EFFECT OF INTERACTION BETWEEN DIFFERENT LIGHTING PROGRAMS AND MELATONIN PROFILE CHANGES ON PRODUCTIVE CHARACTERISTICS IN BROILER CHICKENS

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Abstract

Studying the relationship between photoperiod and Melatonin hormone and its effects in regulating the immune response and affecting productivity is becoming increasingly important. The aim of the present study is to investigate the effects of different lighting programs in open side houses on Melatomin secretion and their effects on the productivity of broiler chickens.

This study was conducted during the period of March to April 2000. All chicks were exposed to continuous light during the first three days of age, and then, exposed to specific three lighting groups with three replicates per group. The first group (ContinuoUs lighting) served as a control and exposed to (23- hour light: 1 hour Dark). The second group (natural lighting) exposed to natural daylight approximately (11- hour light: 13 hour dark). The third group (Intermittent lighting) exposed to natural daylight and (1- hour light: 3 hour dark) during the night time. Birds raised on the continuous light consumed more feed, were heavier in weight during the first 2 wks, and had inferior feed conversion ratios than other groups. At marked age (6 wk) intermittent lighting group had significantly higher body weights and better feed conversion than both natural and continuous light groups. Birds raised on the natural light had the inferior body weight, feed consumption, while, feed conversion was similar to control. Intermittent and natural light was associated with reduced total mortality and mortality from Sudden Death Syndrome (SDS).

Electric used for lights with intermittent light group saved 82 % of that used with continuous light (control). The cost of broiler live weight with intermittent light group was less by 0.21 LE/ kg than continuous light (control).

INTRODUCTION

Light manipulation in the broiler industry represents very specific environmental factor. Most modern broiler operations use artificial light, and it has shown that the light may have a major impact on the performance of broiler chickens (Oilkowski and Classen, 1995). The influence of lighting program on productive and physiological

traits may be attributed to influence of daily light and dark period on melatonin hormone secretion.

Melatonin is a hormone that is secreted from the pineal gland. It regulates daily and seasonal physiological rhythms. It is well established that Melatonin biosynthesis and secretion in all vertebrates, are affected by environmental lig`ht. The enzymatic processes leading to Melatonin biosynthesis are suppressed by light and enhanced by darkness (Reiter, 1988). Also, Tom *et al.* (1999) reported that serum Melatonin levels begin to increase at 20 00 hr, reaching to peak early morning at 03 00 hr, thereafter, levels begin to decrease reaching to baseline day-light values at 08 00 hr .

Broiler chickens do not eat normally during darkness, as long as this period does not extend for more than about 12h. Therefore, it is assumed that feed intake and growth are maximal for broilers that are reared in (nearly) continuous illumination. However, several studies showed that alternative lighting schedule such as intermittent or increasing lighting schedules, improve body weight and feed conversion, reduce mortality and leg problems. (Buyse *et al.,* 1996). Jose Wong-Valle *et al.* (1993) reported that body weight gain between 4 and 7 weeks was significantly greater in broilers exposed to (1L: 3D) than those exposed to continuous lighting (23L: 1D). Body weight at 7 weeks was 2.658 and 2.696 kg/bird in continuous and intermittent light respectively. Rozenboim *et al.* (1999) reported that broilers reared under 16L: 8D regime were heavier at 49 days of age than those exposed to continuous light 23L: 1D at 49 days of age. However Blair *et al.* (1993) found that, at 3 weeks of age birds reared in continuous lighting had significantly heavier body weight than increasing lighting programs; the effect disappeared by 6 weeks of age. Buyse *et al.* (1996) compared the effects of the intermittent lighting (IN) schedule (1hL: 3hD) and continuous CL (23L) light on the performance of floor-reared male and female broiler chickens. They stated that changing from continuous light CL to intermittent lighting IL on 7^{th} days of age depressed body weight of both sexes at 14 days of age. At 4 weeks of age, body weights of IL chickens were still lower than those under CL counterparts. During the period from 14 to 28 days, no significant main effects or interaction on body weight gains were discerned. on contrast, during the subsequent period, growth rates of females were lower than males. In addition, a significant interaction between light treatment and sex was observed. Growth rates of

IL males were significantly higher than those of their CL counterparts, whereas, no differences were found in growth rate of female under different lighting schedule.

