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EFFECT OF DIETARY ENERGY LEVELS AND LIGHT SOURCES ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND ECONOMICAL EVALUATION OF BROILERS

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ABSTARCT: An experiment was conducted to determine and compare the differences in productive performance, carcass traits and economical evaluation of broiler chicks fed three different dietary energy levels [low (2912 & 3032), medium (3006 & 3126) and high (3100 & 3220)], during starter and grower phases, respectively, under two housing light sources (Fluorescent and LED). 180 unsexed one day-old Hubbard broiler chicks were distributed equally in a completely randomized design with 3 ME (E) levels x 2 light (L) sources, resulting in 6 treatments with 3 replicates of 10 chicks each.

The results indicated that:

- Productive performance of broiler chicks: live body weight (LBW); daily weight gain (DWG); performance index (PI) and production efficiency factor (PEF) were not affected significantly by (E) levels, (L) sources and interaction (L*E) at whole experimental period.
- Daily feed intake (DFI) and feed conversion ratio (FCR) recorded a significant response due to interaction between (E), (L) and (L*E).
- Carcass traits indicated that (E) at all levels, (L) sources and interaction (L*E) had no significant effects.
- Blood plasma cholesterol and triglycerides were not affected by interaction between (E) and (L), (L*E).
- Economic evaluation showed that, relative economic efficiency (REE) was improved for broiler chicks only by feeding high energy level (Fluorescent - light source) or low energy level (LED - light source).

It could be concluded that, using low energy diets in rearing sheds with (LED) light source, enhanced productive economic efficiency of Hubbard broiler chicks.

Key words: Broiler performance - Light source - Energy level - Economic efficiency.

INTRODUCTION

The poultry industry has historically used a narrow range of raw materials for diet formulation and modern broiler meat production is now highly competitive and small differences in the efficiency of utilization of the supplied diet can be economically significant (Pirgozliev and Rose, 1999).

Corn or other high starch feedstuffs provide most of the available energy (i.e.: metabolizable energy) in many practical broiler feeds and the cost of supplying (ME) accounts for about half the cost of a broiler chicken feed (Sondakh et al., 1978; Williams, 1997). However, energy level in broiler diets is considered to be the most important nutrient required from the stand point of total cost and quality of broiler diets. Hidalgo et al. (2004) and Kamran et al. (2008) demonstrated that reducing dietary (ME) effect on growth performance and weight gain were linearly decreased, whereas feed intake and feed conversion ratio were increased linearly.

Also, Selim et al. (2016) reported that the reduction in (ME) of broiler diets by 150 kcal/kg led to significant reduction of final body weight, while the reduction in ME by 100 kcal/kg led to significant reduction of abdominal fat % and values of feed intake, feed conversion ratio, breast meat yield % thigh % and drum stick % of broiler meat were increased significantly compared with strain recommendation of (ME).

However, El-Faham et al. (2015) reported that live body weight,feed intake,feed conversion ratio and carcass traits were not affected by the interaction between three (ME) levels and two housing system (floor pens and cages).

On the other hand, during the last decade, there has been a major increase in environmentally controlled broiler farms which require continuous electricity supply to operate their automatic feeding, drinking, environmental control systems and lighting. Therefore, economical energy solutions are required for broiler farmers to be competitive in local and international markets (Khokhar et al., 2015).

The most common light sources in poultry farmers are incandescent and fluorescent lamps. However, sodium vapor lamps are being widely used and they reported an economical light source to the poultry industry (Gomes and Jose, 2016). Fluorescent lamps produce more light per watt when compared to intensity over time. Sodium vapor lamps have a higher initial cost, but lower maintenance and longer service life (Mendes et al., 2010).

Furthermore, seven-day male broiler chickens presented better feed conversion under LED lamps (light-emitting diodes) than males of the same age under compact fluorescent lamps (Mendes et al., 2013). Hence, the use of LED lamps in poultry farmers is apparently, advantageous because of its energy efficiency and long life, compared to the conventional light sources (Parvin et al., 2014).

In spite of there are a lot of researchers on the influences of different dietary levels on chicken performance. However, the results works are contradictory. Therefore, the present work was undertaken to evaluate and compare the differences in productive and economic efficiency of broiler chicks fed different dietary energy levels under two light sources (LED and Fluorescent) lamps.

MATERIALS AND METHODS

Thisstudy was conducted at Agricultural Experiments and Research Station at Shalakan, Poultry Production Experimental Unit, Faculty of Agriculture, Ain Shams University.

