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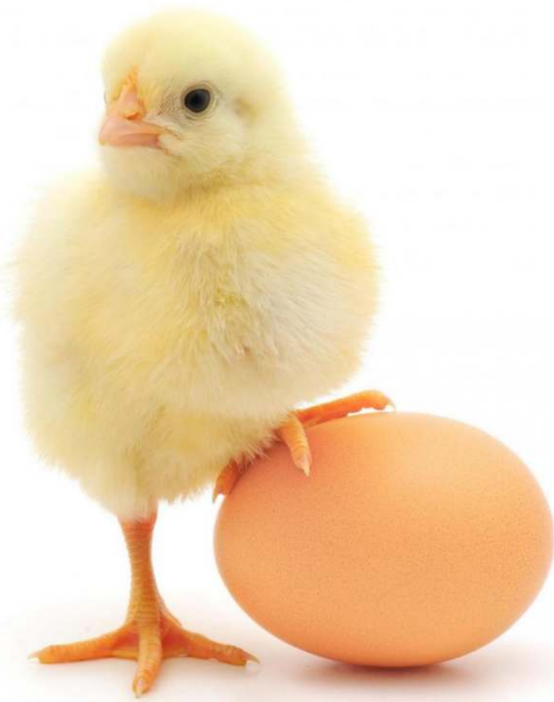

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Research Article
Evaluation of the Growth of the Bursa of Fabricius in Broilers Reared under Different Light Photoperiods

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Abstract

Background and Objective: Previous studies have investigated the interaction of different light sources and light intensity. Studies are lacking concerning the effect of different light sources and photoperiods on broiler growth and health. The results reported here are a part of a larger study to evaluate the interaction of different light sources with different photoperiods on the growth of the bursa of fabricius. **Materials and Methods:** Twelve treatments were designed as a 3×4 factorial arrangement of 4 light sources, incandescent (ICD, control), compact fluorescent light (CFL), light emitting diode (LED) and poultry specific filtered LED (PSF-LED) with 3 different photo periods (short, regular and long). A total of 4 trials were conducted. For each trial a total of 720 broiler chickens were reared under the various light treatments from 8-43 days of age. At 43 days of age, 2 males and 2 females from each treatment group were weighed and then euthanatized for dissection to collect the bursa. The bursas were weighed and the bursa-to-body ratio calculated. **Results:** The interaction of light source, photoperiod and sex did not have a statistically significant effect on the bursa-to-body weight ratios. **Conclusion:** The light sources investigated did not have a negative effect on broiler health.

Key words: Bursa of fabricius, light source, photoperiod, broiler health, light intensity

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In 2014 over 8 billion broilers were produced in the United States[1]. The increase in broiler production is due to optimal genetics, feeding, management and controls in the environment[2]. The lighting program is critical to the poultry industry for supporting broiler productivity and welfare[2]. The poultry industry in the USA is replacing the standard incandescent light bulbs (ICD) for more efficient lighting sources[3,4]. Therefore, different cost-effective light sources under study include: (1) Light emitting diode bulbs (LED), (2) Compact fluorescent lamps (CFL) and (3) Poultry specific filtered LED bulbs (PSF-LED). Therefore, it has been a major goal to understand the effects of replacement light sources on the general physiology and welfare of broilers[5,6].

A number of studies have assessed the effects of different light sources (ICD, LED or CFL) and intensity levels similar to those used by poultry operations in the United States and Europe on broiler health and productivity[7,8]. In general, the interaction of different light sources with light intensity levels did not have a significant negative impact on broiler productivity as measured by body weight gain and feed conversion[3,6-8]. This may be due in part, to the fact that corticosterone levels were not significantly increased with LED light sources[3,5]. In regard to different periods of light exposure or photoperiods, a recent study evaluated broiler growth and well-being under different photoperiods of ICD light exposure[9]. In that study a short photoperiod (8L:16D) resulted in a significantly lower body weight than in the long photoperiod (23L:1D) at 42 days of age. In addition, by 56 days of age a significant increase in footpad dermatitis lesions were observed in broilers reared under the short photoperiod.

The results from the research reported by Olanrewaju *et al.*[9] suggest that short photoperiods with ICD light sources could have a negative effect on broiler health. Therefore, it is important to evaluate the different photoperiods with the light sources currently used by the poultry industry (LED and CFL). To that end, the study reported herein is part of a larger project to determine the effects of different photoperiods on broiler growth and wellbeing. Authors hypothesize that a short photoperiod exposure will induce the production of stress hormones which may reduce broiler growth and performance. Moreover, stress hormones may modulate immune responses directly as well as have a negative impact on primary lymphoid tissues. Many studies have shown that corticosterone production in response to various stressors can lead to atrophy of primary lymphoid tissues such as the bursa which could have a negative impact on broiler health[10,11]. Therefore, the effect of physiological stress on the immune system may impede the overall growth rate and health of broilers. This project evaluated the growth of the bursa of fabricius in broilers subjected to different photoperiod treatments.

