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Effect of Strain, Sex, different Lighting and Vaccination Programs on Productive Performance and Carcass Characteristics of Two Strains of Broiler Chicks.

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ABSTRACT

This study aimed to evaluate the effects of strain, sex; different lighting and vaccination programs on broiler growth performance and carcass characteristics. One old day, two strains of broiler chicks were used (240 Evian-48 and 240 Arbour Acres), which were divided into male and female as sexed by feathered wings after they were selected at random. Under all conditions, each group was subjected to the same environmental factors and litter. Feeding and watering consumption ad libitum. The chicks were rearing under two different lighting (LP.1and 2) and vaccination (VP1and2) Programs too.

The results showed significant improvement in body weight, feed intake and percentage of edible, and mortality in the Evian - 48 compared to the Arbour Acres. Males are more likely to have a higher body weight than females. Also, males had the highest mortality percentage MP (11.5%) compared to females (9.5%). The lighting program2 LP2 and vaccination programs VP2 significantly enhance body weight, edible, and mortality percentages. However, there were no significant differences in the feed conversion ratio (FCR) among strains, sex, lighting programs, and vaccination programs. Interaction groups (G) between different lighting and vaccination programs significantly (P<0.0001) impacted live body weight (BW), cumulative feed intake (CFI), feed conversion ratio (FCR), cumulative mortality percentage (MP), and the absolute and relative weight of edible parts. Especially Group-2 (light Program 2× vaccination Program 2), which gave the best production performance.

***Conclusively,** this study obtained that the significant effects of strain, sex, different lighting, and vaccination programs on broiler growth performance and carcass characteristics. After this study, we are recommending to use the Evian- 48 strain with the lighting program2 LP2 and the vaccination program2 VP2 to give the best results in production performance under Egyptian environmental condition.*

Keywords: Lighting & vaccination programs, broilers, strains, growth performance, carcass characteristics.

INTRODUCTION

It has been predicted that the global population will reach over 9.2 billion in 2050 **(**FAO, 2012)**.** The total global food demand will increase by 35 to 56 % between 2010 and 2050 **(**Van Dijk *et al.,* (2021). The main type of meat produced worldwide, poultry, has recorded the highest absolute and relative growth rate during the last 50 years **(** Windhorst, 2017). Poultry meat has affected human health because poultry meats are essential sources for a balanced diet because they have high contents of protein, vitamins and minerals, and low contents of lipids, which have made chicken meat beneficial for people of all ages **(**Franca *et al.,* 2015**).** Chicken meat contains all necessary amino acids, including cartilage proteins and tissue-building materials. The large amount of minerals in chicken meat supports the blood, cardiovascular, and nervous systems **(**EUP, 2019**).** The low cholesterol and fat content make chicken meat a real salvation for those suffering from problems with blood vessels **(**Gordana *et al.,* 2018**).**

Broiler birds are specifically bred for rapid growth to attain mature body size within 7–10 weeks, depending on the strain, sex and management **(**Abdollahi *et al*., 2017). Commercial production of broiler chickens is actually based on fast-growing high-breast genotypes, which guarantee favorable growth performance, carcass yield, and meat quality **(**Maharjan *et al.,* 2021).

Tahamtani *et al.* (2020) showed that the other factors such as bird genotype**,** environment and housing system, or nutrition also, influence production performance**.** Udeh *et al.* (2015) reported that the Arbour Acres had a higher BW and ADG than Ross-308, but there was no difference between sexes in feed conversation rate (FCR). Also, there were no significant differences among Ross, Arbour Acres, and Marshall broiler strains and sexes in carcass yields. In contrast**,** Kampornet *al.,* (2022) found that strain did not significantly impact body weight, average daily gain, feed intake (FI), and feed conversion rate (FCR) at weeks 1, 2, 3, and 4, but had a significant effect at 6 weeks, while the gender was found to affect carcass weight. Males had a higher carcass weight, breast weight, fillet weight, wing weight, thigh weight, and drumstick weight than females, and females had a higher percentage of fillets than males. In addition**,** Marcu *et al.* (2013) stated that strain had significant effects on overall carcass characteristics such as dressing , breast, drumstick, thigh, back, shank, and edible giblet weights. Sex also significantly affected carcass traits. Interaction between genotype and sex effects on BW, FI, and FCR was reported.

Yonnis *et al*. (2022) shows males reported significantly higher life weight and thigh percentages on the contrary, females had dressing and breast percentages significantly higher than males ($P < 0.01$). All carcass characteristics were substantially higher at the 6th-week slaughtering age.

Sabri Majid *et al.* (2022) showed that there were significant ($P < 0.05$) differences between males and females in edible, gizzard weight, and breast circumference, and also results disagreement with others in there were no significant differences between males and females in other traits.

