EDUCATION AND PRODUCTION

Effect of Differing Light Intensities on Abdominal Fat Deposition in Broilers

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(Received for publication November 24, 1987)

ABSTRACT Two trials were conducted in an attempt to determine if light intensity affected fat content of broilers as measured by the amount of abdominal fat. The light regimens used from 10 days of age had constant intensities of 2 or 52 lx. Results obtained showed that light intensity did not significantly influence the amount of abdominal fat produced by males or females at either 49 or 63 days of age. Light intensity had no significant effect on body weight, feed conversion (grams feed per gram body weight), or mortality at either 48 or 62 days of age for broilers of the same sex. The amount of light used was the amount produced from either 7.5 or 75-W incandescent bulbs in an enclosed house that was 11 m wide with two strings of light bulbs 2.1 m high on 3-m centers equidistant from the ends and sidewalls of the house.
(*Key words:* broilers, abdominal fat, light intensity, growth)

1988 Poultry Science 67:1239–1242

INTRODUCTION

Feed converted to fat not used by the consumer represents production inefficiency. In human nutrition, excess consumption of fat is generally discouraged. At the processing plant, fat must be removed before the water used in processing is released into the environment. These are three of the reasons continual pressure exists to decrease the amount of fat in broilers.

It has been reported that a rearing program restricting day length significantly reduced the fat content of turkeys (Anonymous, 1985). Broilers are usually reared under continuous lighting regimens; therefore, light intensity rather than day length, under commercial conditions, would be the available factor that could be varied to influence abdominal fat deposition. Light intensity can be controlled in a number of broiler houses during part of the year and in some houses the entire year. The objective of this study was to determine if light intensity affected fat content of broilers, as measured by the amount of abdominal fat.

MATERIALS AND METHODS

Two trials were conducted using commercial feather-sexed broiler chicks. Chicks were placed on pine shavings in 32 pens, each pen measuring 1.51 × 3.7 m. Two 38.2-cm diameter tube feeders and 244 cm of linear waterer space were used in each pen. All chicks were brooded and grown at 29 C for the 1st wk, at 27 C for the 2nd wk, at 24 C for the 3rd wk, and at 21 C from the 4th wk to the end of the experiment.

For the first 3 wk, chicks were fed a basal starter diet calculated to contain 21% protein and 3,142 kcal ME/kg. From 3 wk of age, broilers were fed a basal finisher diet calculated to contain 18.4% protein and 3,109 kcal ME/kg. All broilers were provided with feed and water *ad libitum*.

Broilers were reared under a continuous light regimen of 52 lx to 10 days of age. At 10 days, body weights were obtained so that body weights of the two treatments could be equalized. At 10 days of age, 54 chicks were placed in each of 32 pens (16 pens of males and 16 pens of females). Pens were in a windowless house with a solid partition midway through the house. The house, which had both heating and cooling capability to maintain the specified temperature, had an air duct running the length of the house so that equal temperatures could be maintained throughout the entire area of the house. Eight pens of males and eight pens of females were randomly distributed in each half of the house. From 10 days of age, one-half of the broilers was reared in a light regimen of 2 lx and one-half of the broilers was reared in a light regimen of 52 lx. The light source was incandescent bulbs. Light intensity was measured with an illumination meter at bird height. Body weights and feed consumption data were recorded at 10, 48, and 62 days of age. Mortality was recorded as it occurred.

At 49 and 63 days of age, two pens of males and two pens of females were randomly selected from each of the two lighting regimens. All birds in these pens were sacrificed; abdominal fat was removed and weighed according to the procedure of Kubena *et al.* (1974).

The experiment consisted of a split-plot design, with the main plot consisting of trial and pen and light intensity as the sub-plot. Analysis of variance was conducted for body weight, feed conversion (g feed/g body weight), and percentage of abdominal fat. Abdominal fat was transformed with arc sine percentage and expressed as a percentage of body weight, in accordance with procedures of Steel and Torrie (1960). Significantly different treatment means were separated by the multiple range test of Duncan (1955). Mortality was evaluated by chi-square analysis.

