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THE EFFECT OF ADDING DIFFERENT LEVELS OF ASTAXANTHIN ON THE PRODUCTIVE PERFORMANCE OF BROILERS CHICKEN REARED UNDER HIGH ENVIRONMENTAL TEMPERATURES

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Abstract

This study was conducted in the field of poultry, Department of Animal production, College of Agriculture, University of Al-Qasim Green for the period from 1/7/2019 to 5/8/2019. To know the effect of adding different levels of Astaxanthin to the diet of broiler chickens in the productive performance of broiler chickens. 240 unsexed chicks at one day of age used ROSS 308 strain randomly distributed on five treatments (48 chicks/treatment). The chicks were fed on the starting and final diet containing 22.74 and 20.16% crude protein, and representative energy of 3078 and 3125.2 kilograms price/kg feed, respectively, In addition to the Astaxanthin powder at levels 0, 10, 20, 30 and 40 mg/kg feed for T1, T2, T3, T4 and T5 treatments, respectively. The addition treatments (T2, T3, T4 and T5) showed a highly significantly excelled ($P < 0.01$) in both final body weight average, total weight gain, and the amount of cumulative consumed feed and improvement of feed conversion ratio significantly high, with a significant decrease in the total mortality of all adding treatments compared to control treatment (T1). It is concluded from this study that the addition of Astaxanthin to the broiler chickens diet has led to an improvement in the productive performance of broilers chickens reared under high environmental temperatures for 35 days.

Key words: poultry meat, thermal stress, Astaxanthin

Introduction

Poultry meat and meat products are considered one of the most important sources of animal protein with a high nutritional value and healthy ingredients for the people of the whole world because of their biological importance in building the body and maintaining human health (Donma and Donma, 2017). The United Nations Food and Agriculture Organization (FAO) has counted these meat and meat products where healthy food for humans and the poultry industry has witnessed widespread interest by many researchers and breeders interested in developing this sector where a result of rapid growth and high efficiency in food transformation (Marangoni *et al.,* 2015), However, this development was accompanied by some basic problems resulting from several causes such as heat stress, which is one of the stresses that cause major economic losses in the poultry industry (Hirakawa *et al.,* 2020), where stress stimulates oxidation by producing free radicals and causing oxidative damage in the body. It can be treated (Kikusato and Toyomizu, 2019). Recent research and studies have tended to find solutions and alternatives to reduce these constraints by using natural additives such as carotenoids in poultry diets as an alternative to industrial (Marounek and Pebriansyah, 2018) For its positive role in enhancing productive and immune performance in poultry as well as its ability to inhibit the activity and effectiveness of free radicals (Sadik, 2016; Sandmann, 2019), They are safe natural alternatives compared to the industrial used in poultry diets that are a concern for consumers of this meat (Pashtetsky *et al.,* 2019) and Astaxanthin extracted from *Haematococcus pluvialis* is one of these carotenoids and is a safe natural antioxidant approved by the European Food and Safety Authority (EFSA) and the Food and Allergy Committee (NDA) safety and suitability of the product as a nutritional supplement for humans and animals and added to poultry feeds (Elwan *et al.,* 2019; Turck *et al.,* 2020), Its importance is due to that it deals with an unlimited number of free radicals generated as a result of oxidative stress, inhibiting its action and protecting protein, fat and cell membranes from oxidation processes through its extension through the cell membrane (double

layer) compared to other antioxidants whose effect is either on specific sites inside or outside the cell membrane. (Ambati *et al.,* 2014). Based on the above and in line with the trend towards the use of natural antioxidants, this study was conducted to know the effect of adding different levels of Astaxanthin to productive performance and to determine the best level in which Astaxanthin is added to the diet.