Experimental design:A total number of 180 one-day-old Hubbard broiler chicks were randomly allocated in 2 x 3 factorial design in 6 treatments, 3 replicates per treatment and 10 chicks/replicate. The examined factors were three levels of metabolizable energy standard recommendation (SR), 100 and 200 kcal/kg diets higher than (SR) for each feeding phase (starter and grower), and two light sources (fluorescent and light - emitting diodes, LED) lamps.

Experimental diets: Chicks fed on diets based on corn-soybean meal during starting (0-3 weeks) and growing (4-5 weeks) periods as described in Tables (1 and 2). Standard diets were formulated to be 2912 kcal/kg with 23% CP and 3032 kcal/kg with 21% CP. during starting and growing periods, respectively. Birds were fed ad-libitum diets and had access to water.

Lighting source: Two light sources were used; the first source (fluorescent lamp 40 watts) and the second source (LED lamp 18 watts). The light intensity was adjusted to be approximately 40.0 LUX at the center of upper surface of floor and continuous lighting was provided throughout the experiment. Interior light intensity was weekly recorded by using digital illuminometer throughout the experimental period. Chicks of all experimental treatments were kept under similar hygienic and vaccinated against common diseases. Floor brooders with gas heaters were used for rearing chicks in two separate rooms. The performance parameters included body weight and feed intake which were determined at the end of starter and grower periods and taken daily body weight gain (DWG), daily feed intake (DFI), feed conversion ratio (FCR), performance index (PI) and production efficiency factor (PEF) were calculated.

Slaughtering and carcass characteristics: At the end of the experiment (5 weeks of age), 3 birds of each experimental treatment, around the average live body weight of each treatment, were slaughtered and eviscerated, then carcass weight, abdominal fat weight, giblets (liver, gizzard and heart) weight, ready-to-cook weight as percentages of live body weight were recorded.

Blood plasma parameters: Individual blood samples were collected in dry clean centrifuge tubes from the slaughtered birds and plasma was separated by centrifugation at 3000 (r.p.m.) for 15 minutes and assigned for subsequent determination. Plasma samples were stored at (-20°C) in a deep freezer until the time of biochemical determinations. Values of plasma total cholesterol and triglycerides were estimated by using commercial diagnosing kits (Produced by bio-diagnostics company, Egypt).

Economic efficiency: The economical evaluation and production cost analysis, were carried out for all treatments in attempt to investigate the effect of varying dietary metabolizable energy level and/ or light source on production costs.

Statistical procedures: The collected data were subjected to two way analysis of variance to detect the effects of light source (L) and metabolizable energy level (E) and their interactions(L*E) using the general liner model (GLM) procedure of SAS (SAS, 2001) according to the following model:

$Y_{ijk} = \mu + L_i + E_j + (L*E)_{ij} + \varepsilon_{ijk}$

Where:

Y_{ijk} = trait measured

μ = overall mean

L_i = light source, i = (1, 2)

E_j = metabolizable energy level, j = (1, 2, 3)

$(L*E)_{ij}$ = interaction between light source and metabolizable energy level.

ε_{ijk} = experimental error.

In addition, data of all experimental treatments were subjected to detect differences between all treatments and Duncan's multiple range test (Duncan, 1955) was used to separate means when separation was relevant. Statistical significance was accepted at probability level of ($p \leq 0.05$).

RESULTS AND DISCUSSION

Productive performance: Results of live body weight (LBW) and daily weight gain (DWG) as affected by different levels of dietary metabolizable energy and light sources (Fluorescent and LED) throughout the entire experimental periods are presented in Table (3). The obtained data showed that there were significant differences in LBW and DWG values among treatments during starting period (0-3 weeks). Broiler chicks fed low energy diet reflected the highest LBW and DWG compared with other treatments (medium or high, ME). The corresponding figures were 674.95 g versus (636.25 or 623.57 g) for LBW and 29.92 g versus (28.09 or 27.44 g) for DWG with significant differences between treatments. In the same order, Overall, Fluorescent (light source) significantly improved LBW and DWG by about 8% over that of the LED (light source) with significant differences between the two treatments. However, during the growing period (4-5 weeks), chicks reared under LED as light source were significantly higher in DWG than Fluorescent (light source) and the corresponding figures were 77.22 versus 71.43 g with significant differences between the two treatments. In the same order during whole experimental period (0-5 weeks), responses of chicks fed diets containing different levels of (ME) showed that chicks fed diet containing low level of (ME) supported that highest LBW and DWG that those fed the two other higher levels (medium and high). The corresponding figures were 1714.71 g versus (1673.71 and 1671.59 g), respectively for LBW and 47.66 g versus (46.50 and 46.40 g), respectively for DWG without significant differences between treatments. Sources of light showed the same trend since the higher LBW and DWG were detected for the chicks reared under (LED) compared with Fluorescent, without any significant differences.

