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EFFECT OF DIFFERENT PHOTOPERIOD REGIMENS ON GROWTH PERFORMANCE AND SOME PHYSIOLOGICAL RESPONSES OF DIFFERENT BROILER STRAINS

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***ABSTRACT** : The purpose of the present experiment was to compare growth performance of broiler chicks from 4 strains raised under three different photoperiod regimens, namely; 23 h light : 1 h dark (23 L : 1 D), 1 h light : 3 h dark (1 L : 3 D) and 8 h light : 16 h dark (8 L : 16 D). Measurements were taken weekly for 6 wks. Broiler chicks reared under constant lighting (23 L : 1 D) had significantly ($P \leq 0.01$) higher body weights than those grown under the other two photoperiods, meanwhile, those exposed to 8 L : 16 D had the lowest body weights at all ages. The weekly body weight gain was greater for birds under constant lighting (23 L : 1 D) from 1 up to 4 wks and from 5 to 6 wks of age for those under (8 L : 16 D). Feed consumptions of birds exposed to (1 L : 3D), or (8 L : 16 D) were significantly lower than that of birds exposed to (23 L : 1 D). Chicks from (8 L : 16 D) had better feed conversion than chicks from (23 L : 1 D) and (1 L : 3 D) at 2, 3, 5 and 6 wks of age. Intermittent lighting (1 L : 3 D) was intermediate between (23 L : 1 D) and (8 L : 16 D) in feed conversion. However, there were significant ($P \leq 0.01$) differences in feed conversions between the different light regimens. The differences among strains in body weight, weight gain, feed consumption and feed conversion were significant ($P \leq 0.01$). These results indicate that (1 L : 3 D) photoperiod regimens have no adverse effect on body weight, weight gain, feed consumption and feed conversion, when compared to constant lighting. Photoperiod (8 L : 16 D) significantly decreased body weight and feed consumption although feed conversion has been improved.*

The absolute weight of heart and thymus gland were significantly lower in the chicks reared under (8 L : 16 L) compared with those exposed to either constant (23 L : 1 D) or intermittent light (1 L : 3 D). However, the differences between the latter two groups were not significant. The weight of liver, spleen and bursa of fabricius for birds grown under (8 L : 16 L) was significantly greater compared to the other light treatments. The photoperiods significantly affected the relative weight of liver, spleen and bursa of fibricius as well as hematocrit values and total WBC count, meanwhile, it did not significantly affect the relative weight of heart or thymus gland.

The differences in liver, spleen, thymus gland weights and total WBC count, among broiler strains were significant while, that of heart, bursa of fabricius

weight and hematocrit values were not significant. The relative weight of spleen, bursa of fabricius and thymus gland differed significantly among broiler strains. It could be concluded that manipulating daylength may be a practical. Short term measure for improving the birds immunoresponsiveness and lowering physiological stressors, while bird performance is equal to or sometimes better than that of birds housed under traditionally near continuous lighting schedules.
Key words : Photoperiod, Growth, Physiological response, Broilers.

INTRODUCTION

Understanding the role of photoperiod regimens on production performance becomes increasingly important especially in concerning the reduction of the cost-effective management of broiler chicks. There have been attempts to investigate the advantages of using different light regimens rather the one that is commonly used (23 hours of light and 1 hour of darkness daily). Classen and Riddell (1989) and Classen *et al.* (1991) tested different photoperiod regimens in raising broiler chicks and reported that changing the photoperiod length from short to long during broiler growth improves bird health while maintaining equal or slightly superior performance characteristics compared with effects of a long constant day length. They concluded that the use of continuous or near continuous light should not be recommended for broiler chickens. In addition, Weaver *et al.* (1982) reported that broiler chicks subjected to intermittent light had significantly greater body weights and better feed efficiency than did birds under continuous illumination. Moreover, Buckland *et al.* (1971) suggested that an intermittent system of light may be less stressful to the birds than continuous light.

The manipulation of photoperiods in raising broiler chickens has largely consisted of maximizing body weight and improve feed efficiency (Classen and Riddell, 1989). Long photoperiods or constant lighting are believed to increase feed consumption due to continuous access to feed. Consumption of feed is almost entirely restricted to the period of light, with a peak in feed consumption at the beginning or at the end of a photoperiod (Savory, 1980). Little or no feeding occurs during the dark period or scotoperiod (Weaver and Siegel, 1968). Buyse *et al.* (1993) showed that the amount of feed consumed during the dark period is < 1 % of that during the light period. Therefore, feed consumption varies on lighting schedule. Chickens grown under intermittent lighting tend to have a reduced feed intake (Buyse *et al.*, 1996).

Interest in photoperiod alterations can be attributed to industrial efforts to reduce health problems, reduce costs, and increase profits. Recent experiments have shown that intermittent lighting regimens or increasing periods of light can reduce feed intake and improve feed efficiency (Blair *et al.*, 1993). Intermittent lighting, therefore, in addition to improving health status, has potential savings in feed usage and in electrical energy necessary to raise chickens. A reduction in production costs, in addition to the production of healthier birds and possible increases in body weight can make physiological manipulation very practical. It is also known that genetic background influences production performance (Liu *et al.*, 1995). Still further evidence of photoperiod on production performance of broiler chicks is needed. The purpose of this experiment was to examine production parameters such as body weight, feed efficiency, feed conversion, from different broiler strains grown in different photoperiod regimens and to determine the optimum photoperiod regimen that should be used to maximum performance, and to enhance immunoresponser of birds by lowering physiological stress of continuous lighting.

MATERIALS AND METHODS

This study was conducted in Pennsylvania Research Poultry Farm, Department of Poultry Science, Penn State University, USA. A total number of 480 one-day-old commercial broiler chicks of 4 strains namely; (Cobb x Cobb (CC), Cobb x Arbor Acres (CA), Ross x Arbor Acres (RA), and Avian Farms x Avian Farms (AF) were used in this study. The chicks were housed in floor pens and randomly exposed to one of three different photoperiod treatments. Each treatment involved two replicate pens for each strain with 20 birds per pen. The photoperiod treatments were 23 h light : 1 h dark (23 L : 1 D) as constant lighting, 1 h light : 3 h dark (1 L : 3 D) as intermittent lighting and 8 h light : 16 h dark (8 L : 16 D) as short lightining. Food and water were provided ad libitum throughout the experiment. Body weight and feed consumption, on a pen basis, were determined at weekly intervals up to 6 wks of age. Weight gain and feed conversions were then calculated. At the end of experiment, four birds from each pen were slaughtered and blood samples were taken in micro capillaries for measurements of hematocrit value. Total white blood corpuscles (WBC) were also measured using blood smears stained with the brilliant Cresyl blue stain.. Bursa of fabricius, thymus gland, heart, spleen, and liver, were carefully separated and weighed. The relative weight of such organs in proportional to the body weight were calculated.