RESULTS

Light intensity did not significantly affect the amount of abdominal fat (Table 1) within age groups and sex. Females had significantly more abdominal fat than males, and 63-day-old females had significantly more abdominal fat than 49-day-old females. The 63-day-old males had significantly more abdominal fat than 49-day-old males reared under a light intensity of 2 lx.

Within each sex and within each age group at 48 and 62 days of age, reduction of light intensity did not significantly affect body weight, feed conversion (g feed/g body weight), or mortality (Table 2). Body weight and feed conversion (g feed/g body weight) significantly increased with age for each sex, and males within each age group weighed significantly more than females, with a significantly lower feed conversion ratio than that of females. Within each sex and age group, mortality was not significantly affected by reduction of light intensity; however, at each age, more males than females died.

DISCUSSION

The two experimental light regimens could easily be used under commercial industry conditions in a light-controlled house. The amount of light used in the present research was the amount produced from either 7.5 or 75-W incandescent bulbs in an enclosed house 11 m wide with two strings of light bulbs 2.1 m high on 3-m centers equidistant from the ends and sidewalls of the house.

TABLE 1. *Effect of light intensity on amount of abdominal fat in male and female broilers*

	Male								Female							
	49 days				63 days				49 days				63 days			
	2 lx		52 lx		2 lx		52 lx		2 lx		52 lx		2 lx		52 lx	
Abdominal fat	Fat	Live BW	Fat	Live BW	Fat	Live BW	Fat	Live BW	Fat	Live BW	Fat	Live BW	Fat	Live BW	Fat	Live BW
Trial 1	43.1	2,485	44.2	2,456	64.6	3,299	63.3	3,346	49.5	2,061	45.6	2,016	76.2	2,693	75.2	2,680
Trial 2	53.3	2,486	54.8	2,496	74.6	3,406	79.5	3,423	53.4	2,058	56.1	2,058	93.0	2,751	90.8	2,753
$\bar{X}$, %	1.94[d]		2.00[cd]		2.08[c]		2.11[c]		2.50[b]		2.50[b]		3.11[a]		3.06[a]	

[a–d]Within rows, means with no common superscripts are significantly different ($P \leq .05$).

TABLE 2. *Effect of light intensity on body weight, feed conversion, and mortality of male and female broilers*

		Male				Female			
		48 days[1]		62 days[1]		48 days		62 days	
Variable	Trial	2 lx	52 lx	2 lx	52 lx	2 lx	52 lx	2 lx	52 lx
Body weight, g	1	2,423	2,420	3,296	3,265	2,022	1,973	2,688	2,646
	2	2,397	2,435	3,307	3,344	2,028	2,032	2,724	2,705
	$\bar{X}$	2,410^{c}	2,428^{c}	3,302^{a}	3,305^{a}	2,025^{d}	2,003^{d}	2,706^{b}	2,676^{b}
Feed conversion, g feed:g BW	1	1.91	1.90	2.15	2.17	2.01	2.01	2.31	2.32
	2	1.95	1.94	2.11	2.10	2.03	2.02	2.27	2.26
	$\bar{X}$	1.93^{d}	1.92^{d}	2.13^{b}	2.14^{b}	2.02^{c}	2.02^{c}	2.29^{a}	2.29^{a}
Mortality, dead/placed birds	1	18/432	17/432	20/324	23/324	4/432	10/432	9/324	12/324
	2	8/432	12/432	10/324	11/324	2/432	3/432	4/324	3/324
Mortality rate, %	$\bar{X}$	3.01^{bc}	3.36^{abc}	4.63^{ab}	5.25^{a}	.69^{e}	1.50^{de}	2.01^{cd}	2.31^{cd}

[a–d]Within each row, means with no common superscripts are significantly different ($P \leq .05$).

[1]Bird numbers differ on Days 48 and 62 because samples were taken for abdominal fat determination.

In addition to the work reported in the *Nicholas Turkey News* (1985) concerning length of light day and fat content of turkeys, Pyrzak *et al.* (1986) noted that an egg-laying strain of chicken exposed to a blue light spectrum had significantly more abdominal fat at 20 wk of age than those exposed to a red light spectrum and light emitted from incandescent bulbs and fluorescent tubes. Layers used by Pyrzak *et al.* (1986) exposed to the blue light spectrum weighed significantly less than those exposed to the light source from fluorescent tubes, indicating a difference in feed composition.