The results confirm those observed by Zaman et al. (2008) in which they concluded that increasing dietary ME significantly increased the body weight gain. Moreover, El-Faham et al. (2016), stated that body weight and body weight gain were linearly decreased, whereas feed intake and feed conversion ratio were increased as dietary energy with or without constant ME: CP ratio decreased during different experimental periods.

Daily feed intake (DFI) and feed conversion ratio (FCR) data presented in Table (4), indicted that daily feed intake per chick (gram/chick/day) was significantly increased by feeding low energy diet compared with those fed other treatments (medium or high, ME). The increase in DFI was more pronounced during starting period (0-3 weeks), the corresponding figures were 39.11 versus 38.27 and 37.06 (g/ch/d), with significant differences between treatments, while they were 138.43 versus (138.14 and 133.39 g/ch/d), without any significant differences. On the same order, the lowest DFI was detected for the chicks fed diets with high levels of ME during hull experimental period (0-5 weeks) compared with those fed low or medium ME diets. The corresponding figures were 75.60 versus (78.84 and 78.22 g/ch/d) with significant differences between treatments.

Increasing daily feed consumption (g/ch/d) could be related to the fact that broiler chicks consume more feed to meet energy requirement. Moreover genetically, broiler chicks require more dietary energy to maximize growth during short rearing periods. According to Scott et al. (1982), Leeson and Summers (1991), Al-Homidan (2003) and Hermes and Al-Homidan (2004) birds have the ability to meet their energy requirements to certain extent by increasing feed consumption.

Feed conversion ratio (FCR) showed the same trend, since chicks fed high ME diets were more efficient in converting their food into body weight gain compared with those fed low or medium ME diets. The corresponding figures were 1.63 versus (1.65 and 1.68) respectively, with significant differences between treatments.

The best FCR was detected for the chicks fed low ME diet during starting period (1.30), while during growing (1.78) and whole experiment period (1.63) found in chicks fed higher level ME diet, which could be due to the lowest DFI and DWG (Table 4). Some researchers have found that reducing dietary ME effect on growth performance and weight gain were linearly decreased, whereas feed intake and feed conversion ratio were increased linearly (Greenwood et al., 2002; Hidalgo et al., 2004; Kamran et al., 2008; Zaman et al., 2008). However, El-Faham et al. (2015) reported that live body weight, daily weight gain, feed intake and feed conversion ratio were not affected by the interaction between three energy levels and two housing systems.

It was obvious from Table (4) that there were significant effects of either Fluorescent or LED as light source on feed consumption and feed conversion during starter, grower and hull experimental periods. In which chicks reared under Fluorescent (light source) during the whole experimental period (0-5 weeks) led chicks to consume significantly less feed than LED as light source being 76.37 versus 78.73 (g/ch/d). Besides, the differences between the two treatments were significant. In the same order, the figures of FCR indicated insignificant differences between birds reared under different light sources (Fluorescent and LED). The best FCR was detected for the chicks reared under Fluorescent (1.64) compared to LED (1.66), without any significant differences.

Mendes et al. (2013) concluded that broiler exposed to illumination by LED lamps showed better performance compared to birds exposed to illumination by fluorescent lamps. The concept and application of lighting programs for broilers have developed over time, but, in the actual scenario, it is necessary to investigate not only their effects on performance, but also their effects on the health and welfare of birds.

Lewis and Morris (1998) concluded that there was no evidence that fluorescent or high pressure sodium lighting, irrespective of intensity or spectral distribution, has any consistent detrimental effect on growth, feed utilization, reproductive performance, mortality, behavior or live bird quality in either domestic flower turkeys, nor in the egg production of geese.

Buyse et al. (1996) reported that whilst fluorescent light does not affect broiler performance adversely, its lower use of electricity compared with incandescent lighting does reduce input costs.

Based on field traits, Scheideler (1990) noticed no differences in broiler performance when reared under incandescent or fluorescent light, but the later light source significantly reduced electricity costs.

It can be concluded that the impact of the replacement of incandescent light bulbs by fluorescent light well not affect broiler performance and will result in significant electrical energy savings (Buyse et al., 1996).