Materials and Methods

This experiment was conducted in the field of poultry, Department of Animal production, College of Agriculture, University of Al-Qasim Green for the period from 1/7/ 2019 to 5/8/2019. To study the effect of adding Astaxanthin in different levels (0, 10, 20, 30 and 40 mg/ kg) feed to the diet in productive performance of broiler chickens, In this experiment, 240 unsexed chick ROSS 308, equipped with one of the local hatcheries, were used. The chicks were randomly distributed at the age of one day, with an initial weight of 38 g/chick, on five treatments. Each treatment contained three replicates with 16 chicks/ replicate, as follows: First treatment (T1): control treatment free of any addition. Second treatment (T2): add 10 mg of Astaxanthin/kg feed. Third treatment (T3): add 20 mg of Astaxanthin/kg feed. Fourth treatment (T4): add 30 mg of Astaxanthin/kg feed. The fifth treatment (T5): add 40 mg of Astaxanthin/kg feed. The Astaxanthin powder used in the study was obtained from AstaPure® and its natural source, *Haematococcus pluvialis*. The chicks were reared in cages of 2x1.5 m size, and sawdust was placed in a thickness of 2-3 cm, where the replicates were randomly distributed to floor treasures by following a program of thermal stress starting from the first week of the age of the chicks and recording the readings at (1200, 1400, 1600 and 1800 hours) using four thermometers distributed inside the poultry breeding halls, The chicks vaccinated against infectious bronchitis, Newcastle disease, Cambodia, and bird flu, according to a vaccine program prepared for this purpose. The chicks were fed free-feeding Ad libitum and crushed fodder during the experiment, A standard starter diet was used for the period from 1-21 days of the chicks containing 22.74% crude protein and 3078 kilograms price/kg feed energy represented according to the nutrition guide for ROSS 308 chicks to form the ratio of energy to protein (C/P Ratio) 135.35 followed by the final diet that contained 20.16% crude protein and 3125.2 kilograms price/kg for energy represented, thus the energy to protein ratio was equal to 155.07 which lasted up to 35 days and according to table 1. The traits of live body weight was studied weekly according to Al-Fayyad *et al.,* (2011), weekly and total weight gain, the amount of weekly and total consumed feed and feed conversion ratio according to what it indicated (Al-Fayyad *et al.,* 1989; Al-Zubaidi, 1986) and the percentage of total mortality rate according to (Nagy, 2006). Data were analyzed using the SAS (2012). A completely randomized design was applied in data analysis, and Duncan (1955) was used to test the differences between multiple data treatments and to compare the mean differences between the averages of the studied traits.

Table 1: The percentage of feed materials included in the composition of the starting and final diets used in the experiment with the calculated chemical composition of both diets.

Final diet (22-42 days)%	Starter diet (1-21 days)%	Feed materials
30	30	yellow corn
35.5	27.7	Local wheat
20	28	Soybean meal (44% protein)
10	10	Animal Protein Concentrate *
3	3	Vegetable oil
1.2	1	limestone
0.3	0.3	Table salt
100%	100%	total
		Calculated chemical analysis **
3125.2	3078	Energy represented (kilograms/kg)
20.16	22.74	Crude protein (%)
155.070.95	135.351.02	Energy to protein ratio
0.75	0.83	Lysine (%)
1.0	0.97	Methionine + cicin (%)
0.48	0.41	Calcium (%)

*The Animal Protein Concentrate is a product of Al-Hayat Company, Jordanian contains 44% protein, 2800 kilos calorie, 12% fat, 25% ash, 5% calcium, 2.9% phosphorous, 2.55% methionine + cysteine, 2.8% lysine.

** According to the chemical composition according to the feed materials analyzed in (NRC, 1994).

Results and Discussion

Table 2 shows the effect of adding different levels of Astaxanthin to the diet in the body weight ratio, where it is noting that there was a significantly excelled ($P < 0.01$) at the first week in favor of the adding T5 treatment compared to the control treatment (T1) that recorded the lowest values, where it reached 166.00 compared to 163.00 g, followed by the T2 and T4 treatments which reached 165.00 and 165. 00g, respectively, and that did not differ significantly on the T3 treatment, which amounted to 164.00g. In the second week, continued to excel the treatment (T5) on the control (T1) treatment, where it reached 460.00g compared to 428.00g, It was

Table 2: Effect of adding different levels of Astaxanthin to the diet on the weekly body weight (g / bird) for broilers chickens reared under high environmental temperatures (mean ± standard error).