SAS software (1986) general linear model procedure was used to analyze data with a one way analysis of variance. Means were separated using Duncan's multiple range test with significance set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Body weight :

Both strain and lighting system significantly affected the final live body weight ($P \leq 0.01$), Table 1. In this respect, regardless, the strain affect, the birds exposed to 231 : 1 D constant light had significantly ($P \leq 0.01$) the heaviest final body weight. This pattern of response was true for all strains under consideration except CA strain where both constant and intermittent lighting yielded quite similar final body weight. The greatest response to constant and intermittent lighting system was recorded by AF strain, while the least response by CA. In the same time RA strain revealed better response to such photoperiod regimens compared to CC strain.

Data in Figure 1, illustrate that the final body weight of strain (CC) was significantly ($P \leq 0.01$) the heaviest while, and the lightest one for strain (RA). On the other hand, birds from strain (AF) had significantly ($P \leq 0.01$) the greatest average body weight at hatch than other strains. Birds from strain (CC) had significantly ($P \leq 0.01$) greater body weights from 2 up to 6 wks of age than other strains, followed by birds from strains (AF), and (CA). The birds from strain (RA) gave significantly ($P \leq 0.01$) the lowest body weight than other strains at 1, 2 and 4 wks of ages. The interactions between photoperiods and strains in body weight were not significant at all ages.

It could be concluded that the 8 L : 16 D photoperiod regimen has adversely affected the final body weight. Although, birds under intermittent (1 L : 3 D) lighting took longer period of darkness (18 h / day) than birds from (8 L : 16 D), (16 h / day), the former treatment yielded higher body weights than the later one. This may suggest that distribution of light and dark is important to obtain higher body weight. Schedules like intermittent lighting that have periods of darkness abbreviated by light retain body weights near to photoperiods with longer lighting schedules (constant light). The convenient influence of both light treatments (23 L : 1 D and 6 L : 18 D) on final body weight may be due to their effect on feeding activity (Morris, 1967 and Weaver and Siegel, 1968). However, there was no difference in body weight between birds reared on (16 L : 8 D and 23 L : 1 D) as reported by Renden *et al.* (1996) or between (18 L : 6 D and 23 L : 1 D) (Laster *et al.*, 1999).

As early mentioned, the present study also demonstrated that the broiler strains exhibited differences in their response to different light regimens, which agrees with the study of Renden *et al.* (1992) who compared a restricted lighting program (16 L : 8 D) with a standard extended lighting schedule (23 L : 1 D) for broiler strain crosses. They found that the body weight of (Peterson x Arbor Acres) was greater than body weight of (Indian River x Arbor Acres) at 1, 14, 35 and 49 days of age, and body weight of (Cobb x Arbor Acres) was greater than that of (Peterson x Arbor Acres) from 1 to 48 days. In addition, Cave *et al.* (1985) suggested that an interaction between genotype and lighting can be found with body weight.

Body weight gain :

Table (1) and Fig. (2) further, show that the total and daily body weight gain were significantly affected by either strain or photoperiod treatments. In this concern, constant lighting (23 L : 1 D) gave total body weight gain and average daily gain greater than either (1 L : 3 D) or (8 L : 16 D) treatments, and the least response was found for (8 L : 16 D) treatment. Broiler chicks raised under constant light (23 L : 1 D) gave weekly weight gain significantly ($P \leq 0.01$) greater at 1, 2, 3 and 4 wks than that of those under other photoperiod treatments. While, broiler chicks exposed to (8 L : 16 D) had significantly ($P \leq 0.01$) higher weekly weight gain at 5 and 6 wks than others.

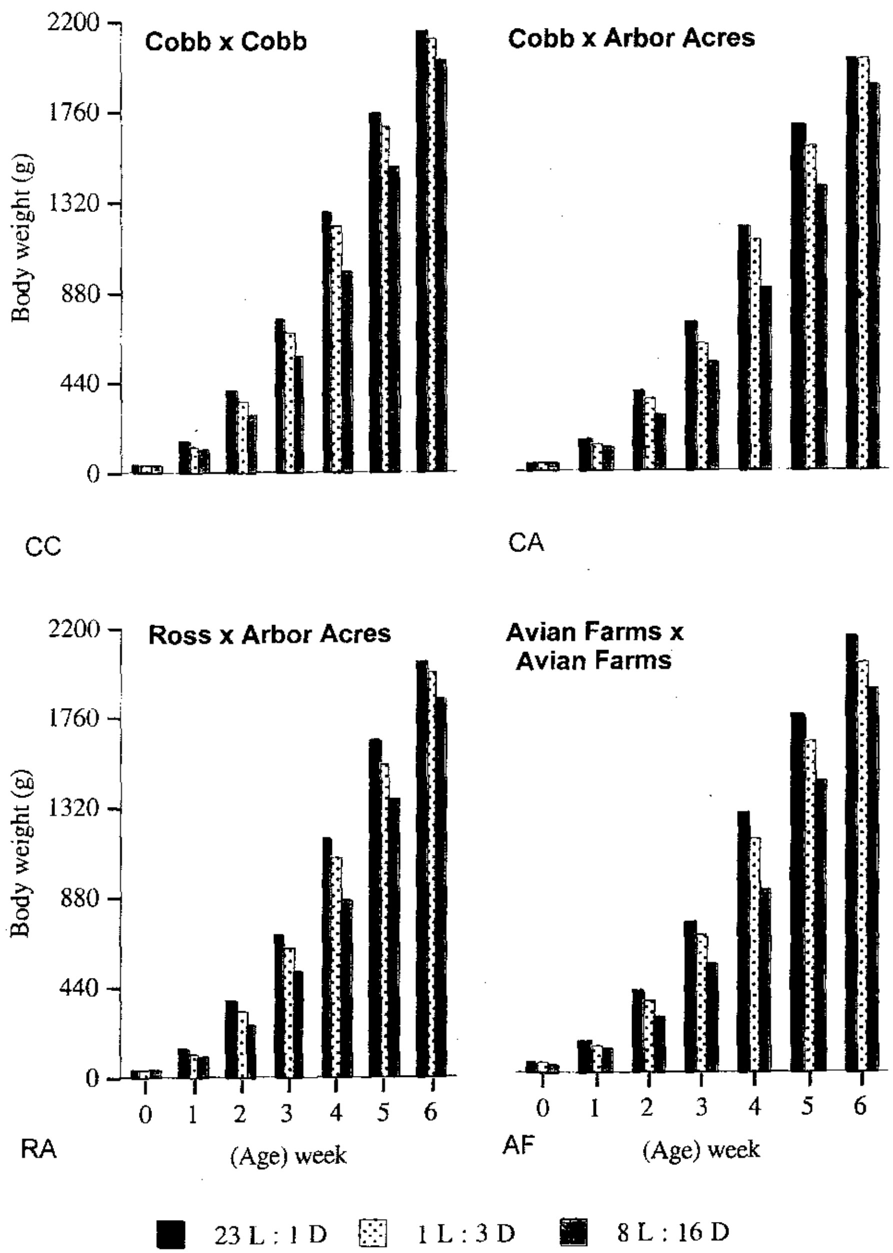

Fig. (1) : Effect of photoperiod treatments on weekly body weight (gm) of different growing broiler strains.

Table (1) : Effect of photoperiod regimens on some productive traits of different broiler strains ($\bar{X}$ ± S.E.)

