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Effect of Lighting Color and Housing System on Some Carcass, Blood and Immunity Characteristics of Broiler Chickens

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Abstract

One of the most important management which influencing the welfare of chickens is color of light. Therefore, the objective of this study was to determine how different light colors affected the immune profile, meat chemical composition, and carcass features of grill chickens. A total number of 504 one-day-old Indian River (IR) broilers were exposed to white light (WL), green light (GL), blue light (BL) and Mix (GL X BL), respectively, by using a light-emitting diode system for 5 wk. Each color group was further divided into three housing systems sand (S), wood shavings (WSH) and cages (C). There were three replicate for each light treatment and housing system, 14 birds per replicate. The effects of monochromatic light and litter type on carcass traits, meat composition and immune response were studied. The results obtained indicated that broiler chicks exposed to white light (WL) and reared on sand litter type recorded the highest absolute and relative weights of carcass, giblets and total edible parts compared with those in WL, BL, MIX, respectively. The interactions between GL with cages showed significantly the lowest averages of plasma AST, ALT, uric acid and creatinine compared with other groups. Broiler chickens exposed to GL and BL showed significantly increased plasma GP_X, IgG and IgM and significant decreased plasma MDA when compared with different lighting color. These results suggest that GL and BL with cage housing system enhance the antioxidant status and immunity response than WL and MIX colors in broiler chicks.

Keywords: Broiler, light color, housing system, carcass, immunity, antioxidant

Introduction

Light is one of the most significant external elements in controlling physiological and behavioural processes as well as the circadian rhythms of immune cells and hormones in birds and mammals. Since most chickens are kept indoors, they typically receive artificial light instead of natural light. According to **Nazar et al. (2011)**, poultry light management focuses on three different light characteristics: photoperiod, light intensity, and light color/wavelength **(Olanrewaju et al., 2006; Engert et al., 2019).**

The type of light source affects the color of the light. Light-emitting diodes are being employed in poultry houses more and more in addition to conventional incandescent and fluorescent illuminants. All sources of lighting have extremely varying wavelength spectra, and they all diverge significantly from the spectral pattern of light in the birds' natural habitats **(Kämmerling et al., 2018)**. Chickens have four types of photoreceptors and can distinguish between wavelengths between 350 and 700 nm, which mean they can see light on the infrared and ultraviolet spectrums in addition to the three single-cone photoreceptors that mammals have **(Osorio et al., 1999).** According to studies, shorter wavelengths (blue 450 nm, green 550 nm) and longer wavelengths (red 700 nm) improve broiler performance while increasing their activity **(Hofmann et al., 2020).**

There is an increasing need to investigate and use non-traditional litter materials as an alternative to wheat straw and wood shaving in Egypt and other nations. Because of a number of issues, including scarcity of supply, rising prices, and unavailability, producers are currently facing significant difficulties. As a result, several researchers and broiler producers are under pressure to find new materials for commercial poultry bedding **(Farghly et al., 2015 a, b; Kuleile et al., 2019; Monckton et al., 2020).** Several attempts have been used made over the past ten years to use organic materials as bedding, including wood sawdust, wheat straw, chopped rice straw, rice hulls, corn stalks, corn ear husks, sugarcane stalks, clover straw, chopped palm fibre, palm spine chips and various grasses (**Karousa et al., 2012; Ramadan et al., 2013 and Farghly et al., 2021a).** Additionally, numerous attempts recycled shaving wood and wheat straw **(El-Deek et al., 2011)** or employed sand and vermiculite as an inorganic source for bedding (**El-Sagheer et al., 2004; Balabel, 2005; Yildiz et al., 2014; and Ramadan, 2017).**

Therefore, this study was performed to assess types of litter materials (wood shaving (WD); sand (S) and cages (C)) under lighting color and their interaction on carcass characteristics, meat chemical composition and immunity profile of broiler chickens.

Material and Methods

Ethical approval

The experimental design and procedures were in compliance with the ethical standards of your relevant national and institutional committee on animal experimentation approved (BUAPD 202110) by the Scientific Ethics Committee, Animal Production Department, Faculty of Agriculture, Benha University, Egypt.