Several researchers found that restricted light programs improved feed conversion. Apeldoorn *et al.* (1999) mentioned that, feed intake and gross energy intake at 41 days of age were not affected by lighting schedule, whereas feed conversion was improved, 1.79 for intermittent light (1hL: 3hD) versus1.89 for continuous ones. Shoukry *et al.* (1993) studied the direct effect of melatonin injection in male Japanese Quail (4mg/kg-body weight). He found that feed intake was decreased within 2 hours after injection.

Death of undiscernibly cause commonly known as "Sudden Death Syndrome (SDS)", has been recognized as a major cause of economic losses in broiler industry throughout the world. Accurate statistics are not available, but, globally, the losses may be total of hundreds of millions of dollars (Olkowski and Classen, 1995). Gardiner and Humt (1988) showed that SDS mortality rates reached their maximum when birds were between 21 to 27 days of age. Virtually, all surveys and experimental studies point out that the incidence of SDS is higher in male than female broiler chickens. Also, Bowes *et al.* (1989) recorded 4% mortality due to SDS in the male broilers versus 0.5% in female broilers. Blair *et al.* (1993), found that increasing lighting, programs, had significantly effect on total and SDS mortality of male broiler chickens. It was 4.8% and 3.5% for constant and increasing lighting program respectively during the first three weeks of age. Sturner and lynch (1990) found that Melatonin levels were lower in SDS death chickens than in those dying of other causes.

The previous researches showed that intermittent lighting scheduled reduced electricity cost. Zakaria (1985) exposed commercial broiler chicks to continuous light through the first three weeks of age and then divided the chicks into three treatments, continuously light (1), 9L: 3D (2) and 8L: 4D (3). He indicated that the intermittent (2,3) saved up to 33% of the calculate electrical lighting cost used during the 3 to 7 week period.

Very few studies have been done to examine the effect of lighting programs in open side houses on broiler performance. The current study was conducted to evaluate the influence of lighting programs and related melatonin profile changes in open side house on broiler productivity, e.g. body weight , feed consumption ,feed conversion , mortality rate and the economic impact.

MATERIALS AND METHODS

Birds and experimental design.

This study was conducted during the period of March to April 2000. On day of hatch, the chicks were sexed using vent method, and 720 males and females (360 from each sex) commercial broiler chicks (Arbor Acrs). All chicks were wing-banded, weighed to the nearest gram and randomly divided into three different lighting groups. With three replicate pens of each sex, all chicks were exposed to continuos lighting during the first three days of age, and then, exposed to different lighting programs (Fig. 1). The first group served as a control and exposed to 23 hours light: 1 hour dark (continuous lighting), The second group exposed to natural daylight (approximately 13 hour light: 11 hour dark) (natural lighting), whereas, the third group exposed to natural daylight and 1- hour light: 3 hour dark during the night (intermittent lighting).

The chicks were fed commercial broiler feeds. Feed and water were provided *ad libitum* throughout the experimental period. The brooding temperature was set initially at 34 °C and reduced gradually with 3 °C each week until reach to 24 °C nearly at the fourth week of age.

Measurements

Serum Melatonin assays

At 35 days of age, blood samples were collected at different periods of light and dark (Fig.2) for Melatonin assay. Melatonin was assayed by ELISA test using Commercial Kits manufactured by IBL, Hamburg, CAT.NO RE. 54021 in the Laboratory of Biochemistry Department, Animal Health Institute, Agricultural Research Center .

Productive traits measurements

Body weight, feed consumption, feed conversion, total mortality, SDS mortality and economic efficiency (cost of Kg. meat as live weight) were recorded and calculated biweekly.

Statistical analysis

Data was statistically analyzed by the use of general linear models procedure as described by statistical analysis system (SAS) sas /stat users guide (1988). Data was analyzed as two-way analysis.

RESULTS AND DISCUSSION

Effect of lighting programs on melatonin concentration

The data of serum Melatonin concentrations are shown in Fig .3. Serum Melatonin concentration of the first sample taken during photo-phase showed that no significant differences were observed between lighting groups. The results of second and fourth samples showed that intermittent and natural lighting group had similar Melatonin levels with significantly higher level than that of continuous lighting group .