Trait	Photoperiod regimens	Strains				Overall average
		Cobb X Cobb (CC)	Cobb X Arbor Acre (CA)	Ross X Arbor Acre (RA)	Avian Farms X Avian Farms (AF)	
Initial B.Wt. (g)	23L : 1D	40.5 ± 1.0	40.0 ± 1.6	39.0 ± 1.9	43.0 ± 1.0	40.6^{A} ± 1.4
	1L : 3D	40.5 ± 1.0	40.5 ± 1.0	38.5 ± 1.4	43.0 ± 1.0	40.6^{A} ± 1.1
	8L : 16D	39.5 ± 2.0	38.5 ± 1.4	39.0 ± 1.6	42.0 ± 1.0	39.8^{A} ± 1.5
	Overall average	40.2^{b} ± 1.3	39.7^{b} ± 1.3	38.8^{b} ± 1.6	42.7^{a} ± 1.0	40.3 ± 1.3
Final B. Wt. (g)	23L : 1D	2151 ± 29.0	1998 ± 38.0	2031 ± 30.0	2136 ± 23.0	2079^{A} ± 30.0
	1L : 3D	2112 ± 35.0	2004 ± 23.0	1974 ± 23.0	2008 ± 29.0	2024^{B} ± 27.5
	8L : 16D	1999 ± 24.0	1878 ± 27.0	1851 ± 28.0	1874 ± 25.0	1902^{C} ± 26.0
	Overall average	2087^{a} ± 29.0	1960^{c} ± 29.3	1954^{c} ± 27.0	2006^{b} ± 25.7	2002 ± 27.8
Total gain (g)	23L : 1D	2111 ± 3.5	1958 ± 18.0	1992 ± 17.0	2093 ± 13.6	2038^{A} ± 13.0
	1L : 3D	2072 ± 4.4	1964 ± 14.5	1936 ± 14.4	1965 ± 4.6	1983^{B} ± 9.5
	8L : 16D	1960 ± 8.5	1840 ± 11.1	1812 ± 5.2	1832 ± 12.4	1862^{C} ± 9.3
	Overall average	2047^{a} ± 8.5	1920^{c} ± 14.5	1913^{c} ± 12.2	1963^{b} ± 10.2	1961 ± 10.6
Daily gain (g)	23L : 1D	50.3	46.6	47.4	49.8	48.5
	1L : 3D	49.3	46.8	46.1	46.8	47.2
	8L : 16D	46.7	43.8	43.1	43.6	44.3
	Overall average	48.8	45.7	45.5	46.7	46.7
Total feed consumption (g / bird)	23L : 1D	3928 ± 26.7	3854 ± 65.4	3629 ± 79.3	3976 ± 19.7	3847^{A} ± 47.8
	1L : 3D	3579 ± 85.3	3365 ± 69.1	3252 ± 89.5	3509 ± 42.4	3426^{B} ± 71.6
	8L : 16D	3276 ± 45.5	3146 ± 48.1	2958 ± 64.7	3185^{ab} ± 32.6	3141^{C} ± 47.7
	Overall average	3594^{a} ± 52.3	3455^{b} ± 60.9	3280^{c} ± 77.8	3556 ± 31.6	3471 ± 55.7
Feed conrevsion (Feed / gain)	23L : 1D	1.86 ±0.01	1.97 ±0.03	1.82 ±0.01	1.90 ±0.01	1.89^{A} ±0.02
	1L : 3D	1.73 ± 0.01	1.71 ± 0.01	1.68 ± 0.01	1.79 ± 0.02	1.73^{B} ± 0.01
	8L : 16D	1.67 ± 0.01	1.71 ± 0.03	1.63 ± 0.01	1.74 ± 0.01	1.69^{C} ± 0.02
	Overall average	1.75^{b} ± 0.01	1.80^{a} ± 0.02	1.71^{c} ± 0.01	1.81^{a} ± 0.01	1.77 ± 0.01

a, b, ab, c. Values having different superscripts in the same row are significant at 0.05
A, B, C. Values having different superscripts in the same column are significant at 0.05

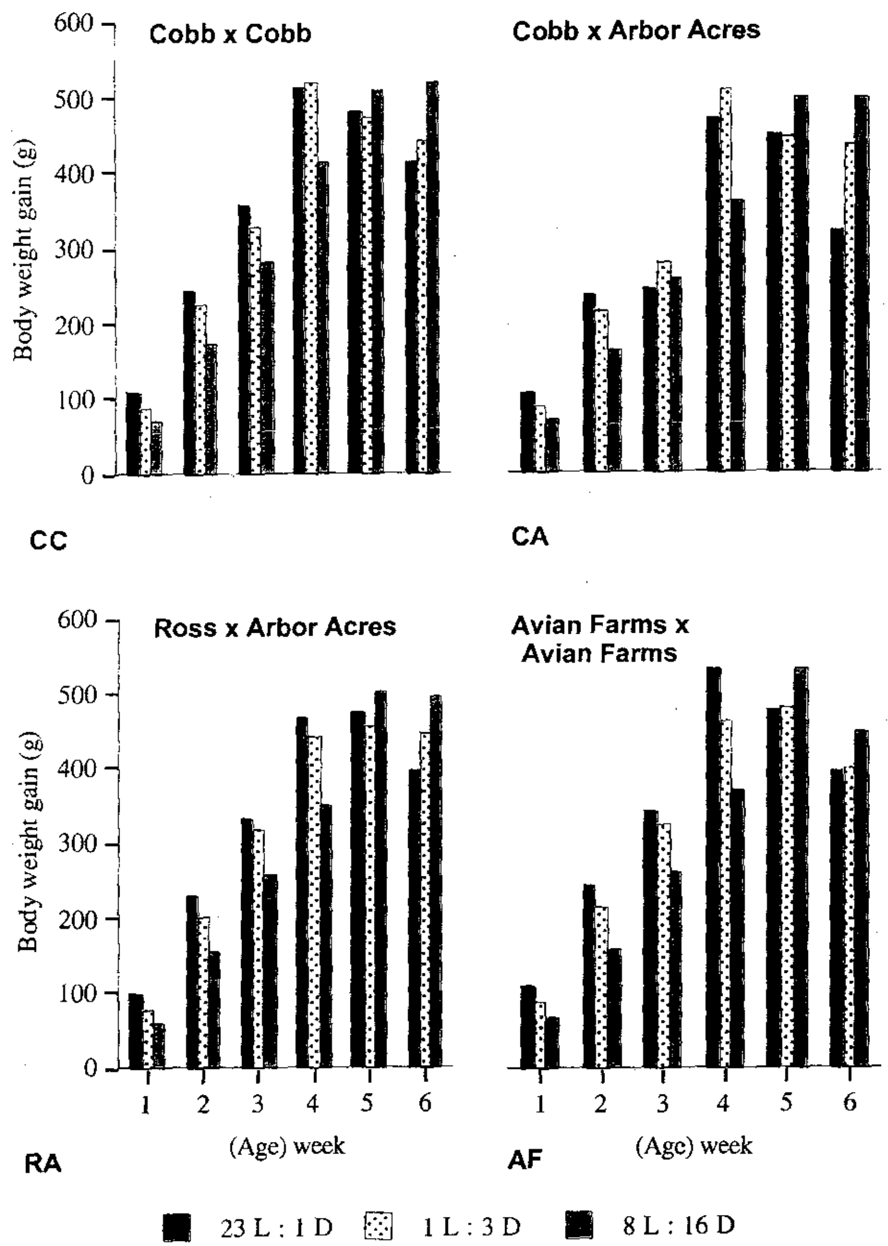

Fig. (2) : Effect of photoperiod treatments on weekly body weight gain (gm) in different growing broiler strains.