Treatments (1)	The first week	second week	the third week	fourth week	The fifth week
T1	163.00 ± 0.57c	428.00 ± 0.57c	834.00 ± 1.52c	1285.00 ± 2.88b	1885.00 ± 1.15d
T2	165.00 ± 0.57ab	455.33 ± 0.33b	930.00 ± 2.08b	1469.00 ± 2.51a	2178.00 ± 0.57a
T3	164.00 ± 0.57bc	458.00 ± 0.57ab	936.00 ± 2.08b	1468.00 ± 1.53a	2172.00 ± 0.57b
T4	165.00 ± 0.57ab	456.00 ± 2.51ab	936.00 ± 2.64b	1466.00 ± 1.52a	2161.00 ± 0.57c
T5	166.00 ± 0.57a	460.00 ± 1.52a	944.00 ± 1.15a	1465.00 ± 0.57a	2163.00 ± 1.73c
Level of significance	**	**	**	**	**

Different letters within a single column mean that there are significant differences between the averages of the treatments.

** Means significant differences at (P <0.01) between the mean treatments.

(1) treatments include the following: - (T1) control treatment without addition, (T2) addition of Astaxanthin 10 mg / kg feed, (T3) addition of Astaxanthin 20 mg / kg feed, (T4) Add Astaxanthin 30 mg / kg feed, (T5) add Astaxanthin 40 mg / kg for feed.

followed by the effects of the T3 and T4 treatments that did not significantly differ from the T2 treatment, where it reached 458.00, 456.00 and 455.33 g, respectively, and the treatment (T5) continued to excel in the third week on the control (T1) treatment, reaching 944.00 compared to 834.00 g, followed by the T2, T3 and T4 treatments in the effect, where their values reached 930.00, 936.00 and 936.00 g, respectively, In the fourth week, all addition treatments achieved the highest values compared to the control treatment (T1), where their values reached 1469.00, 1468.00, 1466.00 and 1465.00 g compared to 1285.00 g respectively, and in the fifth week, the T2 treatment was excelled to the control (T1) As it reached 2178.00 compared to 1885.00 g, followed by the effect of treatment T3 and then the treatments T4 and T5, where their values reached 2172.00, 2161.00 and 2163.00 g, respectively.

It is clear from table 3 the effect of adding different levels of Astaxanthin to the diet in the average of weekly and total weight gain of broiler chickens. It is noted that there is a significantly excelled (P<0.01) in the weight gain average in the first week in favour for the T5 treatment to the control treatment (T1) , As it reached 128.00 compared to 125.00 g/bird and the similar effect was on the T2 and T4 treatments which reached 127.00 and 127.00 g/bird, respectively, which did not differ significantly on the T3 treatment of 126.00 g/bird and In the second week, the adding treatments T2, T3, T4 and T5 recorded the highest values significantly compared to the control treatment (T1), which recorded the lowest value for that traits, It reached 290.00, 294.00, 291.00 and 294.00 g/bird compared to 265.00 g/bird respectively. In the third week, the T5 treatment was significantly excelled compared to the (T1) treatment, where it reached 484.00 compared to 406.00 g/bird, followed by the effect of T4 treatment, which did not significantly differ from the T2 and T3 treatments, where their values reached 480.00, 475.67 and 478.00 g/bird respectively, Where the treatment T2 recorded a significant increase compared to the control treatment (T1) at the fourth week, where it reached 539.00 compared to 451.00 g/bird, It was followed by the T3 and T4 treatments, then the T5 treatment, where their values reached 532.00 and 530.00 and 521.00 g/ bird, respectively. In the fifth week, the treatments of T2, T3 and T4 excelled on the control treatment (T1), where they reached 709.00, 704.00 and 709.00 compared to 600.00 g/t, respectively, and This was followed in the effect by the T5 treatment, which amounted to 698.00 g/

Table 3: Effect of adding different levels of Astaxanthin to the diet in the weekly and total weight gain rate of broilers chickens reared under high environmental temperatures (mean ± standard error).