Melatonin concentration of the third sample showed that natural lighting group had the significantly superior level. On the other hand, continuous lighting group had the significantly inferior level, whereas, intermittent lighting group occupied intermediate with significant differences than other two groups,

The present study showed that serum Melatonin levels were influenced by dark-light cycle and increased by about 3.5 fold during Scot-phase as compared to the level during photo-phase. This finding is in agreement with that of Larry *et al.* (1987), who indicated that the average plasma Melatonin concentration during Scot-phase (320 pg./ml) was 3.2 fold higher than average Melatonin level during photo phase. The higher concentration in dark may refer to the enzymatic processes leading to Melatonin biosynthesis that is suppressed by light, and enhanced by darkness (Reiter, 1988).

Effect of lighting programs on broiler productivity

Body Weight

The data of live body weight is shown in figures 4,5,6. Regardless the influence of sex on body weight, the present results indicated that lighting programs had no effect on live body weight during the first 2 weeks of age. The effect was observed thereafter at fourth week of age, the intermittent lighting group had the significantly superior body weight and followed in descending order by continuous and natural lighting groups, respectively. At 6 weeks of age the superiority was 52-g/bird and 177g/ bird than continuous and natural lighting groups, respectively. These findings are in agreement with those reported by Jose Wong-Valle *et al.* (1993) and Rozenboim *et al.*(1999). The birds subjected to an intermittent lighting were significantly heavier than those exposed to continuous lighting. The superiority of body weight under intermittent lighting may be due to the improvement in feed conversion, which in turn, increased final body weight. The better growth rate obtained of broilers maintained under intermittent lighting might be due to less

energy used by the birds. Recent findings indicated an involvement of Melatonin secretion during dark hours in more basic physiological processes, including growth, development and aging. Growth promoting effects of Melatonin have been suggested by several authors. but possible mechanisms of action are not understood. There are levels at which Melatonin may modulate body growth in poultry species, such as modulation of intermediary metabolism in cells, interaction with growth and transcriptional factors and modulation of energy metabolism and decreasing of physical activity by interaction with hormones involved in growth control (Zeman *et al.,* 1999). There is evidence indicating that Melatonin may modulate central neural pathways involved in the control of growth hormone synthesis at the hypothalamic level. In mature pigeons, I.V. administration of Melatonin stimulates growth hormone secretion (John *et al.,* 1990)

Feed Consumption

The data of feed consumption is shown in figures 7,8,9. The current results showed that males and females of each lighting group consumed a similar amount of feed throughout the first two weeks of age, while, thereafter the males consumed significantly more feed than females within each lighting group. In respect of influence of lighting programs on feed consumption, the current results showed that continuous lighting group consumed significantly more feed than the other two groups throughout the experimental period. This superiority was 30.8, 73.2 and 164.9 (g feed/bird) over intermittent lighting group, whereas it was 31.1, 83.9 and 260.5 (g feed / bird) over natural lighting group during the period of (0-2 wk), (0-4 wk) and (0-6 wk), respectively .

These results were similar to those reported by Buyse *et al.* (1996), that feed intake of broiler chicks during the period of 7 to 41 days of age was 3036 and 2792 g/bird for continuous and intermittent lighting (3hD: 1hL) group, respectively. However Apeldoorn *et al.* (1999) reported that at 41 day of age feed intake and gross energy intake were not affected by intermittent lighting programs.

Feed Conversion

The data of feed consumption is shown in Figures 10,11,12. The present results showed that, within each lighting group, no significant differences were observed between males and females throughout the first two weeks of age. During the first four weeks of age, the only significant differences between males and females were observed in intermittent lighting group. However, during the entire

period of experiment (0-6wks), feed conversion of males was significantly better than females within each group. This finding is in agreement with that reported by Buyes *et al.* (1996), that feed conversion of males is better than females.

Regarding the effect of lighting programs on feed conversion, the present study showed that till four and six weeks of age, continuous lighting group had the same feed conversion as natural lighting group, whereas it has significantly the worst as compared with intermittent lighting group.