The birds under intermittent lighting recorded intermediate values at all ages except at 5 wks.

The strain (CC) gave significantly the highest total gain and daily gain, followed by (AF), while strains (CA) and (RA) gave the lowest values without significant differences between both. Broiler chicks from strain (CC) gave significantly ($P \leq 0.01$) weekly weight gain higher than other strains at 2, 3, 4 and 6 wks and (AF) at 5 wks, while at 1, 2 and 4 wks, (RA) was significantly lower. However, at 6 wks, the strains (CA) and (AF) were significantly ($P \leq 0.01$) lower in weekly weight gain than other strains. The interaction between photoperiods and strains, in this respect, was significant at different ages except at 1 wk where it was not significant.

Foss *et al.* (1972) demonstrated that the environmental light has an influence on a number of physiological mechanisms in birds including growth, reproductive development and thyroid function.

The present study also demonstrated that birds from intermittent photoperiods were able to compensate the early growth decline so that at 6 wks of age they attained an average body weight near to birds reared under constant lighting. Similar findings have been early reported by Buyse *et al.*, (1994 a). Buys *et al.* (1998) reported that, in the first wks, birds under constant light have higher plasma T3 concentrations than those exposed to intermittent light, whereas at later stages, the opposite relationship is found. Results of Lott *et al.* (1996) suggested that manipulation of photoperiod for young broilers is a useful way to limit early growth. However, Smith (1994) found that, photoschedule (23 L : 1 D and 16 L : 8 D) had no effect on body weight gain. Plasma growth hormone levels in birds reared under intermittent light were higher than those of constant light, intermittent light broilers manifesting compensatory growth have higher mean plasma growth hormone levels than their age-matched counterparts (Kuhn *et al.*, 1996). Our study indicated that the broiler strains differed in their response to lighting programs. This finding was supported by findings of Renden *et al.* (1992) who reported significant differences in relative growth among strain crosses (Indian River x Arbor Acres, Peterson x Arbor Acres and Cobb x Arbor Acress) and between light treatments (23 L : 1 D and 16 L : 8 D).

Feed consumption :

Table (1) and Fig. (3) show that feed consumption of constant lighting was significantly ($P \leq 0.01$) greater than that of either (1 L : 3 D) or (8 L : 16 D) treatments, followed by intermittent light (1 L : 3 D). Weekly feed consumption of broiler chicks received (23 L : 1 D) was significantly higher than that of chicks exposed to the other photoperiod treatments at all ages. On the other hand, chicks from (8 L : 16 D) treatment had significantly lower weekly feed consumption at all ages except at 6 wk., while, intermittent lighting was intermediate.

Strain (CC) had significantly ($P\leq 0.01$) higher feed consumption followed by (AF), while, strain (RA) was the lowest. Chicks from (CC) strain had significantly ($P \leq 0.01$) higher weekly feed consumption at 3, 4 and 6 wks than

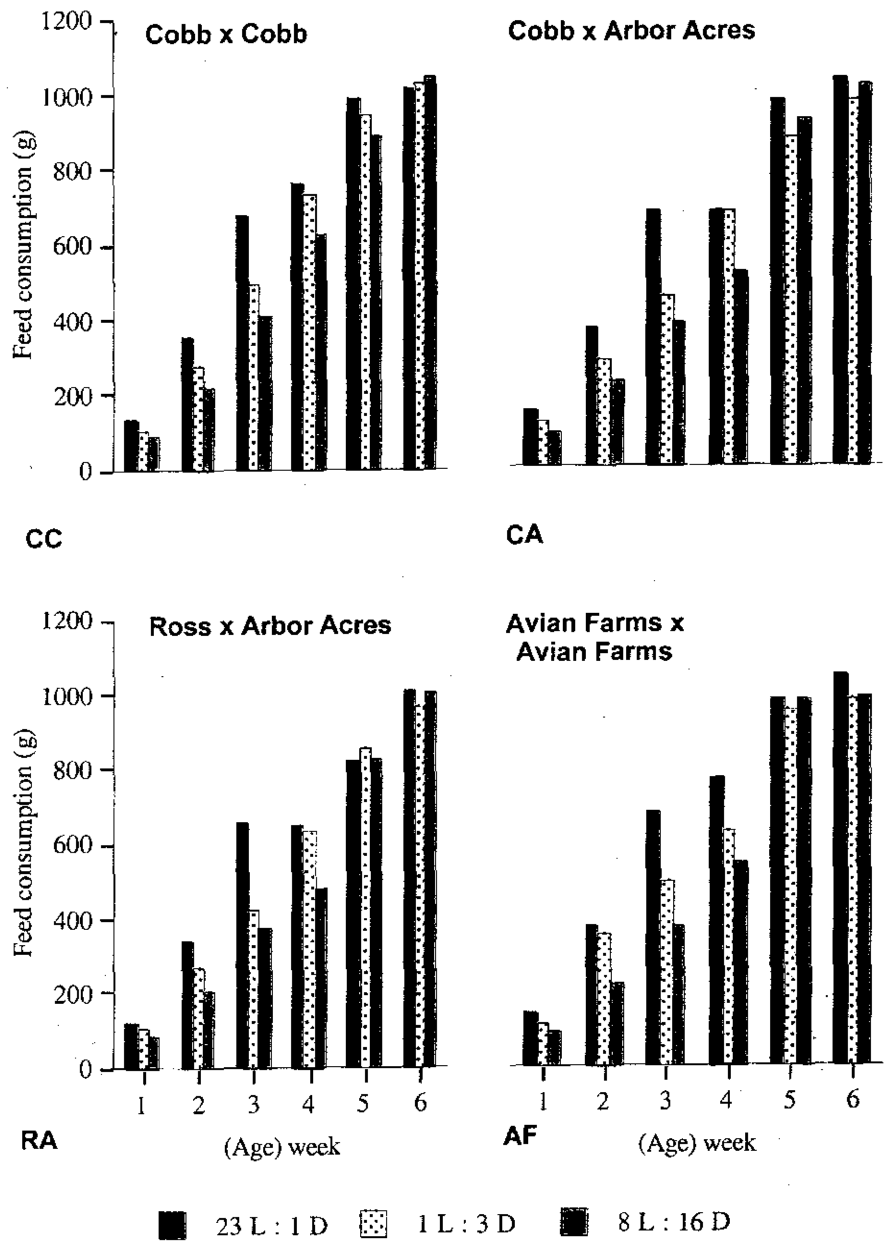

Fig. (3) : Effect of photoperiod and strain on weekly feed consumption (g / bird) of growing broiler chicks..

other strains. However, chicks from (AF) had higher at 1, 2 and 5 wks in weekly feed consumption. Strain (RA) had significantly lower weekly feed comsumption at all ages than other strains. The interaction between photoperiods and strains was significant ($P \leq 0.05$) at 1 and 2 wks and ($P \leq 0.01$) at the other periods.

