	3.00 ± 0.24	0.251	3.33 ± 0.21	3.33 ± 0.33	3.00 ± 0.37	0.702
Tail	3.56 ± 0.18	3.56 ± 0.18	1.000	3.50 ± 0.22	3.50 ± 0.22	3.67 ± 0.21	0.848
Vent	2.67 ± 0.37	3.22 ± 0.22	0.157	3.00 ± 0.26	3.33 ± 0.33	2.50 ± 0.50	0.219
Back	3.44 ± 0.18	3.67 ± 0.24	0.430	3.17 ± 0.31	3.67 ± 0.21	2.50 ± 0.50	0.157
Trait	**Wooden**			**Plastic**			**P-value**
	Square	**Round**	**Triangle**	**Square**	**Round**	**Triangle**	
Neck	2.67 ± 0.33	3.67± 0.33	2.33 ± 0.33	3.33 ± 0.33	3.00 ± 0.58	3.67 ± 0.33	0.150
Wing	3.67 ± 0.33	3.00 ± 0.33	3.33 ± 0.33	3.33 ± 0.33	3.33 ± 0.33	4.00 ± 0.00	0.503
Breast	3.33 ± 0.33	3.67 ± 0.33	3.33 ± 0.67	3.33 ± 0.33	3.00 ± 0.58	2.67 ± 0.33	0.713
Tail	3.33 ± 0.33	3.67 ± 0.33	3.67 ± 0.33	3.67 ± 0.33	3.33 ± 0.33	3.67 ± 0.33	0.922
Vent	3.33 ± 0.33	3.00 ± 0.33	1.67 ± 0.67	2.67 ± 0.33	3.67 ± 0.33	3.33 ± 0.33	0.090
Back	3.33 ± 0.33	3.33 ± 0.33	3.67 ± 0.33	3.00 ± 0.58	4.00 ± 0.00	4.00 ± 0.00	0.271

[1]Values are least-square means ± standard errors.

Table 4. Effect of different perch material, design, and their interaction on egg characteristics of commercial layers.[1]