According to the preliminary study by Abo Ghanima *et al.*, (2021) they found that light has a considerable impact on the birds' growth and development, behavior, physiological functioning, immune response, and growth rate, which is one of the most crucial microclimate factors in the production of chickens**.** Kalaba *et al.* (2016) found that the body weights of broilers who received intermittent light (2 h L: 2 h D) were significantly heavier as compared to the control group that received continuous light (23 h L: 1 h D). Also, they had shown that broilers exposed to an intermittent 16-hour light program and E2 with a combined 18-hour light program had insignificantly less live body weight and daily gain (DG) than the control group. However, broilers reared under 14-hour light and 2 hours light programs consumed slightly higher FI than the control group. Additionally found that, broilers receiving intermittent lighting (12 hours of daylight followed by 3 cycles of 1 hour of light and 3 hours of darkness during the night) had significantly better feed conversion ratios (FCR) than those receiving continuous lighting system. Çoban *et al.* (2014) found that the live body weights (LBW) of broilers included in the continuous lighting (24 h L: 0 h D) and self-photoperiod groups (24 h L: free choice for darkness) were significantly higher than those of birds included in the constant lighting group (16 h L: 8 h D). Also, found that the lighting regimen had no significant effect on feed intake FI of broiler chicks but they found that the lighting program had no effect on the carcass characteristics of broiler chickens . On the other hand, Gornowicz and Lewko (2007) found that intermittent light programs (4 h L: 2 h D or 3 h L: 1 h D) significantly increased slaughter yield, breast and leg muscles yield, and decreased peritoneal fat in broiler chickens compared to birds exposed to 23 h L: 1 h D. Schwean-Lardner *et al.* (2013) studied that the day length increased carcass and breast meat percentages, while drum meat percentage decreased. However, photoperiod did not significantly impact carcass yields or carcass cut yields of broilers.

Chung *et al.*, (2021) have shown that vaccination programs can impact carcass composition, meat quality, and internal chicken organ development. Also there was no significant impact of vaccination programs on carcass weight, breast muscles, wings, or necks, but leg muscle weight was significantly affected. They also evaluated Cobb 500 chickens and Ross 308 broiler chickens, finding that IB vaccination significantly reduced organ percentages, especially in the spleen.

A study by Wegner (2016) found that lack of vaccination during broiler chicken rearing significantly affected final body weight, eviscerated carcass weight, breast and leg muscle weights, and the weight of the eviscerated carcass with neck. Yang *et al.* (2016**)** reported significant differences in the percentage of heart, liver, and spleen in broiler chickens on day 81 of age.

Therefore, the aim of this study to evaluate strain, sex, some lighting and vaccination programs on productive performance and carcass characteristics of Broiler Chicks under Egyptian environmental condition.

MATERIALS AND METHODS

1. Experimental design

This study was carried out in private poultry farm in Damietta Governorate from April to May 2024. 480 one-day-old chicks were used from two strains of broiler chicks (Evan-48 obtained from Al-Sabil Company and Arbour Acre obtained from Cairo Company), the average weight of chick for Evan-48 strain was 42.8 g while the average weight of a chick of the Arbour Acre strain is about 42.3g. These chicks were randomly selected and also sexualized by wing feathers and divided into equally among the strains of 240 chicks (120 females and 120 males). The chicks are distributed randomly to 4 groups under each strain, and then each group is distributed to two sub-groups, each sub-group contained 30 males and 30 females. The Chicks were placed in a closed house, divided internally by partitions into pens the floor pens covered with wood shaving litter (7 cm depth), 15 bird/m^2 allocated. White LED bulbs light were used with a lighting intensity of approximately 30 lux for 3 days to enable the chicks to adapt to the environment and find diet and water. then The lighting can be reduced to 15 lux . The bulbs were installed in the house so that the lighting is homogeneous throughout the house.and .All chicks were reared under the same environmental conditions: heat, humidity, and ventilation, with different lighting (White LED bulbs luxed9 were used) and vaccination programs depending on the type of group. Feed and water were consumed ad libitum. All the birds were fed in three stages: the starting feed, which contained 23% protein and metabolic energy at 2950 kcal/kg; the grower feed, which contained 21% protein and metabolic energy at 3150 kcal/kg; and the finisher feed, which contained 19% protein and 3250 kcal/kg of metabolic energy according to NRC (1994). On the other hand, temperature and relative humidity at one day of age were maintained at 32 ± 1°C and 50 ± 5%, respectively, and constant across all treatments. The temperature was decreased by 2°C per week until it reached 25: 26°C at 35 days of age. The broiler chicks in each strain were rearing with two different lighting and vaccination programs (Tables 1 to 5) as follows:

Table 1: Experimental groups

Treatment groups, G	Lighting program, L	Vaccination program, V
Group 1	1	1
Group 2	2	2
Group 3	1	2
Group 4	2	1

Table 2: Lighting program-1(LP1)

Lighting program number 1(LP1)			
Days	Light hours L	Dark hours D	Serial lighting and darkening
1:35	23 h L	1h D	Every 24 hours

h = Hours, L = Light, D = Dark.