The present study showed that birds receiving a 16 or 18 hour dark per day had lower feed consumption than the birds receiving constant lighting until marketing age. The dark period tends to decrease feed consumption (Weaver and Siegel, 1968). However, an explanation for an increase in feed consumption at marketing age for the birds having 12 or more hours of darkness is not clear. Cumulative feed consumption showed that only birds in the (8 L : 16 D) group was significantly lower (Chad, 1998) which agree with the present study. Our results are also in agreement with early evidence that intermittent lighting reduces weekly and cumulative feed consumptions as compared to constant lighting (Blair *et al.*, 1993 and Buyse *et al.*, 1996). However, Smith (1994) demonstrated that photoschedules (23 L : 1 D and 16 L : 8 D) had no effect on feed consumption.

Feed conversion :

The feed conversion was significantly ($P \leq 0.01$) higher for (23 L : 1 D), lower for (8 L : 16 D) and intermediate for (1 L : 3 D) as shown in Table (1) and Fig. (4). At 1 wk, the weekly feed conversion of birds reared under (8 L : 16 D) was higher than that of those under (23 L : 1 D) and (1 L : 3 D) which were quite similar. The weekly feed conversion for chicks raised under constant lighting was significantly higher than other treatments from 2, to 6 wks. Followed by intermittent light at 2, 3, 5 and 6 wks, and (8 L : 16 D) at 4 wks.

The cumulative feed conversion was significantly ($P \leq 0.01$) greater in strains (CA) and (AF) than other strains, while (RA) was the lowest. The feed conversion was significantly ($P \leq 0.01$) higher at 1, 3 and 6 wks for strain (CA), at 2 and 5 wks for strain (AF), and at 4 wk for (CC). The chicks from strain (CC) had feed conversion better than that other strains at 1 and 2 wks, while, strain (RA) at 3, 5 and 6 wk and strain (CA) at 4 wks. The interaction between photoperiods and strains was significant ($P \leq 0.01$) at different ages.

Significant differences among photoperiod treatments and among the different strains changed weekly so that a pattern of improved feed conversion was difficult to be recorded. Birds in photoperiods (1 L : 3 D and 8 L : 16 D) had better feed conversion at different ages except at 1 wk, for (8 L : 16 D) when compared to birds in constant lighting. This result is in agreement with others who reported an improvement with intermittent lighting in weekly and cumulative feed conversions (Blair *et al.*, 1993; Buyse *et al.*, 1994 a, b and Buyse *et al.*, 1996). Buyse *et al.* (1996) added that, imposing intermittent lighting improved efficiencey of dietary nitrogen retention. However, intermittent lighting of broilers has been shown to result in equal feed efficiency compared with continuous lighting (Classen and Riddell, 1989 and Classen *et al.*, 1991). Moreover, no main effect differences were observd for feed efficiency between light treatments (23 L : 1 D and 16 L

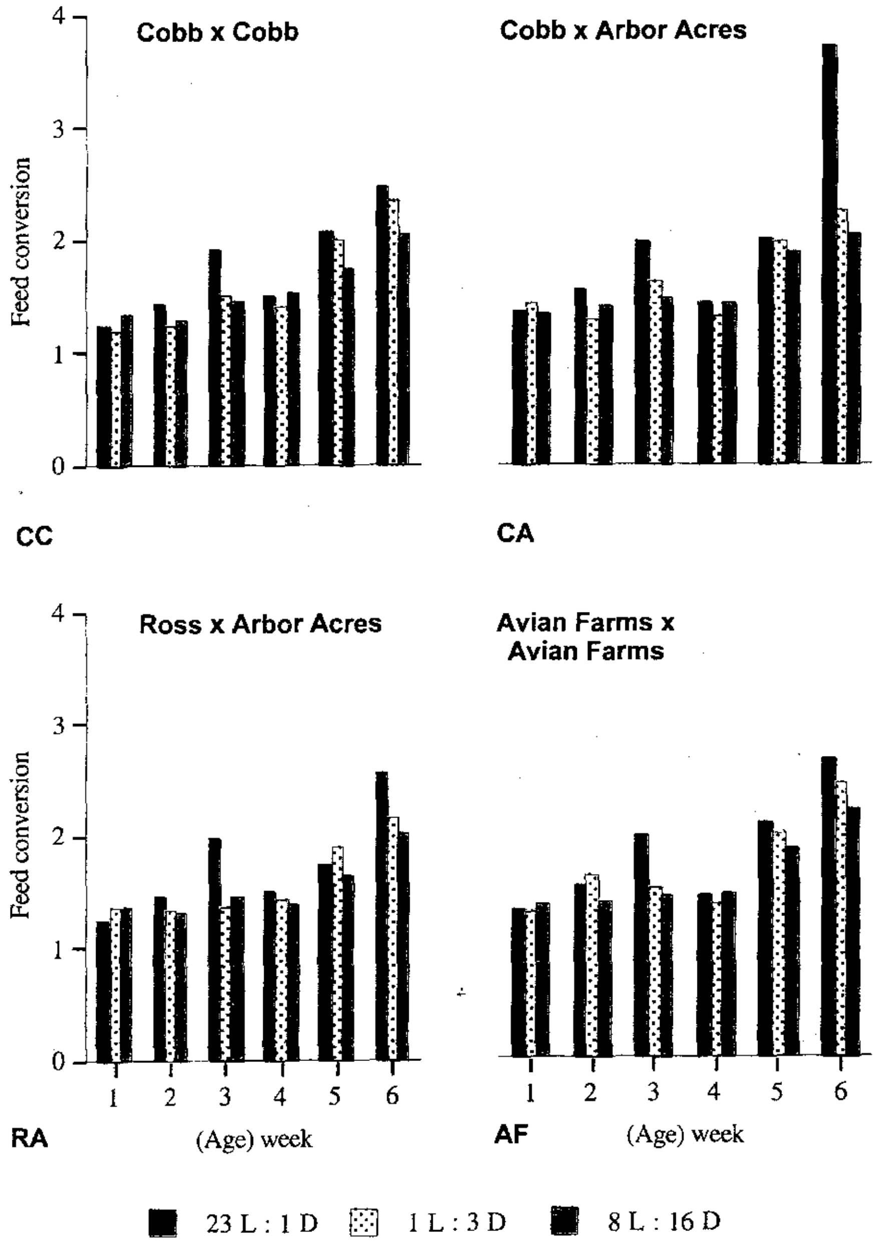

Fig. (4) : Effect of photoperiod and strain on weekly feed conversion (F. consumption / wt. gain) of growing broiler chicks.

: 8 D) (Renden *et al.*, 1996), or between (23 L : 1 D and 18 L : 6 D) (Laster *et al.*, 1999). As described earlier, these differences may be due to the strain of birds used.