Trait	Perch Material		P-value	Perch Design			P-value
	Wooden	Plastic		Square	Round	Triangle	
EW, g	64.26 ± 0.85	64.90 ± 0.82	0.533	62.50[b] ± *0.72*	65.18[a] ± *0.56*	66.05[a] ± *1.10*	0.034
ST, mm	0.38 ± 0.00	0.37 ± 0.01	0.398	0.38[ab] ± *0.01*	0.36[b] ± *0.01*	0.39[a] ± *0.00*	0.004
AH, mm	9.98 ± 0.26	10.17 ± 0.25	0.521	9.57[b] ± *0.22*	9.93[b] ± *0.22*	10.72[a] ± *0.29*	0.021
YW, mm	42.84 ± 0.53	41.83 ± 0.73	0.314	42.15 ± 0.46	42.93 ± 0.98	41.93 ± 0.91	0.682
YH, mm	17.21 ± 0.82	18.77 ± 0.48	0.107	18.47 ± 0.49	18.36 ± 0.40	17.14 ± 1.38	0.434
YI	40.20 ± 1.93	45.02 ± 1.50	0.086	43.90 ± 1.59	42.83 ± 0.97	41.10 ± 3.68	0.679
HU	98.17 ± 1.16	98.93 ± 1.03	0.589	96.73± 1.03	97.83± 1.06	101.09± 1.28	0.058
SI, cm	75.3 2 ± 0.66	76.18 ± 0.80	0.377	74.75 ± 0.93	77.09 ± 0.92	75.41 ± 0.65	0.153
SA, cm^2	74.13 ± 0.66	74.63 ± 0.63	0.531	72.78[b] ± *0.56*	74.86[a] ± *0.43*	75.51[a] ± *0.85*	0.033
EV, cm^3	58.67 ± 0.78	59.25 ± 0.75	0.532	57.06[b] ± *0.66*	59.51[a] ± *0.51*	60.30[a] ± *1.01*	0.034
SBS, N	53.64 ± 3.18	47.95 ± 3.03	0.115	50.02 ± 3.94	54.41 ± 2.88	47.95 ± 4.81	0.309
Trait	**Wooden**			**Plastic**			**P-value**
	Square	**Round**	**Triangle**	**Square**	**Round**	**Triangle**	
EW, g	66.83 ± 0.48	62.07 ± 0.84	65.27 ± 2.29	62.93 ± 1.30	65.8 ± 0.89	64.57 ± 0.64	0.131
ST, mm	0.39 ± 0.01	0.37 ± 0.02	0.39 ± 0.01	0.38 ± 0.01	0.35 ± 0.01	0.37 ± 0.01	0.167
AH, mm	11.05 ± 0.14	9.61 ± 0.25	10.38 ± 0.54	9.52 ± 0.41	9.84 ± 0.28	10.02 ± 0.39	0.087
YW, mm	42.12 ± 1.50	41.66 ± 0.87	41.75 ± 1.36	42.65 ± 0.19	41.72 ± 1.83	44.13 ± 0.05	0.660
YH, mm	19.17 ± 1.07	18.84 ± 0.86	15.11 ± 1.36	18.11 ± 0.59	18.32 ± 0.86	18.40 ± 0.27	0.197
YI	45.75 ± 3.77	45.34 ± 2.97	36.44 ± 5.64	42.46 ± 1.35	43.96 ± 1.76	41.70 ± 0.58	0.380
HU	114.2 ± 0.46	109.9 ± 0.86	112.18 ± 1.79	109.5 ± 1.44	110.37 ± 0.99	111.08 ± 1.35	0.195
SI, cm	75.21 ± 1.79	75.50 ± 1.14	75.25 ± 0.85	74.29 ± 0.98	78.68 ± 0.61	75.57 ± 1.16	0.204
SA, cm^2	76.12 ± 0.37	72.44 ± 0.66	74.90 ± 1.76	73.11 ± 1.01	75.33 ± 0.68	74.38 ± 0.49	0.130
EV, cm^3	61.02 ± 0.44	56.67 ± 0.77	59.59 ± 2.09	57.46 ± 1.19	60.08 ± 0.81	58.95 ± 0.58	0.131
SBS, N	42.18 ± 0.91	41.69 ± 0.87	53.72 ± 9.03	58.34 ± 2.71	59.97 ± 0.65	48.85 ± 3.18	0.297

[1]Values are least-square means ± standard errors.
EW=Egg weight, ST=Shell thickness, AH=albumen height, YW=yolk width, YH=yolk height, YI= Yolk index, HU=Haugh unit score, SI= shape index, SA=Surface area, EV=Egg volume, SBS= Shell breaking strength

Egg Characteristics

Egg weight, shell thickness, albumen height, egg surface area, and egg volume differed ($P \leq 0.05$) among perch designs (Table 4). The egg weight was higher in birds that used triangle and round perch design than square. Shell thickness was maximum in birds used triangle perch than round.

DISCUSSION

The study aimed to evaluate the performance of commercial laying hens when provided with different perch designs in their later stages of life. It was successful as the birds revealed several differences in overall productivity and egg quality traits. The egg weight was higher when the bird was provided with wooden perch material than those reared with plastic perches. The higher egg weight in wooden perch's treatment might be attributed to the innate behaviour of chicken. As red jungle fowl is known for its roosting behaviour on trees during night times, perhaps due to protection from predators. Similarly, when birds were provided with wooden perches, it enhances birds' comfortability and improves egg weight. Tactacan et al. (2009) found higher egg weight when used different perch designs. However, a contradictory study also reported lower egg weight of white leghorn when subjected to different perch availability (Hester et al., 2013). Moreover, Glatz and Barnett (1996) reported a linear decline in production when birds were subjected to wooden perch in conventional cages.