Treatments (1)	The first week	second week	the third week	fourth week	The fifth week	Total weight gain
T1	125.00 ± 0.57c	265.00 ± 0.57b	406.00 ± 1.15c	451.00 ± 1.52d	600.00 ± 1.73c	1847.00 ± 1.15d
T2	127.00 ± 0.57ab	290.00 ± 0.57a	475.67 ± 2.60b	539.00 ± 1.52a	709.00 ± 2.00a	2140.67 ± 3.71a
T3	126.00 ± 0.57bc	294.00 ± 0.57a	478.00 ± 2.00b	532.00 ± 1.15b	704.00 ± 1.73a	2134.00 ± 0.57b
T4	127.00 ± 0.57 ab	291.00 ± 3.00a	480.00 ± 1.15 ab	530.00 ± 4.04b	709.00 ± 1.73a	2137.00 ± 0.57ab
T5	128.00 ± 0.57a	294.00 ± 2.00a	484.00 ± 1.00a	521.00 ± 1.52c	698.00 ± 1.15b	2125.00 ± 1.73c
Level of significance	**	**	**	**	**	**

Different letters within a single column mean that there are significant differences between the averages of the treatments.

** Means significant differences at (P <0.01) between the mean treatments.

(1) treatments include the following: - (T1) control treatment without addition, (T2) addition of Astaxanthin 10 mg / kg feed, (T3) addition of Astaxanthin 20 mg / kg feed, (T4) Add Astaxanthin 30 mg / kg feed, (T5) add Astaxanthin 40 mg / kg for feed.

t. As for the overall weight gain, the T2 treatment was significantly excelled to the control treatment (T1), where it reached 2140.67 g/bird compared to 1847.00 g/bird, respectively, and It was followed by treatment T4, then treatment T3 and finally T5 with values of 2137.00, 2134.00 and 2125.00 g/birds, respectively. The excelled in body weight and weight gain averages in favor of adding treatments may be due to the role of Astaxanthin as an effective antioxidant that has a major role in protecting cells, fats, proteins and membranous fats from oxidation by free radicals and removing all types of effective oxygen (ROS) resulting from bird exposure to heat stress, In addition to protecting tissues from damage and maintaining the level of protein, and then the development of the body and muscles, and what is reflected in the increase in body weight, the secretion of heat stress hormones decreases, and the secretion and activity of thyroid hormones increases, especially the hormone T3 Triiodothyronine, which increases metabolism and as a result, the increase in feed consumption turns into a Weight gain(Kim, Kim, 2018; Sztretye *et al.,* 2019), The reddish color that is characterized by Astaxanthin when mixed with the diet increases its glasses and luster in feeder, which leads to the desire of birds to eat more quantities of the diet despite the conditions of heat stress, where the bird at heat stress compensates for the consumption of feed at night.

Table 4 shows the effect of adding different levels of Astaxanthin to the diet in the average weekly and cumulative feed consumption of broiler chickens, where no significant differences were observed between all treatments in the value of that trait at the first week, as it reached 160.33, 159.00, 161.00 and 161. 00 compared to 159.00 g feed/birds, respectively, As for the second week, the T5 treatment of achieved a significantly higher (P <0.01) excelled compared to control (T1), as it reached 345.00 compared to 325.00 g feed/bird, respectively, The T2 treatment followed by T3 then T4 followed, where their values reached 340.00, 336.00 and 331.00 g for feed/bird, respectively, in the feed consumption rate, At the third week, a significant difference (P<0.01) was observed in favour of all addition treatments compared to the control treatment (T1) that recorded the lowest value for that trait, as the values reached 630.00, 624.00, 630.00 and 630.00 compared to 613.00 g for feed/bird, respectively, As for the fourth week, the T2 treatment was higher than the control (T1) treatment, which recorded the lowest value, as it reached 778.00 compared to 710.00 g for feed/bird. Similar to the effect of the T3 and T4 treatments, which amounted to 768.00 and 772.00 g for feed/bird, which did not significantly differ on the T5 treatment of 763.00 g feed/bird. In the fifth week, the T3 treatment achieved a excelled on the control treatment (T1), whose values continued to decline, as It reached 1130.00 compared to 996.00 g of feed/bird, followed by the effect of T4 treatment then T2 then T5, as their values reached 1110.00 and 1100.00 and 1085.00 g of feed/bird, respectively. As for the average of total feed consumption, the T2, T3 and T4 treatments were significantly different (P<0.01) on the control treatment (T1) whose values continued to decrease, reaching 3008.00, 3017.00 and 3004.00 compared to 2803.00 g/bird, respectively, followed by the T5 treatment of 2984.00 g/bird.