Birds and Housing Management

A total number of 504 unsexed one-day old chicks Indian River (IR) broiler chicks of nearly live body weight were used in this study. They randomly assigned into 4×3 factorial arrangement according to lighting color (4 groups) and 3 housing system (42 Chicks/group) in 3 replicates(14 chicks/each). Until the completion of the experimental period, chicks were housed in separate groups with a stocking density of ten birds/ m2 under similar, standard sanitary and environmental circumstances. For brooding chicks, floor brooders with gas heaters were utilized. After being kept at 33°C for the first week, the temperature was gradually lowered by 2-3°C each week until it reached 22°C, where it remained until the experiment's conclusion. The experiment's mean relative humidity was kept constant at 60-65%. All birds had ad libitum access to feed and water. Standard commercial broiler diets consisted of a crumbled starter (232 g/kg crude protein and 3,000 kcal metabolisable energy/kg diet from 1 to 14 d of age, pelleted grower (211 g/kg crude protein and 3,100 kcal metabolizable energy/kg diet from 15 to 28 d of age and pelleted finisher (195 g/kg crude protein and 3,219 kcal metabolizable energy/kg diet from 29 to 35 d of age. Chicks received vaccinations for Newcastle, Infectious Bronchitis and Gumboro diseases ones for each.

The lighting program was 24-hrs light at the first 5 days of age, and then decreased from 6 to 35 days of age (the end of the experiment) to 23-hrs light and 1 hour dark was applied. Lighting intensity was set at 2.5 foot/candle (25 lux) from the 1st to the 6 days and reduced to 1 foot/candle (10 lux) from the 7 day to the end of the experiment. All 10 watt light multicolor LED bulbs used were purchased from Venus electric instruments, Cairo, Egypt.

The day-old chicks were randomly assigned in 4 light-controlled rooms (n=126). Light treatments were 1); control white at 400:700 nm (mini incandescent light bulbs, 8 pens in each experimental room, (WL)), 2) blue light (BL) at 480 nm (peak wavelength of 480 nm, half-band width between 470 and 490 nm) provided by light-emitting diode lamps (LED) (12 pens), 3); green light (GL) at 560 nm (peak wavelength of 560 nm, half band width between 552 and 565 nm) provided by LED (12 pens) and 4) mixed monochromatic between blue and green light (BL×GL), respectively, with an LED system **(Rozenboim *et al.*, 1999; Er *et al.*, 2007)**. The LED lamps were placed 15 cm above the heads of birds by using plastic crosses attached to the ceiling of the room. Each lighting colors were further divided into two housing systems [ground system with two type of litter (sand and wood shavings) and cages].Chicks in the each lighting color x housing system treatment groups were randomized into three replicates (42 birds each).

Six birds were randomly chosen from each treatment of the two housing systems at the age of 35 days after a 16-hour fast for carcass examinations. Each bird was weighed before being killed by severing the jugular vein close to the first cervical vertebra with a sharp knife. The carcasses were decapitated and eviscerated after being killed and bloodied, and the intestine, gizzard, lungs, spleen, liver, heart, and all internal organs were painstakingly removed. The eviscerated was weighed separately and expressed as a percentage of live weight along with the giblets (empty gizzard, liver, and heart). The proportional weights to live weight of giblets, carcass and total edible parts were calculated as follows: giblets weight (%) = (GW/LW) ×100, edible parts (%) = ((EW+GW)/LW) ×100, where: LW = live weight, EW= eviscerated weigh and GW= giblets weight. the breast and thigh meat was sampled. Part of the meat was immediately used for the determination of pH, moisture, protein, fat, and ash.

The standard method advised by **Horwitz (2000)** "AOAC" method was used to analyze the investigated samples of chicken fillets and sheish to determine their levels of moisture, protein, fat, and ash. The Food and Agriculture Organisation **FAO (1980)** suggested keeping quality tests by measuring pH and total volatile nitrogen (TVN) as follows: TVN/l00g = 26.88 x (2-T1). Where, T1 = volume of NaOH consumed in the titration. Thiobarbituric acid number (TBA) by **Pikul *et al.* (1989)** was applied as follow: TBA value = R x 7.8 (mg malondialdehyde /Kg), where, R = Reading of sample against blank.

Blood samples were collected at slaughtering using a marked falcon tube and instantly centrifuged at 3,500 rpm for 10 min at 4°C, and then transferred to a marked Eppendorf tube using a micropipette and stored at -20°C until analysis. Biochemical blood parameters, including, aspartate aminotransferase (AST, U/I), and alanine aminotransferase (ALT, U/I) concentrations were measured; kidney function tests; creatinine , uric acid; immunoglobulin G (IgG) and immunoglobulin M (IgM) levels; antioxidant capacities of plasma; glutathione peroxidase (GPx), and malondialdehyde (MDA).