Table 3: Vaccination program- 1(VP1)

Vaccination program number 1(VP1)			
No	Age of day	Name of vaccine	Method of vaccine
1	7	Clone + IB	Eye drop
2	9	AI + ND (dead) + IBD (live)	Injection 0.5/B sub-cut + eye drop
3	17	Lasota live	Eye drop
4	22	IBVD (live)	Eye drop
5	28	Clone (live)	Drinking water

IB = Infectious bronchitis, IBD = Infectious bursal disease, AI = Avian influenza, Lasota, and clone = Strain of Newcastle disease. This program started at one day and ended at 28 days of age.

Table 4: Lighting Program- 2(LP2)

Lighting program number 2(LP2)			
Days	Light hours (L)	Dark hours (D)	Serial lighting & darkening
0 – 3	24 hL	-	-
3-7	23hL	1 hD	23 H L-1 H D
7-14	22hL	2hD	11 h L – 1 h D, tow once every 24 H
15-21	21hL	3hD	7 h L-1 hD, three once every 24 H
22-35	20hL	4hD	5 hL, 1 hD, four once every 24 H

h = Hours, L = Light, D = Dark.

Table 5: Vaccination program- 2 (VP2)

Vaccination program number 2(VP2)			
No.	Age of day	Name of vaccine	Method of vaccine
1	1	Vaxxitek live vaccine + Mixes (Hitchener + IBV (primer)	Injection, 0.2m /B sub cut Spraying, 1 dose per bird
2	9	(AIV H5+ NDV) inactivated vaccine + (IBDV intermediate+ Clone M A5)	Injection 0.5/B sub cut Eye dropping, 1 dose per bird
3	15	Lasota live	Eye dropping, 1 dose per bird

Vaxxitek = Marek virus + live Gumboro virus; IBV = Infection bronchitis virus; AIV =Infection influenza virus; NDV = Newcastle disease virus. This program started at one day until 15 days of age.

2. *Growth performance*

Following the growth and development of broiler chickens over time is the objective of taking these measurements at various intervals. Body weights (BW) of chicks were recorded at one-day old, after that broilers were weighted weekly until 5 weeks old (Marketing age). Feed consumption was determined as nearest gram feed/bird/day for the same time periods. Feed conversion ratio (FCR) was calculated at periods (0-1), (1-2), (2-3), (3-4), and (4-5) weeks of age. The present study can assess how well they are growing and alter their diet or management techniques as needed. Mortality rate (%) was also, recorded every day. To enable us to closely monitor the health and well-being of the broilers, during their growth cycle, the following metrics were recorded at the end of the cycle at 35 days of age: cumulative feed intake (CFI), feed conversation rate (FCR), and mortality rate percentage (MP, %).

3. *Carcass characteristics*

Ten male and female chickens, aged 35 days, were randomly selected from each group ,the birds were individually weighed and fasted for eight hours, the following slaughtered for using Islamic rituals by cutting the neck near the first cervical vertebra and then blooded freely for 10 minutes, after slaughter, inedible parts such as (head, legs, feathers, and blood flow and the intestines) were separated and weighting to calculate relative pre- slaughter body weights, the giblet parts, such as (heart, liver, and empty gizzard) are removed, eviscerated to evaluate and to record carcass and measurements of the dressed carcass (carcass weight + giblets weight), edible viscera weight (Giblet = Liver, heart and gizzard weights), breast meat yield, thigh, as percentages of the pre-slaughter body weight were also recorded . Calculations aid in assessing the yield and quality of edible parts based on their total weight, simplifying the comparison and evaluation of different specimens. These measurements support the evaluation of the efficacy of poultry production, as well as, the improvement of breeding and feeding practices for higher meat yields.

4. ***Statistical analysis***

The general linear models (GLM) statistical analysis (**SAS, 2003**) software package was used to statistically analyses the gathered data using Multiple-Way Analyses Of Variance **(**2003)**.** Duncan's multiple range tests (Duncan, 1955) were used to determine differences among means when treatment effects were significant. All data percentages in this study were transformed to arcsine values before analysis. Significant differences were considered to exist (P<0.05).

Model when fixed effects

Was :- Sex (G) Strain (S) group (P)

$$Yijkl=\mu+ G_i+ S_j+ P_k+ (G\times S)_{ij}+ (G\times P)_{ik} + (S\times P)_{jk} + e_{ijkl}$$

Where: Yijkl is the record of the observation for the trait.

µ is the overall mean.

G_i is the fixed effect of (i^{th}) Sex, where i=1 (Male) and 2 (Female).

S_j is the fixed effect of (j^{th}) Strain, where j=1 (Evian- 48) and 2 (Arbo Acres).

P_k is the fixed effect of (k^{th}) groups of vaccination and light Program, where k =1 (lighting program 1 and vaccination program -1), 2 (lighting program -2 and vaccination program- 2), 3 (lighting program-1and vaccination program- 2), and 4 (lighting program-2and vaccination program- 1)

$(G*S)_{ijis}$ the effect of interaction between sex and strain(1,2.. 4).

$(G*P)_{ikis}$ the effect of interaction between sex and groups1,2,…..8).

$(S*P)_{jkis}$ the effect of interaction between strain and group(1,2,…...8)

e_{ijkl} the fixed effect of random error.