Bursa of fabricius :

The bursa of fabricius, a primary immune organ, is the site of B-lymphocyte maturation and differentiation (Rose, 1981). The absolute and relative weight averages of bursa of fabricius were significantly ($P \leq 0.01$) higher in birds received (8 L : 16 D) than both of constant and intermittent lighting which did not significantly different (Tables 2 and 3). The differences among broiler strains were not significant in absolute weight of bursa of fabricius, while, they were significant ($P \leq 0.05$) in relative weight of bursa of fabricius to the body weight among strains. The interactions between light and strain, in this respect, were highly significant ($P \leq 0.01$).

Vriend *et al.*, 1975 stated that the growth of the bursa of fabricius could be related to photoperiod, although there is little empirical evidence to support this view. That is, since light affects activity of several hypothalamic - pituitary - target organ axes (Foss and Carew, 1971 and Oishi and Lauber, 1974) and since the endocrine system is causally related to the growth of the bursa, then light should influence the growth of the bursa. Furthermore, Vriend *et al.* (1975) found that bursa weight was greater in chicks reared under (14 L : 10 D) than that in those under constant light (24 L : 0 D) at 4 to 10 weeks of age and the authers suggested that constant light suppressed bursa weight, which agree with the present study.

Thymus gland :

It is in the thymus that T-lymhocytes gain their characteristics and capabilities. Circulating stem cells originating near the thoracic aorta enter the thymus in waves (Gobel *et al.*, 1996). The absolute and relative weights of thymus gland for birds reared under (8 L : 16 D) were lower than that for those reared under constant (23 L : 1 D) and intermittent light (1 L : 3 D) which were similar (Tables 2 and 3). The differences in this respect, were significant ($P \leq 0.05$) in absolute weights and they were not significant in relative weights. The strain (CA) had significantly ($P \leq 0.05$) greater absolute and ($P \leq 0.01$) relative weights of thymus gland, while, strain (RA) was the lowest. The interactions between light regimens and strains were not significant. In this respect, Vriend *et al.* (1975) studied two light regimens (24 L : 0 D and 14 L : 10 D) and they found that the thymus gland weighed smaller in chicks under constant light (24 L : 0 D) than that in those under (14 L : 10 D).

Spleen :

Antigens enter the spleen via the splenic artery, where inside, dendritic cells collect them and an immune reaction begins (Kuby, 1994). The chicks raised under constant light had significantly lower absolute ($P \leq 0.05$) and relative ($P \leq 0.01$) spleen weight than other lighting regimens. However, the

Table (2) : Effect of photoperiod regimens on absolute organs weights (g), hematocrit value and total WBC count of different broiler strains ($\bar{X} \pm$ S.E).

Item	Photoperiod regimens	Strains					significance
		Cobb X Cobb (CC)	Cobb X Arbor Acre (CA)	Ross X Arbor Acre (RA)	Avian Farms X Avian Farms (AF)	Overall average	
Bursa of fabricius (g)	23L : 1D	1.11 ± 0.13	1.44 ± 0.04	1.27 ± 0.11	1.11 ± 0.06	1.23^{B} ± 0.05	
	1L : 3D	1.37 ± 0.18	1.26 ± 0.13	1.18 ± 0.07	1.49 ± 0.14	1.33^{B} ± 0.07	P ≤ 0.01
	8L : 16D	2.04 ± 0.18	1.59 ± 0.19	2.35 ± 0.22	2.79 ± 0.40	2.19^{A} ± 0.16	
Overall overage		1.508 ± 0.14	1.428 ± 0.08	1.601 ± 0.18	1.793 ± 0.25	1.582 ± 0.09	P ≤ 0.05
Thymus gland (g)	23L : 1D	15.67 ± 2.06	17.36 ± 1.99	13.09 ± 0.79	15.06 ± 2.14	15.29^{A} ± 0.91	
	1L : 3D	18.39 ± 1.84	18.02 ± 2.32	10.06 ± 1.51	16.84 ± 2.50	15.83^{A} ± 1.28	P ≤ 0.05
	8L : 16D	10.47 ± 2.14	14.31 ± 0.87	11.46 ± 0.98	12.25 ± 0.99	12.12^{B} ± 0.70	
Overall overage		14.85^{ab} ± 1.45	16.56^{a} ± 1.08	11.54^{b} ± 0.70	14.72^{a} ± 1.18	14.42 ± 0.61	P ≤ 0.05
Spleen (g)	23L : 1D	2.64 ± 0.12	3.38 ± 0.26	4.23 ± 0.35	2.80 ± 0.16	3.26^{B} ± 0.19	
	1L : 3D	3.89 ± 0.43	3.96 ± 0.43	4.84 ± 0.92	3.31 ± 0.22	4.00^{A} ± 0.29	P ≤ 0.05
	8L : 16D	3.79 ± 0.31	4.28 ± 0.41	4.370 ± 0.20	3.76 ± 0.32	4.051^{A} ± 0.16	
Overall overage		3.438^{b} ± 0.24	3.873^{ab} ± 0.23	4.482^{a} ± 0.31	3.288^{b} ± 0.17	3.770 ± 0.14	P ≤ 0.01
Liver (g)	23L : 1D	57.42 ± 5.82	59.72 ± 2.08	67.98 ± 7.35	63.40 ± 4.56	62.13^{B} ± 2.59	
	1L : 3D	66.35 ± 4.54	70.64 ± 2.50	74.45 ± 2.88	61.56 ± 1.88	68.25^{AB} ± 1.86	P ≤ 0.01
	8L : 16D	74.60 ± 4.11	61.69 ± 1.01	79.17 ± 7.28	77.08 ± 1.57	73.14^{A} ± 2.67	
Overall overage		66.12^{ab} ± 3.31	64.02^{b} ± 1.76	73.87^{a} ± 3.52	67.35^{ab} ± 2.73	67.84 ± 1.51	P ≤ 0.05
Heart (g)	23L : 1D	14.81 ± 1.69	14.08 ± 1.56	13.99 ± 1.36	14.73 ± 1.12	14.40^{A} ± 0.65	
	1L : 3D	13.91 ± 0.41	13.61 ± 1.06	14.11 ± 0.59	13.96 ± 0.62	13.90^{A} ± 0.32	P ≤ 0.01
	8L : 16D	12.59 ± 0.77	10.97 ± 0.59	11.99 ± 0.39	12.38 ± 0.69	11.98^{B} ± 0.32	
Overall overage		13.77 ± 0.64	12.89 ± 0.72	13.36 ± 0.55	13.69 ± 0.53	13.43 ± 0.30	N.S.
Hemato-crit %	23L : 1D	32.18 ± 0.79	32.35 ± 0.57	32.43 ± 0.45	32.05 ± 1.06	32.25^{A} ± 0.34	
	1L : 3D	30.08 ± 0.86	30.55 ± 0.49	29.01 ± 0.72	30.00 ± 0.68	29.93^{B} ± 0.34	P ≤ 0.01
	8L : 16D	28.95 ± 0.91	29.38 ± 1.00	30.60 ± 0.95	31.03 ± 1.52	29.99^{B} ± 0.55	
Overall overage		30.40 ± 0.60	30.76 ± 0.53	30.71 ± 0.56	31.03 ± 0.65	30.72 ± 0.29	N.S.
Total WBC ($x10^3/mm^3$)	23L : 1D	62..3 ± 6.3	55.3 ± 2.9	66.2 ± 5.1	48.3 ± 3.9	58.0^{C} ± 4.6	
	1L : 3D	67.8 ± 3.7	62.6 ± 4.1	78.8 ± 6.0	75.1 ± 7.1	72.1^{A} ± 5.2	P ≤ 0.01
	8L : 16D	57.4 ± 2.8	77.6 ± 4.9	72.2 ± 5.1	61.7 ± 2.1	67.2^{B} ± 3.9	
Overall overage		62.5^{b} ± 4.3	65.2^{b} ± 4.0	72.4^{a} ± 5.5	61.7^{b} ± 4.5	65.7 ± 4.6	P ≤ 0.01