Statistical Analysis

The data were analyzed using the GLM procedure of SAS (SAS User's Guide, 2002, Version 8 ed., SAS Institute Inc., Cary, NC, USA). Statistical differences in results between lighting color and litter materials were determined using the Duncan's multiple range test (**Duncan, 1955**). According to the following linear model:

$$X_{ijk} = \mu + L_i + H_j + LH_{ij} + e_{ijk}$$

Whereas: μ = Overall mean; Li = Effect of the i^{th} lighting color. (i, 1-4); H_j = Effect of the j^{th} housing system. (j, 1-3); LH_{ij}= Interaction between i^{th} lighting color and j^{th} housing system. (4× 3); e_{ijk} = Experimental error, accordingly zero mean and variance = σ^2e.

Results and Discussion

Carcass characteristics

The absolute and relative weights of the eviscerated carcass, giblets, and the relative weight of all edible portions were all significantly ($P \leq 0.05$) influenced by lighting color (Table 1). The highest absolute and relative weights of eviscerated carcass, giblets, and total edible parts were recorded by broiler chicks exposed to green light (GL), followed by those exposed to white light (WL) (control group), then those exposed to blue light (BL), as opposed to mix light (GB) which recorded the lowest absolute and relative weights of eviscerated carcass, giblets, and total edible parts. These findings diverge from those of **Essam and Rania (2019)** who found that in all tested lighting regimes, the blue LED group significantly increased ($P< 0.01$) the weights of the carcass weight (CW), spleen, heart, and liver compared to the red and white LED groups.

According to the findings in Table 1, broilers raised in various housing systems demonstrated significantly varied carcass features in terms of both absolute and relative weight (dressing, giblets, and total edible component as a percentage of final LBW). However, broiler chickens kept on sand litter, followed by wood shaving litter and a cage housing arrangement, had significantly larger absolute weights (g) of the dressed carcass, giblets and edible section. The findings differ from those made public by **Soliman and Hassan (2019).** According to **Okasha (2021),** litter type had no significant impact on the absolute and relative weights of the eviscerated carcass, giblets, and total edible portions.

The absolute and relative weights of the eviscerated carcass, giblets, and total edible portions were highly significant ($P < 0.001$) when considering the interaction effects between illumination color and housing systems. The highest values of absolute weights of eviscerated carcass, giblets and total edible parts were observed from the interactions between WL×S, GL×S and MIX×S, respectively. However, the interactions between MIX×C and GL×C showed the lowest absolute weights of eviscerated carcass, giblets and total edible parts, respectively, compared with the other interactions applied.

Chemical examination of meat

Results presented in Tables 2 showed the effect of lighting color and housing systems on the chemical composition of meat from different chick groups.

Broilers reared under GL, BL and GL×BL, respectively, had significantly ($P < 0.001$) higher protein percentage and significantly ($P<0.001$) lower moisture percentage of meat samples. However, broilers kept under WL and GL×BL, respectively had significantly ($P<0.001$) decreased fat % and increased ash % compared with different treatments applied (Table, 2).

The highest values of PH, TVN and TBA were found in chick which exposed to WL and GL×BL, respectively, compared with other groups reared under GL and BL lighting color (Table, 2). Because it may directly affect other quality criteria, such as meat colour parameters and shear force, the ultimate pH is crucial in the evaluation of meat quality **(Kirmizibayrak et al., 2011).** The results, which concur with those from **Soliman and Hassan (2019)** demonstrated that, in comparison to red and white LED lights in all evaluated lighting regimens, blue LED group revealed a highly significant increase ($P<0.01$) in carcass weight and giblets.

Broilers kept under cage housing (C), floor housing as wood shavings litter type (WSH) and sand litter type (S), respectively significantly ($P<0.001$) higher protein and ash % and significantly ($P<0.001$) lower moisture and fat percentages in meat samples (Table, 2).

The findings demonstrated that, in comparison to the two floor housing systems (S and WSH), broilers raised on C recorded the highest values of PH, TVN, and TBA (Table 2). The outcomes are consistent with those mentioned by **Abdel-Azeem et al. (2020).** The results of the analysis of variance revealed that birds kept in cages had greater values for dressing, giblets, and belly fat ($P \leq 0.05$) than birds kept on floor systems.