RESULTS AND DISCUSSION

In Tables 6, 7 and 8 the data showed that the Evian- 48 broiler strain had the highest BW and CFI as compared to the Arbour Acer strain**.** These results may be due to the difference in the genetic composition of each strain. Furthermore, the genetic improvement in the trend towards increased meat yields and nutrition is qualitative and quantitative. The results also, showed a significant (P<0.040) effect of the strain on the mortality rate percentage, during the different periods studied , where the Arbour Acre broiler strain recorded the highest mortality percentage (11.5%) when compared to the Evian- 48 broiler strain (9.5%) respectively. This may be due to the healthy case for every strain and the ability to withstand environmental and satisfactory conditions of disease, including the recent genetic improvement, which is an important factor in the health and wellbeing of the species. Where males had a greater BW, FI and FCR than females at the end of experiment.

Many studies have shown differences between male and female broiler chickens, where these differences between males and females for a specific trait are influenced by broiler breed, competition for feed, increased aggressive behavior in males, social dominance, growth hormone levels, and differences in nutritional requirements and fatness in female chickens to males. These agreements with Nascimento *et al.* (2018) suggested that genetic line age or breed can significantly affect phenotypic traits in different chicken lines**.** It has previously been reported that broiler chickens that provide higher potentials for weight gain will consume more feed than others due to their higher nutritional requirements to express their genetic potential**.** In contrast, Kamporn *et al.* (2022) found that strain was not significantly affected on final body weight (BW), average daily gain (ADG), feed intake(FI), and feed conversation rat(FCR) at weeks 1, 2, 3 and 4, but strain had a significant effect on feed intake FI and FCR at week 6. Similar results were obtained by Gafar *et al***. (**2022**)** the mortality rate of Cobb females and males was significantly higher than that of Ross females and males.

Ashley *et al.* (2023) reported that the differences observed between the sex contribute to increased variation in nutrition trials, and the potential to rear birds as equally mixed-sex becomes an option to reduce the variation introduced by the sex effect. However, López *et al.* (2011) reported that male broilers had a heavier live weight and feed intake than females. Madilindi *et al.* (2018) noted that there was an insignificant effect (P > 0.05) of sex on FCR during all stages of growth and that both males and females utilized the feed with the same degree of efficiency at the same ages. The results showed a significant (P<0.040) effect of the sex on the mortality percentage MP during the different periods studied, where the males recorded the highest mortality percentage MP (11.5%), respectively, compared to the females (9.5%). The highest mortality rate for males, given the immune rule, the higher the body weight, the less immune they are, and thus the more exposed they are to diseases than females. Also, the effect of the genetic composition of meat deposition genes is higher in males than in females.

In recent study also (Tables 6 & 7) the lighting program 2(LP2) recorded the highest live body weight BW and cumulative feed intake CFI at the end of this experiment (5 weeks)**.** While there was no significant difference (P > 0.05) between light Programs 1 and 2 in feed conversion rate FCR and cumulative mortality percentage MP at the end of the cycle (5 weeks). Lighting Programs may affect the birds' metabolism, which in turn is responsible for maximizing growth performance and maintaining normal

Table 6**:** Effect of strain, sex, different lighting, and vaccination programs on weekly live body weight.

Items	Live body weight, LBW / g /week					
	BW (one-day)	BW 7 days	BW 14 days	BW 21 days	BW 28 days	BW 35 days
Strains						
Evian 48	42.8^{a}± 0.1	180.1^{a} ± 0.4	428.6^{a} ± 0.9	891.9^{a} ± 2.2	1453.89^{a} ± 3.29	1910.7^{a} ±2.8
Arbour Acres	42.3^{b}± 0.1	177.4^{b} ± 0.4	425.4^{b} ± 0.9	860. 1^{b}± 2.2	1410.2^{b}± 3.3	1839.2^{b} ±3.32
P>F	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Sex						
Males	42.7 ± 0.1	182.9^{a} ± 0.4	433.4^{a} ± 0.9	878.1 ± 2.2	1434.8 ± 3.3	1895.3^{a} ± 3.3
Females	42.5 ± 0.1	174.6^{b} ± 0.4	428.6^{b} ± 0.9	873.9 ± 2.2	1429.3 ± 3.3	1854.7^{b} ± 3.3
P>F	0.0856	0.0001	0.0001	0.1737	0.2449	0.0001
Lighting program						
L.P 1	42.7^{a} ± 0.1	179.3^{a} ± 0.4	435.5^{a} ± 0.9	869.4^{b} ± 2.2	1430.0^{a} ± 3.3	1859.5^{b} ± 3.3
L.P 2	42.5^{b} ± 0.1	178.2^{b} ± 0.4	426.5^{b} ± 0.9	882.6^{a} ± 2.2	1434.1^{a} ± 3.3	1890.4^{a} ± 3.3
P>F	0.0280	0.0419	0.0001	0.0001	0.3872	0.0001
Vaccination program						
V.P 1	42.6^{a} ± 0.1	176.3^{b} ± 0.4	432.4^{a} ± 0.9	878.7^{a} ± 2.2	1443. 8^{a} ± 3.3	1850.8^{b} ± 3.3
V.P 2	42.5^{a} ± 0.1	181.2^{a} ± 0.4	429. 7^{b} ± 0.9	873.3^{a} ± 2.2	1420.3^{b} ± 3.3	1899.1^{a} ± 3.3
P>F	0.3660	0.0001	0.0329	0.0818	0.0001	0.0001
Treatment groups						
G1	42.8^{a} ± 0.1	174.5^{c} ± 0.5	423.5^{c} ± 1.3	886.01^{b} ± 2.1	1451.7^{a} ± 3.6	1858.3^{b} ± 4.1
G2	42. 5^{b} ± 0.1	178. 5^{b} ± 0.5	435.2^{a} ± 1.3	894.48^{a} ± 2.1	1432.9^{b} ± 3.6	1937.3^{a} ± 3.1
G3	42.6^{ab} ± 0.1	184.1^{a} ± 0.5	435.9^{a} ± 1.3	852.59^{d} ± 2.1	1408.3^{c} ± 3.6	1860.9^{b} ± 4.0
G4	42. 5^{b} ± 0.1	178.0^{b} ± 0.5	429.6^{b} ± 1.3	870.98^{c} ± 2.1	1435.3^{b} ± 3.6	1842.9^{c} ± 4.0
P>F	0.079	0.0001	0.0001	0.0001	0.0001	0.0001