a, b, ab, c. Values having different superscripts in the same row are significant at 0.05
A, B, C. Values having different superscripts in the same column are significant at 0.05
N.S. = Not significant.

Table (3) : Effect of photoperiod regimens on relative organs weights (g / 100 g B.w) of different broiler strains ($\bar{X}$ ± S.E).

Item	Photoperiod regimens	Strains					significance
		Cobb X Cobb (CC)	Cobb X Arbor Acre (CA)	Ross X Arbor Acre (RA)	Avian Farms X Avian Farms (AF)	Overall average	
Bursa of fabricius	23L : 1D	0.038 ± 0.005	0.052 ± 0.001	0.045 ± 0.005	0.037 ± 0.001	0.043^{B} ± 0.002	P ≤ 0.01
	1L : 3D	0.046 ± 0.006	0.045 ± 0.005	0.037 ± 0.001	0.051 ± 0.005	0.045^{B} ± 0.003	
	8L : 16D	0.077 ± 0.006	0.067 ± 0.008	0.088 ± 0.006	0.113 ± 0.013	0.086^{A} ± 0.006	
Overall overage		0.054^{b} ± 0.006	0.055^{b} ± 0.004	0.057^{b} ± 0.007	0.067^{a} ± 0.011	0.058 ± 0.004	P ≤ 0.05
Thymus gland	23L : 1D	0.545 ± 0.083	0.622 ± 0.066	0.467 ± 0.038	0.505 ± 0.074	0.535 ± 0.034	N.S.
	1L : 3D	0.615 ± 0.062	0.650 ± 0.094	0.324 ± 0.051	0.584 ± 0.087	0.543 ± 0.047	
	8L : 16D	0.402 ± 0.084	0.601 ± 0.038	0.433 ± 0.025	0.499 ± 0.025	0.484 ± 0.030	
Overall overage		0.521^{b} ± 0.048	0.624^{a} ± 0.037	0.408^{c} ± 0.028	0.529^{b} ± 0.037	0.521 ± 0.022	P ≤ 0.01
Spleen	23L : 1D	0.091 ± 0.003	0.122 ± 0.009	0.150 ± 0.012	0.094 ± 0.008	0.114^{C} ± 0.007	P ≤ 0.01
	1L : 3D	0.130 ± 0.015	0.142 ± 0.016	0.157 ± 0.033	0.114 ± 0.008	0.136^{B} ± 0.010	
	8L : 16D	0.145 ± 0.013	0.180 ± 0.018	0.167 ± 0.013	0.154 ± 0.015	0.162^{A} ± 0.007	
Overall overage		0.122^{b} ± 0.009	0.148^{a} ± 0.010	0.158^{a} ± 0.011	0.121^{b} ± 0.009	0.137 ± 0.005	P ≤ 0.01
Liver	23L : 1D	1.98 ± 0.16	2.16 ± 0.05	2.40 ± 0.20	2.12 ± 0.10	2.90^{A} ± 0.08	P ≤ 0.01
	1L : 3D	2.22 ± 0.15	2.54 ± 0.13	2.39 ± 0.12	1.87 ± 0.25	2.25^{B} ± 0.10	
	8L : 16D	2.84 ± 0.13	2.59 ± 0.03	3.00 ± 0.23	3.16 ± 0.12	2.16^{B} ± 0.07	
Overall overage		2.35 ± 0.13	2.43 ± 0.07	2.60 ± 0.12	2.38 ± 0.18	2.44 ± 0.07	N.S.
Heart	23L : 1D	0.51 ± 0.05	0.51 ± 0.06	0.49 ± 0.03	0.49 ± 0.03	0.50 ± 0.02	N.S.
	1L : 3D	0.47 ± 0.01	0.49 ± 0.04	0.46 ± 0.03	0.49 ± 0.02	0.47 ± 0.01	
	8L : 16D	0.48 ± 0.03	0.46 ± 0.02	0.46 ± 0.01	0.51 ± 0.03	0.48 ± 0.01	
Overall overage		0.48 ± 0.002	0.49 ± 0.02	0.47 ± 0.02	0.49 ± 0.01	0.48 ± 0.01	N.S.

a, b, c. Values having different superscripts in the same row are significant at 0.05 N.S. = Not significant.
A, B, C. Values having different superscripts in the same column are significant at 0.05

absolute spleen weight of chicks grown either under intermittent lighting or (8 L : 16 D) were quite similar, while, relative spleen weight was significantly ($P \leq 0.01$) higher in chicks subjected to 8 L : 16 D treatment (Tables 2 and 3). The differences among strains were significant ($P \leq 0.01$) in either absolute or relative weights of spleen. The strains (RA) and (CA) had greater, while strains (AF) and (CC) had lower absolute and relative spleen weight than other strains. The interactions between strains and light were not significant.

This result agrees with that obtained by Stanley *et al.* (1997) who reported that, the spleen weight was significantly affected by photostimulation. In this respect, Vriend *et al.* (1975) found a significant increase of spleen weight in chicks under constant light (24 L : 0 D) which disagree with the present study. It is reasonable to mention that the chicks in their experiment never exposed to dark during the experiment. On the other hand, the splenic weights were significantly higher in hamsters exposed to a short photoperiod as compared to hamsters exposed to a long photoperiod (Brainard *et al.*, 1985 and Vaughan *et al.*, 1987). Furthermore, another study showed that deer mice grown in short days exhibited a larger spleen size than deer mice maintained in long days (Demas and Nelson, 1996).

Liver :

The averages of absolute and relative weights of liver for chicks received (8 L : 16 D) were significantly ($P \leq 0.01$) greater than the (1 L : 3 D) and (23 L : 1 D) treatments followed by intermittent lighting, while, the constant light was the lowest (Tables 2 and 3). There were significant ($P \leq 0.05$) differences among broiler strains in absolute weight of liver however, the relative weights lacked significant. The strain (RA) was higher in both absolute and relative weights of liver while, strain (CA) was lower in absolute weight of liver. The interactions between light and strain were not significant in absolute weight of liver and significant ($P \leq 0.05$) in relative weight of liver.