The interaction between GL×C, BL×C and GL×WSH, respectively, had significantly ($P<0.001$)

increased protein and ash % and decreased meat content of fat %. However, the interaction between WL×S showed significantly ($P<0.001$) the higher average of moisture % compared with different interactions applied (Table, 2). On the other hand, significantly ($P<0.001$) increased in PH, TVN and TBA values were found in the interactions between WL×S and MIX×S, respectively compared with the other interactions applied (Table, 2).

Liver and Kidney function tests

At the conclusion of the experiment, Plasma AST, ALT, uric acid, and creatinine levels were measured (Table 3). While plasma levels of AST, ALT, uric acid, and creatinine were significantly lower in birds raised under the GL and BL light treatments, they were greater in birds raised under the WL and GB light treatments. Broilers raised under GL, BL, and GL BL conditions showed improved growth performance, health conditions, and immunological responses **(Xie et al. 2008; Yang et al. 2016).** The findings corroborate those of **Mohamed et al. (2020),** who found that birds receiving blue light treatment had the lowest GPT values while GL BL treatment animals had the lowest GOT values. According to **Firouzi et al. (2014),** blue light had a negligible ($P>0.05$) impact on the serum lipid, glucose, and urea concentrations.

Results shown in Table 3 show that broiler chickens raised in cage housing, followed by wood shavings litter type, had considerably lower plasma levels of AST, ALT, uric acid, and creatinine than those raised in other housing systems. However, sand-raised groups had the highest AST, ALT, uric acid, and creatinine levels. According to **Darwish et al. (2017),** broiler chicks raised in batteries vs those raised on litter floors did not significantly differ in plasma uric acid levels when they were within the usual range. It is interesting to note that there were negligible variations in most blood parameters, including ALT and AST, as a result of housing systems, according to **Abdel-Azeem et al. (2020).**

The effect of lighting color and housing system on the liver and kidney function of broilers are summarized in Table 3. The lighting color and housing system had significant effect on the AST, ALT, uric acid and creatinin ($P<0.001$). The interactions between GL with C and WSH, respectively showed the lowest averages of plasma AST, ALT, uric acid and creatinin compared with different interactions applied (Table, 3).

Antioxidant status and Immunity response

Results in Table, 4 showed that the antioxidant defense system against different oxidative stressors and immunity profile was activated by lighting color, housing system and the interaction between them.

When compared to other illumination colors, grill chickens exposed to GL and BL had significantly higher plasma concentrations of GP_X, IgG, and IgM and significantly lower concentrations of plasma MDA. A system of antioxidant enzymes, including glutathione peroxidase, has been described by **Milinkovi-Tur et al. (2007)** as the crucial first line of defense against reactive oxygen species. Oxidative stress is the term used to describe this state by **Shini et al. (2009)** and **Simsek et al. (2014).** According to **Li et al. (2015),** broilers' bursa of Fabricius B-lymphocyte proliferation depends on elevated melatonin levels, and green and blue lights have been shown to improve blood antioxidant levels (TAC, SOD, and GP_X). According to **Hassan et al. (2014)**, exposure to monochromatic yellow (Y) and green (G) treatments at 21 days and blue (B) light at 35 days of age resulted in higher circulating levels of IgG and IgA ($P < 0.05$).

Broiler chicks reared on cage housing, floor housing as wood shavings litter type had significantly the highest levels of plasma GP_X, IgG and IgM, while the lowest level of plasma MDA were recorded in sand litter type. According to **Gawe, et al. (2004),** MDA is a byproduct of lipid peroxidation in cells and a key sign of stress. The obtained results are consistent with those published by **Soliman and Hassan (2019),** who found that MDA was highly significant declines ($P <0.01$) and highly significant increases were recorded in IgG and IgM in chicks raised in battery systems, on slatted floors, and wheat straw compared to systems using rice husks and wood shaving litter. According to **Imşek et al. (2014)** research, broiler serum MDA levels were greater in cage housing systems compared to floor housing ($P\leq0.01$), indicating that the chicks were under stress. **Darwish *et al.* (2017)** found that blood level of IgG, IgA and IgM (µg/ml) (within the normal range) studied did not significantly differ between broiler chicks raised in batteries and those housed on the litter floor**.** The interactions between GL with both C and WSH showed significantly the highest values of plasma GP_X, IgG and IgM and the lowest value of plasma MDA when compared with different interactions.

Conclusion

It is concluded that, the results obtained indicated that broiler chicks exposed to white light and reared on sand litter type recorded the highest carcass characteristics. However, broiler chickens exposed to green light with cage housing increased antioxidant status and immunoglobulin profile.