^{a,b,c,d} Means in the same column having different superscripts differ significantly ($P\leq0.05$).Each data entry represents the mean ± standard error. LP1 = light Program 1, LP2 = light Program 2, VP1 = vaccination Program1, VP2 = vaccination Program 2. G1 = group1 (light Program 1× vaccination Program 1), G2 = group2 (light Program 2× vaccination Program 2)**,** G3 = group3 (light Program 1× vaccination Program 2), G4 = group4 (light Program 2× vaccination Program 1)**.**

Table 7**:** Effect of strain, sex, some lighting, and vaccination programs on cumulative feed intake of broilers from 1-5 weeks of age.

Items	Cumulative feed intake / g/week				
	FI(0-1)	FI(1-3)	FI(2-3)	FI(3-4)	FI(4-5)
Strains effects					
Evian 48	156.99 [a] ±0.01	492.5 [a] ±0.5	1122.1 [a] ±0.7	2052.9 [a] ±1.4	3302.4 [a] ±3.2
Arbour Acres	126.51 [b] ±0.01	455.0 [b] ±0.5	1025.5 [b] ±0.7	1954.7 [b] ±1.4	3230.2 [b] ±3.3
P>F	0.0001	0.0001	0.0001	0.0001	0.0001
Sex effects					
Males	141.76 ±0.01	473.8 ±0.5	1074.4 ±0.7	2004.1 ±1.4	3264.6 ±3.3
Females	141.74 ±0.01	473.7 ±0.5	1074.1 ±0.7	2004.7 ±1.4	3268.1 ±3.2
P>F	0.9053	0.9388	0.7701	0.8733	0.4435
Lighting program effects					
L.P 1	140.77 [b] ±0.01	467.6 [b] ±0.5	1065.5 [b] ±0.7	1984.8 [b] ±1.4	3242.8 [b] ±3.2
L.P 2	142.73 [a] ±0.01	479.9 [a] ±0.5	1082.9 [a] ±0.7	2024.8 [a] ±1.4	3289.9 [a] ±3.2
P>F	0.0001	0.0001	0.0001	0.0001	0.0001
Vaccination program					
V.P 1	138.24 [b] ±0.01	457.4 [b] ±0.5	1052.7 [b] ±0.8	1978.4 [b] ±1.5	3240.8 [b] ±3.3
V.P 2	145.27 [a] ±0.01	490.1 [a] ±0.5	1095.7 [a] ±0.7	2031.2 [a] ±1.4	3291.9 [a] ±3.2
P>F	0.0001	0.0001	0.0001	0.0001	0.0001
Treatment groups effects					
G1	140.50 [c] ±0.02	465.0 [c] ±0.1	1070.5 [b] ±0.2	1982.0 [b] ±0.2	3226.7 [c] ±4.4
G2	149.50 [a] ±0.02	510.0 [a] ±0.1	1131.0 [a] ±0.2	2075.0 [a] ±0.2	3325.0 [a] ±4.3
G3	141.03 [b] ±0.02	470.1 [b] ±0.1	1060.5 [b] ±0.2	1987. 5 [b] ±0.2	3258.7 [b] ±4.4
G4	136.00 [d] ±0.02	450.0 [d] ±0.1	1035.0 [c] ±0.2	1975.0 [c] ±0.2	3255.0 [b] ±4.4
P>F	0.0001	0.0001	0.0001	0.0001	0.0001