Performance index (PI) and production efficiency factor (PEF): The results in Table (5) showed the relationship between different treatment (dietary energy levels and light sources) and PI or PEF. The response showed insignificant differences in PI and PEF during experimental period (0-5 weeks). Moreover, PI and PEF values were insignificantly decreased by increasing ME levels in diets during experimental period. Values of PI or PEF ranged between (99.52 and 103.71) or (284.35 and 296.33) respectively and boiler chicks fed low dietary energy level gave the highest figure while, chicks fed medium level of dietary energy had the lowest figures and differences among treatments were insignificant. In the same order, LED light source reflected the highest figures for (PI or PEF) compared with Fluorescent and the corresponding figures being (102.45 versus 101.47) or (292.73 versus 289.92), respectively and differences between treatments were insignificant. These results are in agreement with those reported by Kout El-Kloub et al. (2010) in Domyati duckling and El-Faham et al. (2015) in broiler chicks they reports that PI values were insignificantly differences due to varying dietary metabolizable energy during experimental period.

Carcass traits: Slaughter traits are presented in Table (6) shows the effect of different levels of dietary energy, light sources and interactions on carcass traits at the end of the trial (5 weeks of age). Experimental treatments with energy levels or light sources and their interactions had no significant effects on studied parameters. The corresponding values for dressing percentages ranged between (68.44 and 68.45%) for light sources and (67.88 and 68.95%) for dietary energy without any significant effect, while ready to cook (carcass weight + giblets weight) percentages ranged between (73.05 and 73.30%) for light sources and (72.46 and 73.67%) for dietary energy. Besides, the differences between treatments were insignificant.

On the other hand, the chicks fed low energy diets gave the lowest figures of (67.88 and 72.46%) for dressing and ready to cook percentages respectively.

These results are in agreement with those reported by Leeson et al. (1996); Hidalgo et al. (2004) and Rosa et al. (2007) who found that no significant differences in carcass and breast fillet weights in broilers fed gradient concentrations of metabolizable energy.

On the other hand, these findings are in contrast with the results obtained by (Dozier and Moran, 2001; Albuquerque et al., 2003; Dozier et al., 2007) who reported that carcass and edible parts yields were significantly lowered of broiler fed low-ME than chickens fed high-ME diets.

Blood plasma parameters: Dietary treatments and light sources had insignificant effect upon plasma cholesterol and triglycerides at 5 weeks of age as shown in Table (7). Generally, results showed that chicks fed low energy diets had highest values of cholesterol and triglycerides in plasma compared to other treatments, the corresponding figures were 164.56 and 145.50 mg/dl respectively. While, chicks fed on the medium energy diets showed the lowest values (135.44 and 139.07 mg/dl) respectively. Moreover, the response to light source on lipid metabolism showed the same trend since there were insignificant differences in values of cholesterol (148.32 versus 148.67 mg/dl) and triglycerides (147.43 versus 135.62 mg/dl) in plasma due to light sources (Fluorescent versus LED). These results disagree with those of Hasanein (1995) in quails and Elmansy (2006) in broiler chicks, who reported that higher levels of dietary energy induced a higher level of triglyceride and cholesterol in blood.

Economical traits: Data for economical evaluation are summarized in Table (8). The economical evaluation was calculated on the basis described by Al-Homidan (2003). However, price figures are based on the recent prices of local market for feed ingredients and selling price of live broiler chickens. The average cost/ton of final experimental diets (starter and grower), is shown in Tables (1 and 2). It was clear that using low energy diets relatively reduced the cost final diets compared with (medium and high) dietary energy.

As shown in Table (8), it is interesting to state that under the condition of the present study, the chicks fed low energy diets under LED light, gave the highest economical evaluation compared with the other treatments. This might be due to the highest productive performance figures (live body weight and feed conversion ratio) compared with those fed other treatments.

Moreover, feeding diets containing (medium or high energy level - with LED light) gave the lowest relative economic efficiency compared with other treatments and the corresponding values were 95.31 and 90.60, respectively. These findings are in contrast with the results obtained by Abd El-Hady (2012), who stated that lowering metabolizable energy (100 kcal/kg diet) decreased economic efficiency by 8% while in lowering (200 kcal/kg diet) economic efficiency was inferior to normal metabolizable energy diets by about 4%.

Additionally, Table (9) presents a direct comparison between energy expenses for lighting used during rearing broilers, either as fluorescent or as LED lights. It is noted that calculated lighting costs (L.E.) during the whole experimental period (35 days), recorded about (15.34 L.E.) when LED lamps were used as the sole light source. While using fluorescent lamps recorded about (32.76 L.E.). Which means that replacing one fluorescent lamp with one LED lamp saved about (17.42 L.E.) with about 53.12 % diminution in power costs.

Interactions between dietary energy levels and light source (L*E):

Generally, in most cases, the interaction between dietary treatments and light (L*E) for studied criteria (LBW, DWG, DFI, FCR, PI and PEF) were significant (Tables 3, 4 and 5). On the other hand, there were insignificant effects in some blood plasma parameters, carcass traits and economic traits (Tables 6, 7 and 8).