The present result indicates that intermittent lighting group had better feed conversion than other groups throughout the experimental period. Intermittent lighting group was better by 0.16 than continuous lighting group during (0-6wk). This finding is in agreement with that of Apeldoorn *et al.* (1999), that chicks reared under intermittent lighting treatment had significantly better feed conversion than those under continuous lighting treatment.

The improvement in feed conversion under intermittent lighting group may be due to that physical activity is very low during darkness and energy expenditure for activity is considerable. The reduction in physical activity in intermittent lighting group may be attributed to enhanced production efficiency and reduced fat deposition, especially in males.

Mortality Rate

The data of mortality rate is shown in Figures 13,14,15,16. Regardless of the lighting groups, mortality rate of female due to SDS had not been remarked throughout the experimental period. On the other hand, the SDS mortality rate of males attained to 0.8, 0.83 and 2.5 % when exposed to intermittent, natural or continuous lighting groups, respectively. This finding is in agreement with the report of Bowes *et al.* (1989) who recorded 4% mortality due to SDS in the male broilers versus 0.5% in female broilers. The higher percent of SDS mortality in males than females may be referred to the higher growth rate of males than females during the first 3 weeks of age, which lead to heart and lung failure in males.

Regardless of the sex differences, the relative mortality due to SDS was 0.83%, 0.83 and 1.67 for intermittent, natural and continuous groups, respectively, during the first 28th days of age and was 0.83, 0.83 and 2.5% during the entire experimental period, respectively. These results are in agreement with the report of Blair *et al.,* (1993) who indicated that mortality due to SDS was less in intermittent or increasing lighting programs than continuous light program .

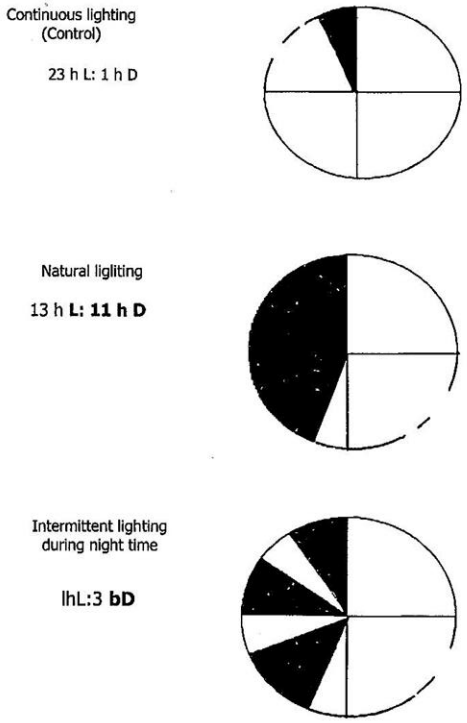
The present results showed that the total mortality percentage was 3.33, 5.83 and 6.83 % for intermittent, natural and control groups, respectively, during the

entire experimental period. This finding was similar to that of Rozenboim *et al.* (1999). The reduction in mortality rate may be referred to the slower growth rate during early life which keeps heart and lung in good volume and condition and provides the need of oxygen, so, prevents right ventricular failure .Also, it may be referred to Melatonin that may act, not only as a hormone, but, to that Melatonin is very effective scavenger of free radicals. Higher rate of free radicals formation may occur in broiler chickens as a consequence of high intensity of metabolism hypoxia , local inflammatory reactions , or toxic insults . Free radical may play significant role in the etiology of metabolic disease, like ascites or sudden death syndrome (SDS). Addition of Melatonin to the diet of broiler chicken tends to decrease the incidence of SDS. A positive effect of Melatonin is further supported by the finding that incidence of SDS increases under high intensity of light, has an inhibitory effect on Melatonin production (Zeman *et al.,* 1999). With reference to economical losses caused by metabolic disease in poultry industry, a possible beneficial effect of Melatonin deserves further research.