[a,b,c,d] Mean in the same column having different superscripts differ significantly ($P \leq 0.05$). .Each data entry represents the mean ± standard error. LP1 = light Program 1, LP2 = light Program 2, VP1 = vaccination Program1, VP2 = vaccination Program 2. G1 = group1 (light Program 1× vaccination Program 1), G2 = group2 (light Program 2× vaccination Program 2), G3 = group3 (light Program 1× vaccination Program 2), G4 = group4 (light Program 2× vaccination Program 1)

physiological processes and functions. Since long-dark situations affect the release of thyroid hormones (T_3 and T_4) and reduce them, this leads to lower dietary metabolism and thus reflects on the food conversion coefficient and thus the final weight of the chicken. The high mortality and low livability rate in groups raised during a long continuous photoperiod may be due to the rapid growth rate of broilers, which reflects in several problems, such as a high incidence of metabolic diseases (ascites and sudden death syndrome), tibialdy schondroplasia, and other skeletal disorders. Kalaba *et al*. (2016**)** found that light has a considerable impact on the birds' growth and development, behavior, physiological functioning, immune response, and growth rate, which is one of the most crucial microclimate factors in the production of chickens**.**

Abo Ghanima *et al.* (2021) discovered that broiler performance, specifically BW and BWG, were significantly influenced by lighting intervals. Reducing lighting intervals and using intermittent light programs led to a significant decrease in BW and BWG, particularly in older broilers. This reduction is attributed to reduced feeding time, which decreases feed consumption by birds at the shortest light intervals, where there is a strong correlation between BW and FC .The study suggests that birds raised under intermittent light IL may experience reduced feed intake due to reduced activity during light off periods, which is linked to the secretion of melatonin from the pineal gland. Schwean- Lardner et al., (2016), discovered that feed intake decreases at light periods below 18L: 6D, the feed conversion ratio, did not show significant differences between the treatments.

The recent results (Tables 6,&7, and 8) showed the best significant impact of vaccination program2(VP2) on the body weight, the cumulative feed intake and the % mortality rate especially in 1, 2, 3, and 5 weeks of age. While there was no significant difference ($p > 0.05$) between vaccination programs 1 and 2 in feed conversion rate FCR at the end of the cycle (5 weeks). These results may be due to the impact of vaccination programs on the health status of chickens and the increase in chicken immune systems, which increase their ability to withstand diseases, especially viral ones. These diseases have the most significant effect on the low rate of feed consumption and hence the low feed conversion rate, low growth rates, and the final weight of chickens, as well as increased mortality rates, resulting in heavy weights in the chicken herd. According to findings from the current work, vaccination against ND+IB and IBD on days 7 and 14 proved to be the best vaccination regime for broiler production due to the better production performance and health status of broilers. Previous studies **by** Emamanuel (2013) found that vaccination groups receiving live, killed, or a combination of both vaccines had no significant effect on growth

Table 8: Effect of strain, sex, some lighting, vaccination programs and interaction groups on the feed conversion rate (FCR), Mortality rate percentages (MR, %) of broiler chickens from1-5 weeks of age.

Items	Feed conversion rate (FCR)					MR, %
	FCR1	FCR 2	FCR3	FCR4	FCR5	
Strains effects						
Evian 48	0.89 [a] ±0.001	1.16 [a] ±0.003	1.26 [a] ±0.004	1.47 [a] ±0.009	1.73 [a] ±0.008	0.41 [b] ±9.50
Arbour Acres	0.71 [b] ±0.002	1.04 [b] ±0.003	1.19 [b] ±0.004	1.39 [b] ±0.009	1.75 [a] ±0.008	0.41 [a] ± 11.50
P>F	0.0001	0.0001	0.0001	0.0001	0.1699	0.040
***Sex** effects*						
Males	0.78 [b] ±0.002	1.09 [b] ±0.0003	1.23 [a] ±0.004	1.40 [b] ±0.009	1.72 [b] ±0.008	0.41± 11.50 [a]
Females	0.82 [a] ±0.002	1.11 [a] ±0.003	1.23 [a] ±0.004	1.46 [a] ±0.009	1.75 [a] ±0.008	0.41[b] ±9.50
P>F	0.0001	0.0001	0.6081	0.0001	0.0126	0.040
Lighting program effects						
L.P 1	0.79 [b] ±0.002	1.08 [b] ±0.003	1.23 [a] ±0.004	1.41 [b] ±0.009	1.73 [a] ±0.008	11.0[a] ± 0.50
L.P 2	0.80 [a] ±0.002	1.13 [a] ±0.003	1.23 [a] ±0.004	1.45 [a] ±0.009	1.74 [a] ±0.008	10.00[a] ± 0.50
P>F	0.0001	0.0001	0.6937	0.0077	0.4561	0.292
Vaccination program effects						
V.P 1	0.79 [b] ±0.002	1.06 [b] ±0.003	1.20 [b] ±0.004	1.42 [b] ±0.009	1.74 [a] ±0.008	12.50 [a] ±0.50
V.P 2	0.80 [a] ±0.002	1.14 [a] ±0.003	1.25 [a] ±0.004	1.45 [a] ±0.009	1.73 [a] ±0.008	8.50 [b] ± 0.50
P>F	0.0001	0.0001	0.0001	0.0176	0.5057	0.029
Treatment groups effects						
G1	0.81 [b] ±0.003	1.07 [c] ±0.004	1.21 [c] ±0.003	1.42 [b] ±0.01	1.72 [b] ±0.11	13.00 [a] ± 0.58
G2	0.84 [a] ±0.003	1.21 [a] ±0.004	1.26 [a] ±0.003	1.48 [a] ±0.01	1.72 [b] ±0.11	8.00 [bc] ±0.58
G3	0.77 [c] ±0.003	1.08 [b] ±0.004	1.24 [b] ±0.003	1.41 [b] ±0.01	1.75 [a] ±0.11	9.00 [b]± 0.58
G4	0.77 [c] ±0.003	1.05 [d] ±0.004	1.19 [d] ±0.003	1.42 [b] ±0.01	1.77 [a] ±0.11	12.00 [b] ± 0.58
P>F	0.0001	0.0001	0.0001	0.0001	0.002	0.021