CONCLUSION

From the present results, it could be stated that, productive performance (except DFI and FCR), blood plasma parameters and carcass traits of broiler chicks were not affected by different dietary energy and/ or light source till 5 weeks of age. Moreover, feeding diets containing (high energy level-Fluorescent light or low energy level-LED light) presented higher REE.

Table (1): Feed ingredients and chemical analyses of experimental diets during starter phase (0-21 days)

Ingredients	Dietary Treatments					
	Fluorescent Light			LED Light		
	1	2	3	4	5	6
Yellow Corn	55.25	53.39	51.55	55.25	53.39	51.55
Soybean Meal 44%	33.15	33.51	33.85	33.15	33.51	33.85
Corn Gluten 60%	6.00	6.00	6.00	6.00	6.00	6.00
Soybean Oil	1.00	2.50	4.00	1.00	2.50	4.00
Ca Carbonate	1.60	1.60	1.60	1.60	1.60	1.60
Mono CaPh	1.80	1.80	1.80	1.80	1.80	1.80
LYS	0.30	0.30	0.30	0.30	0.30	0.30
DL-METH	0.30	0.30	0.30	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix	0.30	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100	100
Chemical Analysis (Calculated)						
CP%	23.00	23.00	23.00	23.00	23.00	23.00
ME Kcal/Kg diet	2912	3006	3100	2912	3006	3100
Ca%	1.00	1.01	1.01	1.00	1.01	1.01
AP%	0.50	0.50	0.50	0.50	0.50	0.50
LYS	1.40	1.40	1.40	1.40	1.40	1.40
METH & CYS	1.07	1.07	1.07	1.07	1.07	1.07
Price/ Ton (L.E.)	3568	3675	3781	3568	3675	3781

MCP: mono-calcium phosphate, MHA: methionine hydroxy-analogue, NPP: non-phytate phosphorus.

The premix contains: Vitamins: A, 12000000 IU; D3, 2000000 IU; E, 10000 mg; K_3, 2000 mg; B_1, 1000 mg; B_2, 5000 mg; B_6,1500 mg; B_{12}, 10 mg; Biotin, 50 mg; Coline chloride, 250000 mg; Pantothenic acid, 10000 mg; Nicotinic acid, 30000 mg; Folic acid, 1000 mg; Minerals: Mn, 60000 mg; Zn, 50000 mg; Fe, 30000 mg; Cu, 10000 mg; I, 1000 mg; Se, 100 mg and Co, 100 mg.

Table (2): Feed ingredients and chemical analyses of experimental diets during grower phase (22-35 days)

Ingredients	Dietary Treatments					
	Fluorescent Light			LED Light		
	1	**2**	**3**	**4**	**5**	**6**
Yellow Corn	59.66	57.78	55.94	59.66	57.78	55.94
Soybean Meal 44%	29.15	29.53	29.87	29.15	29.53	29.87
Corn Gluten 60%	5.00	5.00	5.00	5.00	5.00	5.00
Soybean Oil	2.00	3.50	5.00	2.00	3.50	5.00
Ca Carbonate	1.45	1.45	1.45	1.45	1.45	1.45
Mono CaPh	1.60	1.60	1.60	1.60	1.60	1.60
LYS	0.27	0.27	0.27	0.27	0.27	0.27
DL-METH	0.27	0.27	0.27	0.27	0.27	0.27
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix	0.30	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100	100
Chemical Analysis (Calculated)						
CP%	21.00	21.00	21.00	21.00	21.00	21.00
ME Kcal/Kg diet	3032	3126	3220	3032	3126	3220
Ca%	0.90	0.91	0.91	0.90	0.91	0.91
AP%	0.45	0.45	0.45	0.45	0.45	0.45
LYS	1.26	1.26	1.27	1.26	1.26	1.27
METH & CYS	0.98	0.98	0.98	0.98	0.98	0.98
Price/ Ton (L.E.)	3446	3553	3659	3446	3553	3659

MCP: mono-calcium phosphate, MHA: methionine hydroxy-analogue, NPP: non-phytate phosphorus.

The premix contains: Vitamins: A, 12000000 IU; D3, 2000000 IU; E, 10000 mg; K_3, 2000 mg; B_1, 1000 mg; B_2, 5000 mg; B_6, 1500 mg; B_{12}, 10 mg; Biotin, 50 mg; Coline chloride, 250000 mg; Pantothenic acid, 10000 mg; Nicotinic acid, 30000 mg; Folic acid, 1000 mg; Minerals: Mn, 60000 mg; Zn, 50000 mg; Fe, 30000 mg; Cu, 10000 mg; I, 1000 mg; Se, 100 mg and Co, 100 mg.