The present results disagree with that reported by Stanley *et al.* (1997) who indicated that the relative weight of liver (g / 100 g Bw) was not affected by photostimulation. Furthermore, the liver weight either being absolute or relative to body weight did not differ between different regimens of photoperiod (Charles *et al.*, 1992). The differences between these results may be due to differences in photoperiod treatments utilized and / or type of birds used.

Heart :

The differences among light treatments were significant ($P \leq 0.01$) in absolute heart weight and not significant in relative heart weight. The constant light was higher, 8 L : 16 D was lower and intermittent light was intermediate in absolute weight of heart. The differences among strains and the interactions between light treatment and strain were not significant, in this concept (Tables 2 and 3). Stanley *et al.* (1997) reported that relative heart weight was not affected by photostimulation which is in agreement with the present study. Moreover, Charles *et al.* (1992) found that absolute and relative heart weight were unaffected by different photoperiod regimens.

Hematocrit values :

Broiler chicks raised under constant light (23 L : 1 D) had significantly ($P \leq 0.01$) higher hematocrit values than that of those received either intermittent light (1 L : 3 D) or (8 L : 16 D), which were similar. The differences among strains were not significant. The interaction between photoperiods and strains was not significant. The present result agree with that reported by Buys *et al.* (1998) who found that birds reared under intermittent lighting had lower hematocrit values than those reared under continuous lighting. Reasons of such alteration in hematocrit values are notclear. However, it may be due to an increase in erythropoiesis and / or decrease the degeneration of the erythrocytes under constant lighting.

Total WBC

The birds exposed to intermittent light (1 L : 3 D) have total WBC count significantly ($P \leq 0.01$) lower than other photoperiod treatments. An opposite trend was observed for constant lighting. The strain (RA) have total WBC higher ($P \leq 0.01$) than other strains. The interaction between photoperiod and strains was not significant. The present study suggest that the decreased total of WBC in birds under constant lighting (23 L : 1 D) may be due to decrease of melatonin under this photoperiod treatment.

From the present results, it appears that extending the dark period increases the daily synthesis and release of pineal melatonin (Gordon, 1997 and Pang and Ralph, 1975). Melatonin has been recognized to enhance cell-mediated immune response (Glick, 2000) and its serum levels are altered by photoperiod (Lynch, 1971) and may be greater in birds housed in an intermittent or short daylength than in birds given a 23 h photoperiod (Eberhard and Michaela, 2000).

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تأثير فترات مختلفة للإضاءة على أداء النمو وبعض الاستجابات الفسيولوجية لسلالات دجاج لحم مختلفة

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الملخص العربي

أجريت هذه الدراسة بمزرعة بنسلفانيا لأبحاث الدواجن – قسم علوم الدواجن – ولاية بنسلفانيا – الولايات المتحدة الأمريكية .

وكان الهدف من الدراسة مقارنة أداء النمو لكتاكيت أربع سلالات لدجاج اللحم ربيت تحت ثلاث نظم مختلفة لفترات الاضاءة وهى إضاءة مستمرة (٢٣ ساعة إضاءة : ١ ساعة إظلام) وإضاءة متقطعة (١ ساعة إضاءة : ٣ ساعة اظلام) وإضاءة قصيرة (٨ ساعة إضاءة : ١٦ ساعة اظلام) حيث قسمت الطيور فى كل سلالة إلى ثلاثة مجاميع متساوية العدد لتشمل هذه النظم الثلاثة للاضاءة . وتم أخذ المقاييس أسبوعيا حتى عمر ٦ أسابيع (عمر التسويق) وتلخصت النتائج فى الآتى :

– كانت الطيور المرباه تحت نظام الاضاءة المستمرة (٢٣ ساعة اضاءة : ١ ساعة اظلام) أثقل معنويا فى وزن الجسم عن المعاملتين الآخرتين بينما كانت المعاملة (٨ ساعة اضاءة : ١٦ ساعة اظلام) أخف فى وزن الجسم عند كل الأعمار .

– كان النمو الأسبوعى فى الطيور التى عرضت للضوء المستمر (٢٣ ساعة اضاءة : ١ ساعة اظلام) أكثر معنويا من عمر ١ : ٤ أسبوع . وكذلك المعاملة (٨ ساعة اضاءة : ١٦ ساعة اظلام) عند عمر ٥ ، ٦ أسبوع .

– كان استهلاك الغذاء للطيور المعرضة للضوء المتقطع (١ ساعة إضاءة : ٣ ساعة اظلام) و (٨ ساعة إضاءة : ١٦ ساعة اظلام) أقل معنويا عن تلك المعرضة للضوء المستمر (٢٣ ساعة اضاءة : ١ ساعة إظلام) .

– كانت الكتاكيت المرباه تحت نظام (٨ ساعة إضاءة : ١٦ ساعة اظلام) أحسن معنويا فى كفاءة تحويل الغذاء (الغذاء / النمو) عن المعاملتين الآخرتين عند عمر ٢ ، ٣ ، ٥ ، ٦ أسبوع بينما كان الضوء المتقطع وسطا بين المعاملتين الآخرتين .

– كانت الاختلافات بين السلالات معنوية (باحتمال ١٠ر٠ ٪) فى كل من وزن الجسم والنمو واستهلاك الغذاء والكفاءة الغذائية .

– كان الوزن المطلق للقلب وغدة الثيموس أقل معنويا بينما كان وزن الكبد والطحال والبرسا أعلى معنويا فى الطيور المرباه تحت نظام (٨ ساعة إضاءة : ١٦ ساعة اظلام) بالمقارنة بالنظامين الآخرين .

– كان تأثير فترة الاضاءة على الوزن النسبى للكبد والطحال والبرسا وكذلك نسبة الهيماتوكريت والعدد الكلى لكرات الدم البيضاء معنويا بينما كان غير معنوى على الوزن النسبى للقلب وغدة الثيموس .

وكانت الاختلافات بين السلالات معنوية على وزن الكبد والطحال وغدة الثيموس والوزن النسبى للطحال

والبرسا وغدة الثيموس والعدد الكلى لكرات الدم البيضاء ، بينما كان غير معنوية على وزن الكبد والبرسا ونسبة الهيماتوكريت .

وخلص البحث إلى أن الضوء المستمر أعطى أوزان جسم للطيور أعلى وكفاءة غذائية أقل من المعاملتين الآخرتين والضوء المتقطع لم يكن له تأثير عكسى على وزن الجسم والنمو واستهلاك الغذاء والكفاءة الغذائية بعكس المعاملة (٨ ساعة إضاءة : ٦ ساعةاظلام) التى أدت إلى انخفاض كل من وزن الجسم واستهلاك الغذاء بالرغم من أنها أدت إلى تحسين الكفاءة الغذائية . كما أثرت السلالات معنويا على تلك هذه الصفات .

أثرت فترات الاضاءة معنويا على كل من أوزان الكبد والقلب والطحال والبرسا وغدة التيموس ونسبة الهيماتوكريت وعدد كرات الدم البيضاء . وكان تأثير السلالات معنويا على كل من وزن الكبد والطحال وغدة التيموس وعدد كرات الدم البيضاء .