Table 1. Effects of lighting color and housing system on carcass characteristics in broiler chickens

Items		**Absolute and relative weights of carcass traits**					
		Eviscerated		**Giblets**		**Total edible parts**	
		g	**%**	**G**	**%**	**g**	**%**
Lighting color (LC)	White	1492.3^{a}	73.5^{a}	94.7^{ab}	4.6^{ab}	1587.0^{a}	**78.2^{a}**
	Green	1492.6^{a}	73.6^{a}	97.7^{a}	4.8^{a}	1590.3^{a}	**78.5^{a}**
	Blue	1435.6^{a}	73.0^{a}	86.3^{b}	4.3^{b}	1521.8^{a}	**77.4^{a}**
	Mix(green x blue)	1433.0^{c}	70.5^{b}	91.4^{ab}	4.5^{ab}	1524.4^{a}	**75.0^{b}**
	MSE	39.3	0.50	3.4	0.13	41.2	**0.48**
	P-value	0.5483	0.0001	0.1075	0.1003	0.4848	**0.0001**
Housing system(HS)	Sand	1544.5^{a}	73.0^{a}	100.4^{a}	4.7^{a}	1644.9^{a}	**77.8^{a}**
	Wood shaving	1469.0^{ab}	72.8^{a}	90.1^{b}	4.4^{a}	1559.1^{ab}	**77.3^{a}**
	Cages	1375.7^{b}	72.2^{a}	86.9^{b}	4.5^{a}	1462.7^{b}	**76.7^{a}**
	MSE	34.0	0.44	2.9	0.11	35.7	**0.41**
	P-value	0.0039	0.3463	0.0056	0.2513	0.0029	**0.2184**
Interaction							
White (W)	Sand	1599.0^{a}	73.3^{abc}	112.2^{a}	5.1^{a}	1711.2^{a}	**78.4^{ab}**
	Wood shaving	1454.0^{abc}	73.5^{ab}	85.8^{d}	4.3^{cde}	1539.8^{abc}	**77.9^{ab}**
	Cages	1424.0^{abc}	73.9^{ab}	86.2^{cd}	4.4^{bcde}	1510.2^{abc}	**78.4^{ab}**
Green (G)	Sand	1572.0^{ab}	74.2^{a}	94.8^{bcd}	4.4^{bcde}	1666.8^{ab}	**78.6^{ab}**
	Wood shaving	1535.0^{ab}	74.0^{ab}	103.6^{abc}	5.0^{abc}	1638.6^{ab}	**79.0^{a}**
	Cages	1367.0^{bc}	72.7^{abcd}	94.8^{bcd}	5.0^{ab}	1461.8^{bc}	**77.7^{ab}**
Blue(B)	Sand	1472.0^{abc}	73.6^{ab}	88.4^{cd}	4.4^{bced}	1560.4^{abc}	**78.0^{ab}**
	Wood shaving	1392.0^{abc}	73.2^{abc}	84.0^{d}	4.4^{bcde}	1476.0^{abc}	**79.0^{a}**
	Cages	1443.0^{abc}	72.1^{abcd}	86.0^{bc}	4.3^{de}	1529.0^{abc}	**77.7^{ab}**
Mix (green x blue) (MX)	Sand	1535.0^{ab}	71.1^{bcd}	106.4^{ab}	4.9^{abcd}	1641.4^{ab}	**76.0^{bc}**
	Wood shaving	1495.0^{ab}	70.5^{cd}	87.0^{cd}	4.1^{e}	1582.0^{abc}	**74.6^{c}**
	Cages	1269.0^{c}	70.0^{d}	80.8^{d}	4.4^{bcde}	1349.8^{c}	**74.5^{c}**
	MSE	67.9	0.91	5.4	0.20	71.1	**0.86**
	P-value	0.0658	0.0156	0.0015	0.0088	0.0479	**0.0026**

a-e: within column, values with different superscript letters differ significantly (P<0.05).

