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Effects of Light Restriction on Broiler Performance and Specific Body Structure Measurements

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Primary Audience: Poultry Extension Personnel, Researchers, Broiler Integrators

Summary

This experiment was conducted over a 42-day period to determine the effect of light restriction on performance parameters and specific body structure measurements of male broilers. The two light treatments studied were 23 hr light:1 hr dark (control) and 12 hr light:12 hr dark (restricted). Measurements taken during the experiment were body weight, feed conversion, livability, length of shank and keel, and tibiotarsal weight and strength.

The results of this experiment showed that light restriction significantly decreased body weight but significantly improved feed conversion. Additionally, shank length was significantly decreased by light restriction. Keel length and tibiotarsal weight and strength were not significantly affected by the light restriction treatment.

Key words: Body structure, broilers, light restriction, performance

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Description of Problem

For many years, it has been assumed that rearing broiler chicks under nearly continuous lighting conditions would give a maximal growth rate due to higher feed consumption. However, over the past three decades extensive research has been conducted dealing with the effects of different lighting schemes on broiler performance and body structure. Most of the research has focused on intermittent lighting schedules, consisting of short light/dark cycles. The majority of these studies showed that birds reared under intermittent lighting had heavier body weights at market age [1, 2, 3, 4, 5, 6, 7, 8]. The amount of body weight gained under an intermittent lighting program has been determined to be related to the sex of the bird [9]. It has been shown that the intermittent lighting of male broilers results in a more pronounced body

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weight gain at market age over continuous-lighting male broilers compared to intermittent and continuous-lighting females [1, 5]. Intermittent lighting-reared broilers have also had a significant improvement in feed conversion compared to continuous-lighting broilers [4, 10].

Studies on restricted lighting, consisting of long blocks of light and dark, have shown decreased body weight and feed conversion as duration of darkness increases [11, 12]. Only limited research has been conducted in broiler production on the effects of restricted lighting on body structure parameters such as keel length, shank length, and bone strength, and on livability. Determining the effects of restricted lighting on these parameters as well as on feed conversion and body weight were the objectives of this study.

Materials and Methods

For this experiment, 4,800 day-old male broilers were randomly housed in blocks of 12 pens with four replications of two light treatments (96 pens total) in an open-sided house in late October. The pens measured 1.52 × 3.05 m and housed 50 birds. Light was provided by a row of 60-watt incandescent light bulbs spaced 0.91 m apart. This row of lights was located 1.83 m above the litter and near the center of the pens. Continuous light was given to both treatment groups for Days 1 and 2 of the 42-day study. On Day 3, lighting treatments of 23 hr light:1 hr dark (control) or 12 hr light:12 hr dark (restricted) were initiated. Lights were off daily from 2300 to 2400 for the control, or from 1800 to 0600 for the light-restricted treatment group. Water and feed were provided *ad libitum* throughout the study. Diets used in the study are provided in Table 1.

Body weight and feed consumption data were recorded at Weeks 2 and 4 and at the end of the study. Keel and shank length as well as tibiotarsal weight and strength measurements were taken at the end of the experiment. Any mortality was recorded daily to calculate percentage mortality. Body weight was taken by group weight by pen and used with feed consumption to calculate feed conversion. All body structure measurements and bone data were taken on 5 birds/pen. Shank and keel length were taken with a vinyl metric measuring tape. Shank length was measured on the back of the left shank from top of the back toe to the top of the shank. Keel length measurements were obtained from sternum to bottom of the keel. Tibiotarsal weight and strength were taken on both left and right tibia after they were boiled for 6 min, all tissue removed, then dried for 16 hr at 100 °C and placed in a desiccator. Tibia strength was measured using an Instron apparatus with a flexure fixture head.

All data were analyzed utilizing SAS, using a randomized block design with block X treatment as the error term. When significant treatment effects were found, Duncan's New Multiple Range Test was used to separate treatment means.

TABLE 1. Percentage composition and calculated analysis of experimental diets used for both treatments

INGREDIENT	STARTER 0–3 wks	GROWER 4–6 wks
	(%)	(%)
Corn	57.85	65.60
Soybean meal (44%)	32.80	26.43
Menhaden fishmeal	2.00	0.50
DL-Methionine	0.21	0.25
Animal tallow	4.50	4.35
Defluorinated phosphate	1.45	1.50
Limestone	0.65	0.75
Microingredients[A]	0.25	0.25
Salt	0.25	0.25
Lysine*HCl	0.04	0.12
Total	100.00	100.00
Calculated Analysis		
Crude protein (%)	21.20	18.25
ME (kcal/kg)	3100	3166
Calcium (%)	0.94	0.89
Available phosphorus (%)	0.46	0.41
Sodium (%)	0.19	0.18
Chloride (%)	0.21	0.19

[A]Supplies per kg of diet: vitamin A, 11,000 IU; vitamin D_3, 1650 IU; vitamin E, 8.25 IU; menadione sodium bisulfite, 0.73 mg; thiamine, 1 mg; riboflavin, 4.4 mg; niacin, 33 mg; d-pantothenic acid, 8.1 mg; folic acid, 0.45 mg; biotin, 0.05 mg; pyridoxine, 2.2 mg; vitamin B_{12}, 0.01 mg; choline, 400 mg; manganese, 60 mg; zinc, 44 mg; iron, 20 mg; copper, 2 mg; iodide, 1.2 mg; and cobalt, 0.20 mg.