Generally, feed consumption or feed composition differences or both are the factors reportedly involved in abdominal fat deposition. Mabray and Waldroup (1981) outlined in a review four general nutritional factors that may influence the degree of fatness in broilers: 1) the dietary calorie to protein ratio–narrowing the ratio has generally been found to prevent excessive deposition of body fat; 2) an imbalance of amino acids–this may cause an increase in body fat; 3) dietary fat; and 4) dietary energy levels. The effects of the latter two factors are not totally clear.

Rearing temperatures have also been identified as influences on broiler abdominal fat: Kubena *et al.* (1972) observed an increase in total carcass fat at higher rearing temperatures. Generally, as temperatures increase above 21 C, feed consumption and growth rates decrease (Deaton *et al.,* 1978). Neither Kubena *et al.* (1972) nor Pyrzak *et al.* (1986) reported feed consumption data. In the present study, on the day before each fat-sampling period, no significant differences existed in body weight or feed consumption as measured by feed conversion (g feed/g body weight) for broilers of the same sex under differing light intensities.

If the composition of the feed remains constant and no differences in feed intake and growth rate exist, the amount of abdominal fat should remain the same, all other factors remaining equal. In this study, within sexes, broilers on differing light regimens were fed the same feed, and feed intake and growth rate were the same; no differences in the amount of abdominal fat were noted. Miller *et al.* (1985) did not note any differences in leaf fat for broilers when they used differing light regimens at one intensity.

When using a moderate temperature regimen and continuous light regimens differing in intensity, Deaton *et al.* (1976) found that a difference existed in feed conversion for broilers. The low

light intensity group of broilers had a significantly better feed conversion rate than those reared under a bright light. The intensity of the bright light used by Deaton *et al.* (1976) was 204.5 lx and the intensity of the dim light was 12.9 lx. Activity rates of broilers differed when exposed to differing light intensities in the Deaton *et al.* (1976) study. Bird activity increased as light intensity increased, which could have caused excess feed use and waste. Bird activity was not visually higher among birds in the present research at light intensities of 52 lx *vs.* 2 lx, and no differences between feed conversion rates at 48 and 62 days of age were noted for broilers of the same sex (Table 2). Deaton *et al.* (1976) simulated a day-night regimen possible in a curtain-type broiler house whereas conditions in this study simulated constant lighting regimens possible in a windowless broiler house that uses 7.5 W or 75 W bulbs from 10 days of age.

REFERENCES

Nicholas Turkey News, 1985. Volume 27. No. 7, 8. Nicholas Turkey Breeding Farms, Sonoma, CA.

Deaton, J. W., F. N. Reece, L. F. Kubena, and J. D. May, 1976. Effect of varying light intensity on broiler performance. Poultry Sci. 55:515–519.

Deaton, J. W., F. N. Reece, and J. L. McNaughton, 1978. The effect of temperature during the growing period on broiler performance. Poultry Sci. 57:1070–1074.

Duncan, D. B., 1955. Multiple range and multiple F tests. Biometrics 11:1–42.

Kubena, L. F., J. W. Deaton, T. C. Chen, and F. N. Reece, 1974. Factors influencing the quantity of abdominal fat in broilers. 1. Rearing temperature, sex, age, or weight, and dietary choline chloride and inositol supplementation. Poultry Sci. 53:211–214.

Kubena, L. F., B. D. Lott, J. W. Deaton, F. N. Reece, and J. D. May, 1972. Body composition of chicks as influenced by environmental temperature and selected dietary factors. Poultry Sci. 51:517–522.

Mabray, C. J., and P. W. Waldroup, 1981. The influence of dietary energy and amino acid levels on abdominal fat pad development of the broiler chicken. Poultry Sci. 60:151–159.

Miller, B. F., F. Deyhim, and R. E. Moreng, 1985. Effect of light regimen on body fat in broilers. Poultry Sci. 64(Suppl. 1):147. (Abstr.)

Pyrzak, R., N. Snapir, G. Goodman, E. Arnon, and M. Perek, 1986. The influence of light quality on initiation of egg laying by hens. Poultry Sci. 65:190–193.

Steel, R.G.D., and J. H. Torrie, 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York, NY.