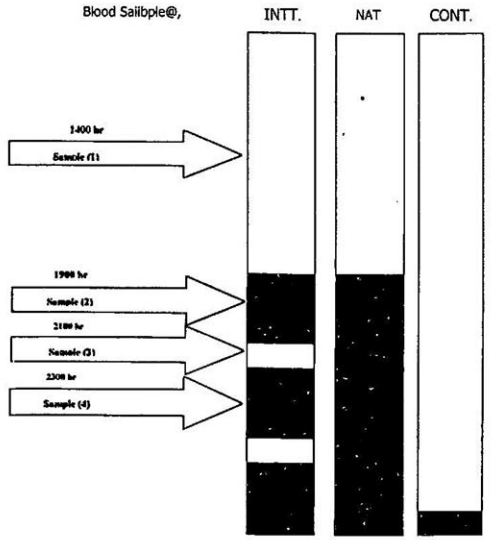
Economic efficiency

The data of economic efficiency is shown in Fig. 17. Current results indicated that intermittent lighting saved up to 80% of the calculated electricity used throughout experimental period as compared to continuous lighting. This finding is in agreement with that reported by Zakaria (1985) that intermittent lighting saved up to 33% of the calculated electricity used. The cost of broiler live body weight with intermittent light group was less by 0.21 LE/ kg than continuous light (control).

It is worth-mentioning that, although the cost of electricity is cheap in general (one kilowatt costs only LE 0.10), the way applied for rearing purposes has great impact on improving the efficiency of production resulting in less cost per unit. It can then be concluded that the intermittent program is the most economically efficient program among the three lighting programs.



Figffe (1) Lighfing Groups



IN'TT. Is intermittent lighting group NAT @ Is Natural lighting group
CONT. Is Continuous lighting group

Fig .2 Time of blood samples collection

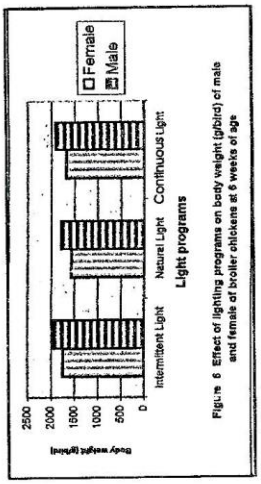


Figure 6 Effect of lighting programs on body weight (g/bird) of male and female of broiler chickens at 6 weeks of age

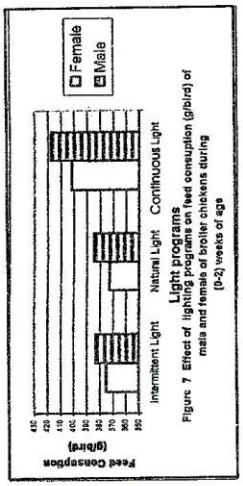


Figure 7 Effect of lighting programs on feed consuption (g/bird) of male and female of broiler chickens during (0-2) weeks of age

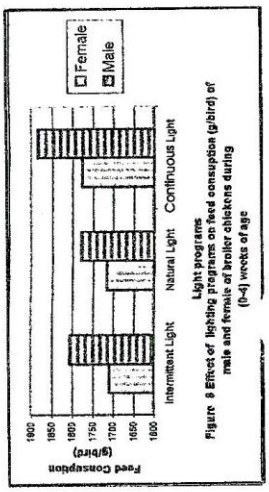


Figure 8 Effect of lighting programs on feed consuption (g/bird) of male and female of broiler chickens during (0-4) weeks of age

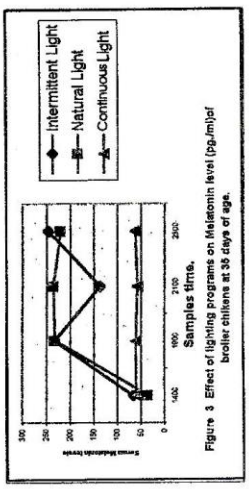


Figure 3 Effect of lighting programs on Melatonin level (pg/ml)of broiler chikens at 35 days of age.

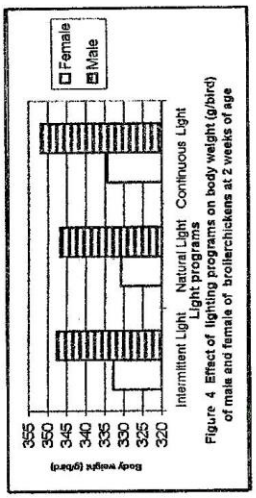


Figure 4 Effect of lighting programs on body weight (g/bird) of male and female of broilerchickens at 2 weeks of age