MATERIALS AND METHODS

Animal husbandry: For each trial a total of 720 one-day old Ross×Ross 708 chicks were weighed, sexed and then randomized into 12 rooms (30 males and 30 females per room) each with a floor bedding consisting of pine shavings. Each room was environmentally controlled and feed and water given *ad libitum*. The experiments with broilers were approved by the USDA-ARS Animal Care and Use Committee at the Mississippi State location.

Experimental design: The goal of this project was to investigate the possible interactions between 4 light sources and 3 levels of photoperiod within each light source. In this project there were 12 treatment combinations (3×4 factorial design) consisting of 3 levels of photoperiod, long/continuous (23L:1D), regular/intermittent (2L:2D) and short (8L:16D) with 4 different light sources, incandescent (ICD, control), compact fluorescent (CFL), light emitting diode (LED) and poultry specific filtered LED (PSF-LED) all used at an intensity of 51x. The experiment was replicated with 4 separate trials. In each trial 12 rooms were used for the different treatment combinations and the rooms were alternated from trials 1 through 4 to remove room effects. The light intensity treatments were initiated at 8-days of age and continued until experimental measurements were conducted at 43-days of age.

Experimental measurements: At 43 days of age 2 males and 2 females were collected from each room to determine live body weight. After euthanization by cervical dislocation, the birds were dissected to collect the bursa for weighing. In Table 1, 2 and 3 the numbers for live body weight and bursa weight represent the mean of the birds within each treatment. The bursa-to-body weight ratio was calculated with bursa weight (g)/live body weight (g) x 100 as described[12] for each bird. The mean of the bursa-to-body weight ratios for each treatment is presented in Table 1, 2 and 3.

Statistical analysis: The live body weights, weights of the bursa of fabricius and the bursa-to-body weight ratio data were fit to separate linear mixed-effects models using PROC MIXED in SAS for Windows 9.4 (SAS Institute, Inc, Cary, NC USA). The fixed effects were light source, photoperiod, sex and

Table 1: Main effects of photoperiod, light source and the interaction of treatments on the bursa weight to body weight ratio in male broilers at 43 days of age[1]

Treatments	Live BW (g)	Bursa WT (g)	Bursa WT:BW
Photoperiod			
Long	4038.531[a]	3.925	0.114
Regular	3915.594[a]	4.274	0.137
Short	3745.281[b]	3.570	0.120
Light source			
ICD	3794.000	3.714	0.117
CFL	3899.458	4.163	0.133
LED	3938.667	3.892	0.122
PSF-LED	3967.083	3.924	0.121
Photoperiod by light source			
Long-ICD	3853.750	3.200	0.092
Long-CFL	4205.250	3.700	0.110
Long-LED	3897.500	4.090	0.123
Long-PSF-LED	4197.625	4.711	0.132
Regular-ICD	3955.750	4.215	0.131
Regular-CFL	3789.250	4.890	0.160
Regular-LED	3913.250	4.021	0.131
Regular-PSF-LED	4004.125	3.970	0.125
Short-ICD	3572.500	3.726	0.129
Short-CFL	3703.875	3.900	0.130
Short-LED	4005.250	3.565	0.113
Short-PSF-LED	3699.500	3.090	0.106
Source of variation	----------------------	p-value	----------------------
Photoperiod	0.0312	0.0722	0.0550
Light source	0.5326	0.6343	0.5201
Photoperiod x light source	0.2728	0.1418	0.1825

[1]Means within a column with different superscripts differ significantly (p<0.05)

Table 2: Main effects of photoperiod, light source and the interaction of treatments on the bursa weight to body weight ratio in female broilers at 43 days of age