[a,b,c,d] Mean in the same column having different superscripts differ significantly ($P \leq 0.05$). Each data entry represents the mean ± standard error. LP1 = light Program 1, LP2 = light Program 2, VP1 = vaccination Program1, VP2 = vaccination Program 2. G1 = group1 (light Program 1× vaccination Program 1), G2 = group2 (light Program 2× vaccination Program 2), G3 = group3 (light Program 1× vaccination Program 2), G4 = group4 (light Program 2× vaccination Program 1).

performance or live body weight. These findings confirm previous studies that showed no effect on body weight gain or growth performance.

The significant effect of the interaction groups on the body weight, the cumulative feed intake, the feed conversion and the mortality percentage during the experiment, especially G2, which was the best in body weights, and mortality percentage at the end of experiment. Also, G2&G1 had better feed conversion than other interaction groups. These results may be due to the overlap of the effects of the factors affecting these characteristics, such as strain, sex, lighting, and vaccination programs, as well as the genetic effects of the strains and the physiological, nutritional, and immune effects. Reducing the growth rate by controlling the photoperiod may reduce the incidence of skeletal and metabolic diseases. According to Kim *et al*. (2022) they found that body weight, body weight gain, and feed intake were the lowest in the 8L: 16D treatment ($P < 0.05$). Interaction between genotype and sex effects on BW, FI, and FCR was reported.

2*. Carcass characteristics*

2.1. Relative weight of edible parts.

In Table 9**,** the data showed that the Evian 48 strain was superior to Arbour Acres strain in the percentage of dressing, liver, goblet and edible. While, there is no significant effect for the strains on the percentages of gizzard and heart organs. As for the effect of sex, it was found that males outperform females in the percentages of dressing, heart and liver but no effect of the sex on the gizzard, giblet, and edible percentages. The recent data also found that there is no significant effect of lighting programs on the dressing, heart, liver, gizzard and giblet relative weights, while the lighting program 2 had a positive effect on the percentage of edible. It was found that the vaccination program 2 gave better results for the percentage of dressing, liver, giblets, and edible parts, while there was no significant difference between the vaccination programs on the percentage of heart and gizzard. It was found that Group 2, followed by Group 3, gave the best results for the percentage of dressing, heart, and edible parts, while there were no significant differences between the interaction groups on the percentage of gizzard and liver organs.

These results may be due to differences between strains in the genetic component, dietary feed intake quality and qualitative, sex effects, feed conversion rate, weight gain, and healthy cases for birds during the cycle. Several factors influence the performance of broilers, carcass cuts, and meat quality. Among these factors are strains, sex, and age at slaughter**,** nutrition, and post-slaughter processing. Zuidhof *et al.* (2014) reported that the changes in carcass traits are likely attributed to the effects of allometric growth and genetic selection, where modern broilers

Table 9: Effect of strain, sex, some light, vaccination programs and interaction groups on Absolute and relative weight of edible parts of broiler chicks at 35 days of age.