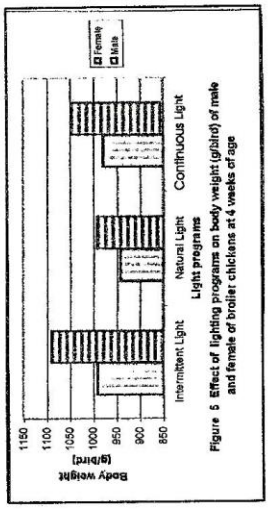


Figure 5 Effect of lighting programs on body weight (g/bird) of male and female of broiler chickens at 4 weeks of age

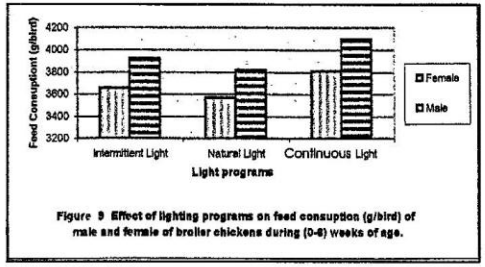


Figure 9 Effect of lighting programs on feed consuption (g/bird) of male and female of broiler chickens during (0-6) weeks of age.

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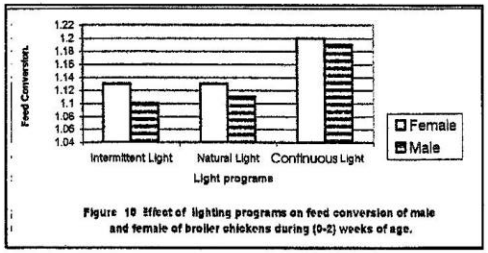

Figure 10 Effect of lighting programs on feed conversion of male and female of broiler chickens during (0-2) weeks of age.

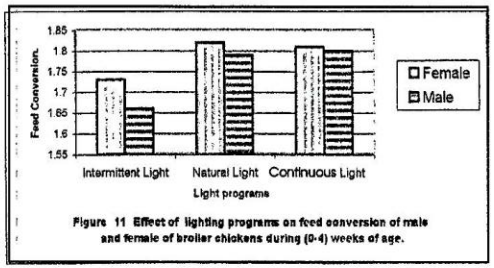

Figure 11 Effect of lighting programs on feed conversion of male and female of broiler chickens during (0-4) weeks of age.

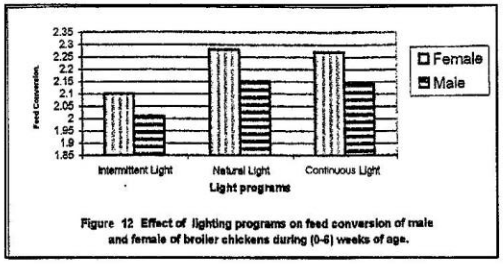

Figure 12 Effect of lighting programs on feed conversion of male and female of broiler chickens during (0-6) weeks of age.

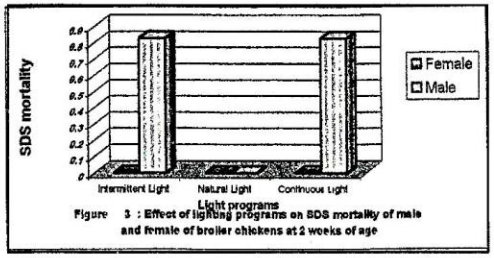

Figure 13 : Effect of lighting programs on SDS mortality of male and female of broiler chickens at 2 weeks of age

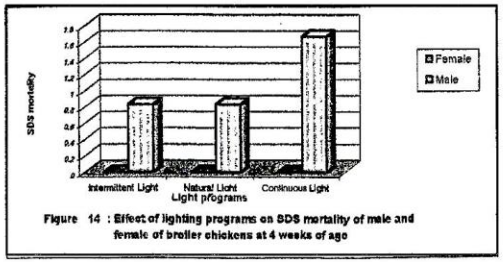

Figure 14 : Effect of lighting programs on SDS mortality of male and female of broiler chickens at 4 weeks of age

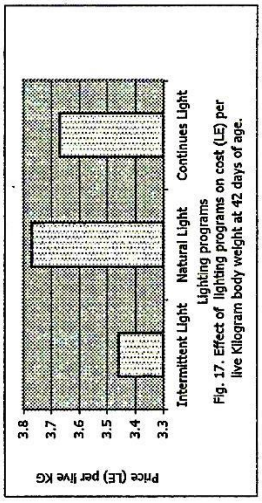

Fig. 17. Effect of lighting programs on cost (LE) per live Kilogram body weight at 42 days of age.