Table 2. Effects of lighting color and housing system on meat chemical examination in broiler chickens

Items		**Meat chemical examination (%)**						
		Moisture	**Protein**	**Fat**	**Ash**	**pH**	**TVN(mg/kg)**	**TBA (mg/kg)**
Lighting color (LC)	White	73.58^{a}	19.37^{c}	1.90^{d}	2.82^{a}	5.74^{a}	4.40^{a}	**0.16^{a}**
	Green	72.86^{c}	20.28^{a}	2.70^{a}	2.16^{c}	5.63^{c}	2.80^{c}	**0.08^{b}**
	Blue	73.13^{bc}	19.96^{ab}	2.38^{b}	2.45^{bc}	5.67^{b}	3.35^{b}	**0.11^{ab}**
	Mix (green × blue)	73.32^{ab}	19.63^{bc}	2.17^{c}	2.66^{ab}	5.71^{a}	4.02^{a}	**0.14^{a}**
MSE		0.10	0.14	0.10	0.07	0.01	0.18	**0.01**
P-Value		0.0004	0.0008	0.0008	0.0019	0.0001	0.0001	**0.005**
Housing system (HS)	Sand	73.74^{a}	19.19^{b}	2.99^{a}	2.35^{c}	5.74^{a}	4.48^{a}	**0.17^{a}**
	Wood shaving	73.13^{b}	19.95^{a}	2.50^{b}	2.64^{b}	5.67^{b}	3.59^{b}	**0.12^{b}**
	Cages	72.80^{c}	20.30^{a}	2.09^{c}	2.99^{a}	5.65^{b}	2.85^{c}	**0.08^{c}**
MSE		0.09	0.12	0.09	0.06	0.01	0.16	**0.01**

P-Value		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	**0.0002**
Interaction								
White (W)	Sand	74.20a	18.66e	3.33a	2.10e	5.79a	5.26a	**0.21a**
	Wood shaving	73.50bcd	19.56bcd	2.80abcd	2.43de	5.72abcd	4.33abc	**0.16abc**
	Cages	73.06^{cdef}	19.90^{abcd}	2.33^{cdef}	2.76^{abcd}	5.71^{bcde}	3.60^{cd}	**0.11^{bcd}**
Green (G)	Sand	73.36^{bcde}	19.70^{bcd}	2.53^{cde}	2.53^{cde}	5.69^{bcde}	3.66^{cd}	**0.12^{abcd}**
	Wood shaving	72.76^{ef}	20.40^{ab}	2.13^{ef}	2.86^{abcd}	5.60f^{g}	2.73^{de}	**0.08^{cd}**
	Cages	72.46^{f}	20.76^{a}	1.83^{f}	3.23^{a}	5.59^{g}	2.00^{e}	**0.05^{d}**
Blue (B)	Sand	73.56^{bc}	19.36^{cde}	2.90^{abc}	2.43^{de}	5.74^{abc}	4.13^{abc}	**0.15^{ab}**
	Wood shaving	73.0^{bcdef}	20.06^{abc}	2.43^{cdef}	2.73^{bcd}	5.65^{defg}	3.33^{cd}	**0.12^{abcd}**
	Cages	72.83^{def}	20.46^{ab}	2.03^{ef}	3.03^{ab}	5.64^{egf}	2.60^{de}	**0.08^{cd}**
Mix (green ×blue)(MX)	Sand	73.83^{ab}	19.36^{cde}	3.20^{ab}	2.23^{e}	5.76^{ab}	4.86^{ab}	**0.18^{ab}**
	Wood shaving	73.26^{cdef}	19.76^{bcd}	2.63^{bcde}	2.53^{cde}	5.70^{bcde}	3.96^{bc}	**0.14^{abc}**
	Cages	72.86^{def}	20.10^{abc}	2.16^{def}	2.93^{abc}	5.67^{cdef}	3.23^{cd}	**0.09^{cd}**
MSE		0.20	0.28	0.19	0.14	0.02	0.36	**0.02**
P-Value		**0.0001**	**0.0009**	**0.0003**	**0.0004**	**0.0001**	**0.0001**	**0.014**

a-g: within column, values with different superscript letters differ significantly (P<0.05).

Table 3. Effects of lighting color and housing system on liver and kidney function in broiler chickens