Table (3): Effect of dietary energy level, light source and their interactions on live body weight (LBW) and daily weight gain (DWG)

Items	Light Source (L)	Dietary Energy Level (E)			Overall
		Low	Medium	High	
LBW (at 3 weeks)	Fluorescent	690.01±2.21	660.77±6.59	658.85±10.21	669.87[a]
	LED	659.89±6.95	611.73±2.74	588.30±7.13	619.97[b]
	Overall	674.95[a]	636.25[b]	623.57[b]	
LBW (at 5 weeks)	Fluorescent	1656.59±14.75	1612.67±25.07	1740.68±34.97	1669.98
	LED	1772.83±55.79	1734.75±19.28	1602.50±2.04	1703.36
	Overall	1714.71	1673.71	1671.59	
DWG (0-3 weeks)	Fluorescent	30.68±0.13	29.25±0.31	29.12±0.48	29.68[a]
	LED	29.17±0.33	26.94±0.11	25.76±0.36	27.29[b]
	Overall	29.92[a]	28.09[b]	27.44[b]	
DWG (4-5 weeks)	Fluorescent	69.04±1.21	67.99±1.32	77.27±1.76	71.43[b]
	LED	79.49±3.48	80.21±1.18	72.44±0.36	77.22[a]
	Overall	74.26	74.10	74.85	
DWG (0-5 weeks)	Fluorescent	46.02±0.41	44.75±0.71	48.38±1.00	46.38
	LED	49.30±1.59	48.25±0.53	44.43±0.07	47.32
	Overall	47.66	46.50	46.40	

Probability			
Traits	L	E	L*E
LBW (3 weeks)	0.01	0.01	0.02
LBW (5 weeks)	NS	NS	0.01
DWG (0-3)	0.01	0.01	NS
DWG (4-5)	0.01	NS	0.01
DWG (0-5)	NS	NS	0.01

Means within the same row or column with different superscripts are significantly different. NS = Non Significant.

Table (4): Effect of dietary energy level, light source and their interactions on daily feed intake (DFI) and feed conversion ratio (FCR)

Items	Light Source (L)	Dietary Energy Level (E)			Overall
		Low	Medium	High	
DFI (0-3 weeks)	Fluorescent	39.67±0.02	37.53±0.42	38.68±0.21	38.63^a
	LED	38.54±0.01	39.02±0.34	35.45±0.11	37.67^b
	Overall	39.11^a	38.27^b	37.06^c	
DFI (4-5 weeks)	Fluorescent	134.14±0.94	128.93±3.06	135.88±2.67	132.98^b
	LED	142.73±4.02	147.35±1.44	130.91±0.99	140.33^a
	Overall	138.43	138.14	133.39	
DFI (0-5 weeks)	Fluorescent	77.46±0.36	74.09±1.48	77.56±1.19	76.37^b
	LED	80.22±1.62	82.36±0.37	73.63±0.46	78.73^a
	Overall	78.84^a	78.22^a	75.60^b	
FCR (0-3 weeks)	Fluorescent	1.29±0.01	1.28±0.01	1.33±0.02	1.30^b
	LED	1.32±0.01	1.45±0.02	1.37±0.02	1.38^a
	Overall	1.30^b	1.36^a	1.35^a	
FCR (4-5 weeks)	Fluorescent	1.94±0.02	1.89±0.01	1.76±0.01	1.86^a
	LED	1.80±0.02	1.84±0.01	1.81±0.01	1.81^b
	Overall	1.87^a	1.86^a	1.78^b	
FCR (0-5 weeks)	Fluorescent	1.68±0.01	1.65±0.01	1.60±0.01	1.64
	LED	1.63±0.02	1.71±0.06	1.66±0.01	1.66
	Overall	1.65^b	1.68^a	1.63^b	

Probability

Traits	L	E	L*E
DFI (0-3)	0.01	0.01	0.01
DFI (4-5)	0.01	NS	0.01
DFI (0-5)	0.01	0.01	0.01
FCR (0-3)	0.01	0.01	0.01
FCR (4-5)	0.01	0.01	0.01
FCR (0-5)	0.07	0.01	0.01

Means within the same row or column with different superscripts are significantly different. NS = Non Significant.