Results and Discussion

The incorporation of a non-intermittent (12L:12D) restricted lighting program on male broilers significantly decreased body weight (*p*

< 0.03) throughout the experiment when compared to conventionally lighted broilers (Table 2). These data agree with past experiments on the effects of longer periods of darkness on body weight [11, 12]. However, intermittent restricted lighting programs incorporating short periods of light and dark have shown increased body weight. The effects of these programs on body weight have recently been reviewed and summarized [13]. While the intermittent restricted lighting programs may have the same or longer periods of darkness overall as the non-intermittent restricted programs, the intermittent programs show body weight gain and the non-intermittent programs show body weight loss. This is probably the result of the dividing up of the periods of darkness with short periods of light. In the intermittent programs, the broilers eat to satiation in the lighted portion of the photoperiod and then do not expend much energy during the periods of darkness, causing greater weight gain. These data suggest that an intermittent restricted lighting program would be more beneficial than a non-intermittent restricted lighting program.

The 12L:12D treatment group had significantly improved feed conversion ($p < 0.04$) over the 23L:1D control group (Table 2). These results of feed conversion data from the study do not support the results of past studies that have shown feed conversion to be poorer in non-intermittent restricted lighting programs [11, 12]. The increased period of darkness caused an overall decrease in feed intake of 4% and in body weight of 2%, when compared to the control, thus improving feed conversion. However, if feed conversion is adjusted for body weight reduction (6 points body weight = 1 point feed conversion), there is only a 1-point difference in feed conversion. This is a minor difference, and most of the feed conversion reduction is in line with the lighter weight.

There was no difference found in percentage mortality by treatment (Table 2). Non-intermittent restricted lighting programs have been shown to decrease mortality in broilers in other studies [14]. However, those experiments utilized restricted lighting programs that had shorter periods of darkness and longer periods of light than the 12L:12D used in this experiment.

Keel length was not significantly affected by light restriction, but shank length was significantly decreased ($p < 0.01$) when compared to the control (Table 3). Keel length and shank length are generally regarded as good indicators of skeletal development, which is related to the amount of meat a broiler can carry. The decrease in shank length would therefore agree with the data that show decreased body weight.

Tibiotarsal weight and strength were not affected by treatment (Table 3). It has been shown that the use of intermittent restricted lighting significantly decreases the occurrence of leg disorders. One hypothesis to explain this is that the increased activity of the birds during the short periods of light may improve bone strength development [13]. The long blocks of light and dark in this experiment may not have increased activity enough to cause any discernable difference in bone strength or development.

TABLE 2. Effects of lighting schemes on body weight, feed conversion, and mortality of male broilers raised to 42 days of age

	WEEKS						
	0–2		0–4		0–6		
TREATMENT	Bodyweight (kg)	Feed Conv	Body weight (kg)	Feed conv.	Body weight (kg)	Feedconv.	Mort. (%)
23L:1D (control)	0.41[a]	1.32[a]	1.18[a]	1.73[a]	2.27[a]	1.96[a]	2.83[a]
12L:12D	0.37[b]	1.29[b]	1.12[b]	1.69[b]	2.22[b]	1.93[b]	2.50[a]
P>F	0.01	0.002	0.001	0.02	0.03	0.04	0.81

[a,b]Different letters indicate significant difference between means within columns ($p < 0.05$).

TABLE 3. Effects of lighting schemes on shank and keel length and tibiotarsal weight and strength of male broilers at 42 days of age

TREATMENT	SHANK LENGTH (cm)	KEEL LENGTH (cm)	TIBIOTARSAL WEIGHT (g)	TIBIOTARSAL STRENGTH (kg of force)
23L:1D (control)	6.09[a]	10.81[a]	7.77[a]	24.58[a]
12L:12D	5.60[b]	11.03[a]	7.53[a]	24.81[a]
P>F	0.001	0.66	0.23	0.68

[a,b]Different letters indicate significant differences between means within columns ($p < 0.05$).

Conclusions and Applications

1. A 12L:12D lighting program significantly improved feed conversion but decreased body weight, with no effect on mortality.
2. Restricted lighting did not affect keel length and decreased shank length, indicating a detrimental affect on frame size.
3. Restricted lighting did not benefit tibiotarsal weight or strength.

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