Items		**Plasma (U/ L)**		**Plasma (mg/dl)**	
		AST	**ALT**	**Creatinine**	**Uric acid**
Lighting color	White	37.39±0.19^{a}	25.38±0.14^{a}	0.98±0.02^{a}	**27.21±0.23^{a}**
	Green	34.99±0.19^{d}	23.68±0.14^{d}	0.75±0.02^{c}	**23.36±0.23^{d}**
	Blue	35.78±0.19^{c}	24.42±0.14^{c}	0.86±0.02^{b}	**24.58±0.23^{c}**
	Mix (green × blue)	36.78±0.19^{b}	24.88±0.14^{b}	0.92±0.02^{ab}	**25.86±0.23^{b}**
	p-value	0.0001	0.0001	0.0001	**0.0001**
Housing system	Sand	36.99±0.17^{a}	25.20±0.12^{a}	0.93±0.02a	**26.41±0.20^{a}**
	Wood shaving	36.20±0.17^{b}	24.55±0.12^{b}	0.88±0.02a	**24.91±0.20^{b}**
	Cages	35.53±0.17^{c}	24.02±0.12^{c}	0.82±0.02b	**24.43±0.20^{b}**
	p-value	0.0001	0.0001	0.0001	**0.0001**
Interaction					
White	Sand	37.98±0.79^{a}	25.98±18.0^{a}	1.04±0.04^{a}	**28.44±0.42^{a}**
	Wood shaving	37.36±0.79^{abc}	25.38±18.0^{ab}	0.98±0.04^{ab}	**26.88±0.42^{bc}**
	Cages	36.84±0.79^{bcd}	24.78±17.5^{bcd}	0.91±0.04^{abcd}	**26.32±0.42^{bcd}**
Green	Sand	35.88±0.79^{de}	24.38±18.0^{cde}	0.81±0.04^{cde}	**24.56±0.42^{ef}**
	Wood shaving	34.94±0.79^{ef}	23.60±17.3^{ef}	0.77±0.4^{de}	**23.12±0.42^{gh}**
	Cages	34.16±0.79^{f}	23.08±17.5^{f}	0.69±0.04^{e}	**22.40±0.42^{h}**
Blue	Sand	36.46±0.79^{cd}	24.94±17.5^{bc}	0.90±0.04^{abcd}	**25.62±0.42^{cde}**
	Wood shaving	35.74±0.79^{de}	24.32±17.3^{cde}	0.86±0.04^{bcd}	**24.14±0.42^{fg}**
	Cages	35.16±0.79^{ef}	24.01±17.3^{de}	0.82±0.04^{cde}	**23.98±0.42^{fg}**
Mix (green ×blue)	Sand	37.64±0.79^{ab}	25.52±17.8^{ab}	0.98±0.04^{ab}	**27.02±0.42^{b}**
	Wood shaving	36.76±0.79^{bcd}	24.92±18.0^{bc}	0.92±0.04^{abc}	**25.52±0.42^{de}**
	Cages	35.96±0.79^{de}	24.22±17.5^{bcd}	0.85±0.04^{bcd}	**25.04±0.79^{def}**
	p-value	**0.0001**	**0.0001**	**0.0001**	**0.0001**

a-h: within column, values with different superscript letters differ significantly (P<0.05).

Table 4. Effects of lighting color and housing system on antioxidant status and immunity response in broiler chickens