Table (5): Effect of energy level, light source and their interactions on PI and PEF

Items	**Light Source (L)**	**Dietary Energy Level (E)**			**Overall**
		Low	**Medium**	**High**	
Performance index (PI) [1]	Fluorescent	98.43±1.29	97.40±1.12	108.59±2.75	101.47
	LED	109.00±4.75	101.64±1.80	96.72±0.89	102.45
	Overall	103.71	99.52	102.71	
Production efficiency factor (PEF)[2]	Fluorescent	278.29±3.21	281.23±3.69	310.25±7.86	289.92
	LED	311.43±13.57	290.42±5.16	276.34±2.55	292.73
	Overall	296.33	284.35	293.30	

Probability			
Traits	L	E	L*E
PI [1]	NS	NS	NS
PEF [2]	NS	NS	NS

Means within the same row or column with different superscripts are significantly different.
Sig. = Significance, * ($p \leq 0.05$), NS = Non Significant.
[1]: North (1981), [2]: Emmert (2000)

Table (6): Effect of dietary energy level, light source and their interactions on carcass traits

Items	Light Source (L)	Dietary Energy Level (E)			Overall
		Low	Medium	High	
Dressing %	Fluorescent	67.26±0.31	68.81±0.55	69.24±0.69	68.44
	LED	68.50±0.94	69.09±0.56	67.74±0.83	68.45
	Overall	67.88	68.95	68.49	
Abdominal Fat %	Fluorescent	0.96±0.13	1.04±0.22	0.71±0.20	0.90
	LED	0.97±0.24	1.01±0.20	0.90±0.21	0.95
	Overall	0.96	1.02	0.80	
Liver %	Fluorescent	2.39±0.14	2.40±0.14	2.32±0.14	2.37
	LED	2.35±0.04	2.71±0.14	2.52±0.08	2.53
	Overall	2.37	2.56	2.42	
Gizzard %	Fluorescent	1.82±0.09	1.67±0.23	1.48±0.10	1.65
	LED	1.63±0.13	1.40±0.09	2.15±0.44	1.73
	Overall	1.72	1.53	1.81	
Heart %	Fluorescent	0.48±0.03	0.58±0.04	0.68±0.06	0.58
	LED	0.50±0.05	0.66±0.07	0.62±0.05	0.59
	Overall	0.49^{b}	0.62^{a}	0.65^{a}	
Giblets %*	Fluorescent	4.69±0.11	4.66±0.31	4.48±0.11	4.61
	LED	4.48±0.15	4.78±0.20	5.30±0.48	4.85
	Overall	4.58	4.72	4.89	
Ready-to-Cook %#	Fluorescent	71.95±0.31	73.47±0.65	73.73±0.59	73.05
	LED	72.98±0.87	73.88±0.71	73.05±1.20	73.30
	Overall	72.46	73.67	73.39	

Probability			
Traits	L	E	L*E
Dressing %	NS	NS	NS
A Fat %	NS	NS	NS
Liver %	NS	NS	NS
Gizzard %	NS	NS	NS
Heart %	NS	0.02	NS
Giblets %*	NS	NS	NS
RTC %#	NS	NS	NS

NS = Non Significant, Giblets = Liver + Gizzard + Heart, # Ready to Cook = (Carcass weight + Giblets weight)

Table (7): Effect of dietary energy level, light source and their interactions on some blood plasma cholesterol and triglycerides

Items	Light Source (L)	Dietary Energy Level (E)			Overall
		Low	Medium	High	
Cholesterol (mg/dl)	Fluorescent	157.56±17.82	142.50±4.31	144.88±30.76	148.32
	LED	171.56±19.13	128.36±22.32	146.10±2.49	148.67
	Overall	164.56	135.44	145.49	
Triglycerides (mg/dl)	Fluorescent	153.99±14.97	151.28±31.92	137.01±22.41	147.43
	LED	137.01±25.63	126.85±29.80	143.01±15.85	135.62
	Overall	145.50	139.07	140.01	

Probability			
Traits	L	E	L*E
Cholesterol	NS	NS	NS
Triglycerides	NS	NS	NS

Means within the same row or column with different superscripts are significantly different.
NS = Non Significant

Table (8): Effect of dietary energy level, light source and their interactions on economic evaluation

Items	Dietary Treatments					
	Fluorescent Light			LED Light		
	1	2	3	4	5	6
Average feed consumption (Kg)	2.71 ±0.01	2.59 ±0.05	2.71 ±0.04	2.81 ±0.05	2.88 ±0.01	2.58 ±0.01
Total cost (L.E.) #	24.01 ±0.07	23.79 ±0.33	25.11 ±0.27	24.61 ±0.35	25.65 ±0.08	24.19 ±0.11
Feed cost (L.E.)	17.01 ±0.07	16.79 ±0.33	18.11 ±0.27	17.61 ±0.35	18.65 ±0.08	17.19 ±0.11
Live body weight (Kg)	1.65 ±0.01	1.61 ±0.02	1.74 ±0.03	1.77 ±0.05	1.73 ±0.01	1.60 ±0.01
Total return (L.E.) *	41.41 ±0.36	40.31 ±0.62	43.52 ±0.87	44.32 ±1.39	43.37 ±0.48	40.06 ±0.05
Net return (L.E.)	17.40 ±0.28	16.52 ±0.29	18.40 ±0.59	19.71 ±1.04	17.71 ±0.40	15.87 ±0.15
Economic efficiency	72.42 ±0.96	69.43 ±0.25	73.22 ±1.57	79.92 ±3.08	69.02 ±1.33	65.62 ±0.94
Relative economic efficiency$	100.00	95.87	101.11	110.36	95.31	90.60