Items	Absolute and relative weight of edible parts					
	Dressing	Heart	Ggizzard	Liver	Giblets	Edible parts
Strains effects						
Evian-48	68.8 [a] ±0.25	0.34 [a] ±0.01	0.98 [a] ±0.02	1.38 [a] ±0.02	2.69 [a] ±0.03	70.3 [a] ±0.4
Arbour Acres	66.9 [b] ±0.25	0.32 [a] ±0.01	1.00 [a] ±0.02	1.25 [b] ±0.02	2.57 [b] ±0.03	69.1 [b] ±0.4
P>F	0.0001	0.0674	0.4553	0.0001	0.0126	0.0471
Sex effects						
Males	68.2 [a] ±0.25	0.34 [a] ±0.01	1.0 [a] ±0.02	1.34 [a] ±0.02	2.7 [a] ±0.03	70.0 [a] ±0.4
Females	67.4 [b] ±0.25	0.32 [b] ±0.01	1.0 [a] ±0.02	1.29 [b] ±0.02	2.6 [a] ±0.03	69.4 [a] ±0.4
P>F	0.0286	0.0333	0.4429	0.0476	0.0781	0.3122
Lighting program effects						
L.P 1	67.6 [a] ±0.25	0.32 [a] ±0.01	1.0 [a] ±0.02	1.31 [a] ±0.02	2.6 [a] ±0.03	69.0 [b] ±0.4
L.P 2	68.0 [a] ±0.25	0.33 [a] ±0.01	1.0 [a] ±0.02	1.32 [a] ±0.02	2.7 [a] ±0.03	70.3 [a] ±0.4
P>F	0.2124	0.1433	0.2076	0.7697	0.3047	0.0279
Vaccination program effects						
V.P 1	67.0 [b] ±0.25	0.32 [a] ±0.01	1.0 [a] ±0.02	1.29 [b] ±0.02	2.6 [b] ±0.03	68.6 [b] ±0.4
V.P 2	68.6 [a] ±0.25	0.34 [a] ±0.01	1.0 [a] ±0.02	1.34 [a] ±0.02	2.7 [a] ±0.03	70.8 [a] ±0.4
P>F	0.0001	0.0770	0.2228	0.0519	0.0396	0.0004
Treatment groups effects						
Groups						
G1	67.45 [cb] ±0.35	0.32 [b] ±0.008	0.98 [a] ±0.02	1.28 [a] ±0.03	2.56 [a] ±0.05	68.07 [c] ±0.6
G2	69.45 a ±0.35	0.34 [a] ±0.008	0.97 [a] ±0.02	1.34 [a] ±0.03	2.65 [a] ±0.05	71.5 [a] ±0.6
G3	67.70 [b] ±0.35	0.33 ab±0.008	1.04 [a] ±0.02	1.33 [a] ±0.03	2.71 [a] ±0.05	70.03 [ab] ±0.6
G4	66.60 [c] ±0.35	0.33 [ab] ±0.008	0.97 [a] ±0.02	1.30 [a] ±0.03	2.60 [a] ±0.05	69.2 [cb] ±0.6
P>F	0.0001	0.0015	0.1245	0.2639	0.1614	0.0008

[a,b,c,d] Mean in the same column having different superscripts differ significantly ($P \leq 0.05$).. Each data entry represents the mean ± standard error. LP1 = light Program 1, LP2 = light Program 2, VP1 = vaccination Program1, VP2 = vaccination Program 2. G1 = group1 (light Program 1× vaccination Program 1), G2 = group2 (light Program 2× vaccination Program 2), G3 = group3 (light Program 1× vaccination Program 2), G4 = group4 (light Program 2× vaccination Program 1).

prioritizes lean muscle accretion. A preview study by Maynard *et al.* (2022) reported that dietary treatments affected male and female broilers differently. Female fat, wing, breast, and tender yields responded to dietary treatment, whereas males expressed responses in hot carcass, fat, cold carcass, wing, breast, and tender yield. The same others found that male broilers reached target carcass weights at younger ages than females with better FCR. Strain had an effect on male and female broiler performance and some carcass trait**s.** Benyi *et al.* (2015) reported a significant effect of sex on relative back, wing, and leg weights, with higher means for males than females, but no significant effect of sex on relative breast weight. Kim *et al*. (2022) found that the photoperiod did not significantly affect carcass yields or carcass cut yields of broilers. Previous studies have shown that the photoperiod has little effect on carcass yield or carcass cut yields, with consistent wing, leg, and breast meat proportions **(**Fidan *et al.,* 2017). High-yielding strains are selected to have an increased high-value breast meat yield, while standard-yielding strains have a better FCR. Abo Ghanima *et al.* (2021**)** reported the group that was exposed to 22 h (CL22). The increased dressing, breast, abdominal fat, liver, and intestine % in the CL22 group may be due to the increase in pre-slaughter weight, which is highly correlated with dressing yield. This results in disagreement with Mahmoud Ghanima *et al.* (2021); they found that, dressing %, carcass traits and internal organs as affected by lighting programs. Also showed that, the lighting program significantly (P < 0.05) affected the dressing, breast muscle, liver, heart, intestine and abdominal fat % of broiler chick groups. Cleary, the broiler group subjected to 22 h continuous light (CL22) manifested higher dressing %, breast muscle, liver, intestine and abdominal fat % as compared to all other groups. Alternatively, non-significant differences (P < 0.05) were found in the thigh, shoulder, left fillet, gizzard, and spleen % between all groups of broilers as affected by different lighting programs intervals (22, 20 or 20 h), whether it was continuous or intermittent (CL or IL). Farghly and Makled **(**2015), who reported that lighting had minimal effects on the carcass or part yields, However, they found non-significant differences in the percentages of the drumstick, femur, and gizzard among all groups under IL, although the differences were significant (P < 0.05) in the dressed carcass, breast, liver, and abdominal fat percentages.

In Conclusion:

This study obtained that the significant effects of strain, sex, different lighting, and vaccination programs on broiler growth performance and carcass characteristics. After this study, we are recommending using the Evian 48 strain with the LP2 lighting system and the VP2 vaccination system to give the best results in production performance.

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