Items		Antioxidant status		Plasma immunoglobulin	
		GPX (U/mL)	MDA (nmol/ml)	IgG (ug/dl)	IgM (ug/dl)
Lighting color	White	1.75 ± 0.05^{c}	2.32 ± 0.06^{a}	15.44 ± 0.15^{d}	32.42 ± 0.16^{c}
	Green	2.28 ± 0.05^{a}	1.69 ± 0.06^{d}	17.34 ± 0.15^{a}	34.33 ± 0.16^{a}
	Blue	2.06±0.05b	1.90 ± 0.06^{c}	16.49 ± 0.15^{b}	33.40 ± 0.16^{b}
	Mix (green × blue)	1.89±0.05c	2.12 ± 0.06^{b}	15.94 ± 0.15^{c}	33.02 ± 0.16^{b}
	p-value	0.0001	0.0001	0.0001	0.0001
Housing system	Sand	1.89 ± 0.04^{b}	2.22±0.05a	15.67 ± 0.134^{c}	32.81 ± 0.14^{c}
	Wood shaving	1.98 ± 0.04^{ab}	1.95±0.05b	16.36 ± 0.13^{b}	33.28 ± 0.14^{b}
	Cages	2.11±0.04a	1.82±0.05c	16.89 ± 0.13^{a}	33.79 ± 0.14^{a}
	p-value	0.0001	0.0001	0.0091	0.0001
Interaction					
White	Sand	1.66 ± 0.10^{f}	2.58 ± 0.11^{a}	14.84 ± 0.28^{f}	31.88 ± 0.30^{f}
	Wood shaving	1.72 ± 0.10^{abc}	2.34 ± 0.11^{ab}	15.40 ± 0.28^{ef}	32.40 ± 0.30^{ef}
	Cages	1.88 ± 0.10^{cde}	2.06 ± 0.11^{bcd}	16.10 ± 0.28^{cde}	32.98 ± 0.30^{cde}
Green	Sand	2.10 ± 0.10^{bc}	1.86 ± 0.11^{cde}	16.62 ± 0.28^{cd}	33.86 ± 0.30^{bc}
	Wood shaving	2.46 ± 0.10^{a}	1.70 ± 0.11^{de}	17.52 ± 0.28^{ab}	34.28 ± 0.30^{ab}
	Cages	2.80 ± 0.10^{ab}	1.52 ± 0.11^{e}	17.90 ± 0.28^{a}	34.86 ± 0.30^{a}
Blue	Sand	2.00 ± 0.10^{bcd}	2.06 ± 0.11^{bcd}	15.92 ± 0.28^{de}	33.0 ± 0.30^{cde}
	Wood shaving	2.08 ± 0.10^{bc}	1.84 ± 0.11^{cde}	16.58 ± 0.28^{cd}	33.46 ± 0.30^{bcd}
	Cages	2.12 ± 0.10^{bc}	1.80 ± 0.11^{cde}	16.98 ± 0.28^{cd}	33.76 ± 0.30^{bc}
Mix (green ×blue)	Sand	1.82 ± 0.10^{ab}	2.34 ± 0.11^{ab}	15.30 ± 0.28^{ef}	32.52 ± 0.30^{def}
	Wood shaving	1.86 ± 0.10^{bcd}	2.10 ± 0.11^{bc}	15.96 ± 0.28^{de}	32.98 ± 0.30^{cde}
	Cages	2.00 ± 0.10^{bcd}	1.90 ± 0.11^{cde}	15.58 ± 0.28^{cd}	33.58 ± 0.30^{bc}
	p-value	0.0001	0.0001	0.0001	0.0001

a-f: within column, values with different superscript letters differ significantly ($P<0.05$).

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تأثير لون الإضاءة ونظام الإسكان على بعض صفات الذبيحة والدم والمناعة لدجاج التسمين

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لون الإضاءه من أهم العوامل التي تؤثر على رفاهية الدواجن. لذلك كان الهدف من الدراسة الحالية تحديد تأثير الوان الإضاءه المختلفة على صفات الذبيحة والتركيب الكيميائي للحم والمناعة لدجاج التسمين. تم استخدام عدد 504 كتكوت عمر يوم من سلالة (Indian River IR) والتي تعرضت للضوء الأبيض (WL) والضوء الأخضر (GL) والضوء الأزرق (BL) والخليط (BL × GL) ، على التوالي ، لمدة 5 اسابيع . تم تقسيم كل مجموعة لونية إلى ثلاثة نظم إسكان :الرمل ، نشارة الخشب والأقفاص .تم توزيع كل مجموعة لونية ونظام الإسكان إلى ثلاث مكررات. عدد 14 كتكوت لكل مكرره. تمت دراسة تأثير لون الاضاءة ونظام الإسكان على صفات الذبيحة والتركيب الكيماوي للحم والإستجابة المناعية. أشارت النتائج التي تم الحصول عليها إلى أن كتاكيت التسمين التي تعرضت للضوء الابيض والمرباة على فرشة الرمل سجلت أعلى وزن جسم نسبة الذبيحة والأجزاء الكلية القابلة للأكل مقارنة مع تلك التي تعرضت للضوء الابيض والازرق والخليط بين الازرق والاخضر ،على التوالي. أظهرت التداخلات بين اللون الاخضر مع نظام الاسكان في البطاريات ونشارة الخشب على التوالي اقل متوسطات من مستويات AST و ALT وحمض البوليك والكرياتينين في بلازما الدم مقارنة المجموعات الاخري. أظهر المجاميع التي تعرض للون الاخضر والازرق زيادة ملحوظة في مستويات بلازما الدم من GPX و IgG و IgM وانخفاض مستوي MDA مقارنة بألوان الإضاءة المختلفة. تشير هذه النتائج إلى أن استخدام اللون الاخضر والازرق مع نظام التربية في البطاريات ادي الي تحسين استجابة مضادات الأكسدة والاجسام المناعية مقارنة بأللون الابيض والخليط (الاخضر مع الازرق) في دجاج التسمين.

الكلمات الدالة: دجاج التسمين – لون الإضاءة – نظم الإسكان – الذبيحة – المناعة – مضادات الاكسدة