Regarding perch design, egg weight was higher in birds who used square and triangle perches than round. A most likely explanation of this egg weight increase is only the bird's choice as chicken has a better cognitive ability and can decide the most useful things for its use. Therefore, when a different perch design was provided to the birds, selects the most favourite one that satisfied its needs and ultimately improves the performance especially egg weight. Similar findings were also reported by Donaldson and O'Connell (2012),who found higher egg weight in laying hens when subjected to different perch designs. Furthermore, productive performance did not affect by perch shapes.

The laying hens' used triangle perch in their later stages of life revealed higher egg production than those reared with round and square design. It seems that birds are more habitual and comfortable with triangular perches that improve their egg productivity. This corresponds to the findings of Donaldson and O'Connell (2012) who found higher egg production in laying hens when provided with plastic and rubber perches. Furthermore, the feed conversion ratio was better in square and round perches than in a triangle. Similarly, Glatz and Barnett (1996) reported a reduction in feed intake when provided different perch designs.

Walking and sitting behaviour were more pronounced in birds provided with plastic perches. A higher incidence of walking and sitting behaviour could be due to less attraction in plastic perches, therefore, birds avoid perching behaviour and spent most of their time walking and sitting. Moreover, standing behaviour was found higher in birds provided with wooden perches. A most likely explanation of these behaviours is innate behaviour and association with red jungle fowl which is popular for its natural standing behaviour on shadow trees especially during night times to avoid any predator attack and look after its harem. Perhaps wooden perch seems more natural to the birds and they showed calming behaviour such as sand in the presence of wooden perches. Similarly, Struelens et al. (2008) reported a higher incidence of standing behaviour followed by sitting, preening, and walking on the perch in Hisex brown medium hybrid laying hens when subjected to wooden perches. In addition, Pickel et al. (2010) reported a higher incidence of standing behaviour in Lohmann Selected Leghorns when provided with wooden and rubber perches.

Regarding perch design, birds spent most of their time wing-flapping near square perch. Furthermore, perching behaviour was more pronounced in square and round perches. Wing flapping and perching were different among perch designs and that could be due to the installation of perch materials with different shapes later in their life as the birds are unfamiliar with these perching designs therefore it stimulated roosting behaviour and decrease stress, resulting in excitement behaviour such as wing flapping. This corresponds to the findings of Liu et al. (2018) reported more wing flapping in birds subjected to square perch design than round. However, a contradictory study (Lamb and Scott, 1998) reported no difference in perching behaviour in laying hens when subjected to square and hexagonal perches. The provision of different perch designs did not influence feather scoring. Perhaps it could be due to the bird's age (40 weeks) that did not impact the feather condition. Similarly, Appleby et al. (1992) did not find any effect of the perches in cages on feather condition. Similarly, Tauson (2005) reported that the total plumage score was not affected by perch treatments.

Egg surface area, egg volume, egg weight, shell thickness, and albumen height differed among perch designs. Shell thickness was maximum in birds used triangle perch than round, which could be attributed to bird's satisfaction during perching on triangular perches which promotes exercise in their body which leads to the strengthening of tibial bones and ultimately improves shell thickness. Similar findings also reported better shell integrity when laying hens were provided with different perch designs (Appleby, 1995). However, in another study, Nakaue et al. (1984) reported that perch shapes and access in cages did affect egg internal quality. Similarly, Hester et al. (2013) reported no difference in shell thickness when birds were subjected to different perch shapes.

CONCLUSIONS

Based on the above discussion, it can be concluded that the provision of round perche stothe commercial layer at later stages of its life had a positive influence on egg weight, egg mass, and perching behaviour whereas the addition of triangular perches had improved shell thickness, albumen height, and egg volume. Hence, round and triangular perches should be provided in later stages of laying hens to improve overall productivity and egg quality traits.

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CONFLICT OF INTEREST

None declared.

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