Treatments	Live BW (g)	Bursa WT (g)	Bursa WT:BW
Photoperiod			
Long	3391.500	3.460	0.126
Regular	3405.344	3.295	0.121
Short	3167.813	3.177	0.124
Light source			
ICD	3228.708	3.183	0.122
CFL	3326.958	3.439	0.125
LED	3489.750	3.306	0.120
PSF-LED	3240.792	3.313	0.128
light source			
Long-ICD	3372.500	3.343	0.126
Long-CFL	3461.375	3.574	0.127
Long-LED	3610.000	3.250	0.112
Long-PSF-LED	3122.125	3.673	0.139
Regular-ICD	3285.500	2.898	0.104
Regular-CFL	3457.375	3.210	0.113
Regular-LED	3522.625	3.641	0.132
Regular-PSF-LED	3355.875	3.431	0.136
Short-ICD	3028.125	3.309	0.136
Short-CFL	3062.125	3.534	0.136
Short-LED	3336.625	3.028	0.115
Short-PSF-LED	3244.375	2.836	0.110
Source of variation	----------------------	p-value	----------------------
Photoperiod	0.0651	0.4999	0.8624
Light source	0.1657	0.8354	0.8671
Photoperiod×light source	0.7022	0.5196	0.1952

Table 3: Main effects of photoperiod, light source and the interaction of treatments on the bursa weight to body weight ratio and effects by sex in broilers at 43 days of age[1]

Treatments	Live BW (g)	Bursa WT (g)	Bursa WT:BW
Photoperiod			
Long	3715.016[a]	3.693	0.120
Regular	3660.469[a]	3.785	0.129
Short	3456.547[b]	3.373	0.122
Light source			
ICD	3511.354	3.448	0.120
CFL	3613.208	3.801	0.129
LED	3714.208	3.599	0.121
PSF-LED	3603.938	3.619	0.125
Photoperiod by light source			
Long-ICD	3613.125	3.271	0.109
Long-CFL	3833.313	3.637	0.118
Long-LED	3753.750	3.670	0.118
Long-PSF-LED	3659.875	4.192	0.136
Regular-ICD	3620.625	3.556	0.118
Regular-CFL	3623.313	4.050	0.136
Regular-LED	3717.938	3.831	0.131
Regular-PSF-LED	3680.000	3.701	0.130
Short-ICD	3300.313	3.518	0.133
Short-CFL	3383.000	3.717	0.133
Short-LED	3670.938	3.296	0.114
Short-PSF-LED	3471.938	2.963	0.108
Source of variation	----------------------	p-value	----------------------
Photoperiod	0.0038	0.0897	0.3752
Light source	0.1893	0.4813	0.6145
Photoperiod×light source	0.6924	0.1794	0.1209
Sex	0.0001	0.0002	0.9708
Photoperiod×sex	0.5846	0.2644	0.1044
Light source×sex	0.3438	0.9781	0.7482

[1]Means within a column with different superscripts differ significantly ($p<0.05$)

each two-way interaction. The random effects were the replicate and the room within replicate. Statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSION

In this study it is expressed bursa weight as a percentage of overall body weight as an estimate of bursal growth in male and female broilers exposed to different photoperiods with the light sources evaluated in previous studies[9]. Male broilers from the long or regular photoperiod treatments were significantly heavier ($p = 0.0312$) than male broilers from the short photoperiod, independent of light source. However, the bursa weights did not differ among the treatments (Table 1). Body weights and bursa weights did not differ among female broilers in response to treatments (Table 2). These results agree with findings in a previous study where a short photoperiod significantly reduced final body weights in broilers[9]. The slowing male broiler growth rate may be due to an overall decrease in broiler movement in the short photoperiod[9].

The differences between males and females with regard to treatment are presented in Table 3. Male broilers had a significantly higher body weight ($p = 0.0001$) than female broilers. The male broilers also had significantly higher weights for the bursa ($p = 0.0002$) than females. However, there was no effect of sex on the bursa-to-body weight ratio indicating that bursa weight was relative to live body weight. There were no main effects of photoperiod or light source on the bursa-to-body weight ratios.

The growth and development of the bursa is modified by the endocrine glands[13]. In a previous study, chickens raised under two different photoperiods exhibited differences in body weights and differences in organ weights[14]. Importantly, the body and tissue weights changed with the age of the bird suggesting a role for hormones in response to photoperiod[14]. In particular, a shorter photoperiod can have a positive effect and result in enhanced immune responses in broilers, which may be mediated by melatonin[15]. Conversely, exposure to a suboptimal photoperiod could induce a stress response in broilers characterized by an increase in plasma corticosterone levels, which could have a negative impact on broiler health in general[2]. Indeed, experimentally-induced plasma corticosterone causes a reduction in the weights of the primary and secondary lymphoid organs in chickens as well as a reduction in B- and T-cell proliferation in response to mitogens[16]. In this study the 3 levels of photoperiod did not cause a reduction in bursa weights relative to final live body weights. Therefore, it is suggested that the different light treatments did not cause significant stress in the broilers.

CONCLUSION

The different light sources and photoperiods can be used in the industry without a detrimental outcome on bursal growth and the humoral immune system in broilers.

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