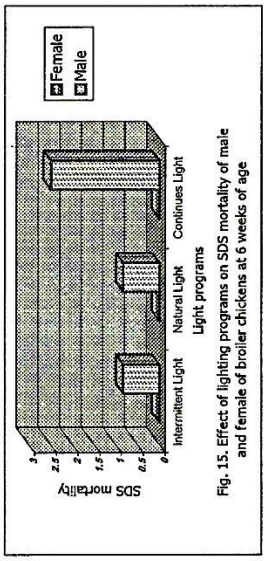

Fig. 15. Effect of lighting programs on SDS mortality of male and female of broiler chickens at 6 weeks of age

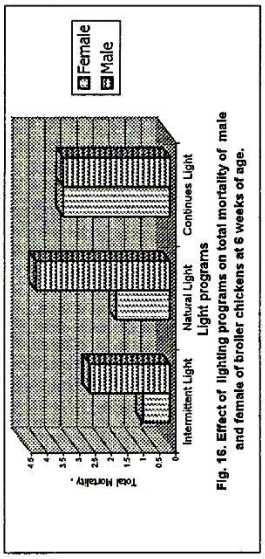

Fig. 16. Effect of lighting programs on total mortality of male and female of broiler chickens at 6 weeks of age.

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تأثير التداخل بين نظم الإضاءة المختلفة والتغيرات الحادثة لهرمون الميلاتونين على الخصائص الإنتاجية في دجاج اللحم

نجيب الهلالي جوهر ١ ، عبد الرحمن محمد عطا ١
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٢ *معهد بحوث الإنتاج الحيواني– مركز البحوث الزراعية وزارة الزراعة – الدقى – جيزة*

أجريت هذه الدراسة خلال الفترة من مارس إلى أبريل عام ٢٠٠٠ بأحد مزارع دجاج التسمين التجارية (نظام مفتوح) الغرض من هذا العمل هو دراسة تأثير ثلاثة برامج الإضاءة المختلفة على الأداء الإنتاجي لدجاج اللحم متضمنا الدور الهام لهرمون الميلاتونين وكذا التقييم الاقتصادي للبرامج الثلاثة.

استخدم لذلك عدد ٧٢٠ كتكوت تسمين من سلاله اربر ايكرزعمر يوم ٣٦٠ من الذكور و٣٦٠ من الإناث وتم ترقيمها ووزنها ثم تم تقسيمها عشوائيا إلى ثلاث مجاميع أضاءه مختلفة . المجموعة الأول وهى معاملة الإضاءة المستمرة (كنترول) وفيها يتم تعريض الطيور إلى إضاءة طبيعية نهارا وإضاءة مستمرة صناعيا ليلا٠ بمقدار٢٣ ساعة إضاءه وساعة واحده إظلام – المعاملة الثانية وهى معاملة الإضاءة الطبيعية وفيها يتم تعريض الطيور إلى إضاءة طبيعية نهارا وكذلك إظلام طبيعي كامل ليلا – المعاملة الثالثة وهى معاملة الإضاءة المتقطعة وفيها يتم تعريض الطيور إلى إضاءة طبيعية نهارا وإضاءة متقطعة ليلا بمعدل ١ ساعة إضاءة إلى ٣ ساعات ظلام. أوضحت نتائج هذه الدراسة ارتفاع تركيز هرمون الميلاتونين أثناء ساعات الإظلام و انخفاض التركيز أثناء ساعات الأضاءه و بالنسبة للصفات الاقتصادية فإن برنامج الأضاءه المتقطعة المستخدم طريقه مفيدة لإظهار القوه الوراثية لدجاج التسمين التجاري . حيث ارتفع وزن الجسم و تحسن معدل التحويل الغذائي وانخفض معدل النفوق مقارنه بمعامله الإضاءة المستمرة (الكنترول) مما أدي إلى تحسن الكفاءة الاقتصاديه.