Total Cost = (Feed Cost + price of one-day live chicks + incidental costs).
* According to the local price of Kg sold live birds which was 25.00 L.E.
$ Assuming that the relative economic efficiency of (Fluorescent – low Energy) group equals 100.

Table (9): Comparison between costs of lighting during experimental period (0-5 weeks)

Light Source	Operative Costs (LE) Power (energy/ Kilowatt)	Lamp Depreciation	Total Costs
Fluorescent	24 hours * 35 days = 840 hours 840 hours * 40 watts = 33.60 kilowatts 33.6 kilowatts * 0.95 L.E. = 31.92 L.E.	0.07 Lamp * 12 L.E. = 0.84 L.E.	32.76 L.E.
LED	24 hours * 35 days = 840 hours 840 hours * 18 watts = 15.12 kilowatts 15.12 kilowatts * 0.95 L.E. = 14.36 L.E.	0.28 Lamp * 35 L.E. = 0.98 L.E.	15.34 L.E.
Difference Relative variation	31.95 – 14.36 = 17.56 L.E. - 55.01 %	0.14 L.E. + 11.76 %	17.42 L.E. - 53.12 %

Lifetime for a fluorescent lamp (40 Watts) is considered to be 12000 hours (i.e. 480 Kilowatt) and for a LED lamp (18 Watts) is about 30000 hours (i.e. 540 Kilowatts).
Price of Fluorescent lamp (40 Watts) is about 12.00 L.E., and LED lamp (18 Watts) is about 35.00 L.E.
Energy Cost of 1 Kilowatt is about 0.95 L.E., according to National Authority of Electricity Distribution.

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الملخص العربى

تأثير مستويات الطاقة بالعليقة ومصادر الإضاءة على أداء النمو، صفات الذبيحة و التقييم الإقتصادى لبدارى التسمين

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أجريت هذة التجربة لتقييم ومقارنة إستخدام ثلاث مستويات مختلفة من الطاقة الممثلة فى علائق بدارى التسمين (منخفضة ومتوسطة ومرتفعة) تحت نظامين فى الإضاءة داخل عنبر التربية (فلورسنت، ليد) على الأداء الإنتاجى وصفات الذبيحة والكفاءة الإقتصادية.

أستخدم عدد 180 كتكوت غير مجنس من سلالة (Hubbard) عمر يوم وزعت عشوائياً بالتساوى فى تجربة عاملية 3 (مستويات من الطاقة الممثلة) × 2 (مصدر إضاءة) مكونة من 6 معاملات، كل معاملة 3 مكررات وكل مكررة 10 كتاكيت.

أظهرت النتائج أن:

- الأداء الإنتاجى لبدارى التسمين (وزن الجسم الحي، الزيادة الوزنية اليومية، معامل الأداء ومعامل الإنتاج) لم تتأثر معنوياً بالتداخل بين مستويات الطاقة الممثلة × مصدر الإضاءة أو مستويات الطاقة أو مصدر الإضاءة.
- إستهلاك العلف اليومى وكفاءة التحويل الغذائى تأثر معنوياً بالتداخل بين مستويات الطاقة الممثلة × مصدر الإضاءة أو مستويات الطاقة أو التداخل بينهم.
- صفات الذبيحة لم تتأثر بمستويات الطاقة أو مصدر الإضاءة أو التداخل بينهما.
- الكوليستيرول والدهون الثلاثية فى بلازما الدم لم تتأثر بمستويات الطاقة أو مصدر الإضاءة أو التداخل بينهما.
- قيم الكفاءة الإقتصادية النسبية سجلت أعلى متوسط لبدارى التسمين المغذاة على المستوى المرتفع من الطاقة المرباة تحت مصدر الفلورسنت والمغذاة على المستوى المنخفض من الطاقة المرباة تحت مصدر الليد.

وتوصى الدراسة بإستخدام مستويات منخفضة من الطاقة فى علائق بدارى التسمين عند إستخدام الليد كمصدر إضاءة فى عنابر الدواجن.