It is noted from table 5 the effect of adding different levels of Astaxanthin to the diet in the weekly feed conversion ratio for broilers chickens reared Under high environmental temperatures. In the first week, the treatment of addition of T5 recorded a significant improvement (P <0.01) on the control treatment (T1),It amounted to 1.25 compared to 1.27 and Similar to the improvement in the T2, T3 and T4, treatments whose values are 1.25, 1.26 and 1.26, respectively, while in the second week, both treatments (T3 and T4) recorded an improvement in the value of that trait on the control treatment (T1), reaching 1.14 and 1. 13 compared to 1.22, respectively, followed by the treatments (T2 and T5)

Table 4: Effect of adding different levels of Astaxanthin to the diet on the average weekly and total consumed feed of broilers chickens reared under high environmental temperatures (mean ± standard error).

Treatments (1)	The first week	second week	the third week	fourth week	The fifth week	total consumed feed
T1	159.00±0.57	325.00±0.57e	613.00±1.15b	710.00±3.46c	996.00±1.15e	2803.00±5.68c
T2	160.33±0.66	340.00±1.00b	630.00±2.88a	778.00±4.16a	1100.00±0.00c	3008.00±1.76a
T3	159.00±1.15	336.00±0.57c	624.00±2.08a	768.00±5.68ab	1130.00±1.52a	3017.00±3.78a
T4	161.00±0.00	331.00±0.57d	630.00±1.73a	772.00±3.46ab	1110.00±2.08b	3004.00±4.16a
T5	161.00±0.57	345.00±1.00a	630.00±1.00a	763.00±1.73b	1085.00±2.08d	2984.00±3.60b
Level of significance	N.S	**	**	**	**	**

Different letters within a single column mean that there are significant differences between the averages of the treatments.
** Means significant differences at (P <0.01) between the mean treatments.
(1) treatments include the following: - (T1) control treatment without addition, (T2) addition of Astaxanthin 10 mg / kg feed, (T3) addition of Astaxanthin 20 mg / kg feed, (T4) Add Astaxanthin 30 mg / kg feed, (T5) add Astaxanthin 40 mg / kg for feed.

Table 5: Effect of adding different levels of Astaxanthin to the diet in the weekly and total Total feed conversion ratio for broilers chickens reared under high environmental temperatures (mean ± standard error).

Treatments (1)	The first week	second week	the third week	fourth week	The fifth week	Total feed conversion ratio
T1	1.27±0.003a	1.22±0.00a	1.50±0.003a	1.57±0.003a	1.65±0.006a	1.44±0.001a
T2	1.25±0.003ab	1.17±0.003b	1.32±0.00b	1.44±0.011b	1.55±0.006c	1.35±0.001b
T3	1.26±0.003ab	1.14±0.00c	1.30±0.00d	1.44±0.005b	1.57±0.00b	1.34±0.001b
T4	1.26±0.005ab	1.13±0.01c	1.31±0.00c	1.45±0.005b	1.56±0.003bc	1.34±0.00b
T5	1.25±0.005b	1.17±0.003b	1.30±0.00d	1.46±0.00b	1.55±0.00c	1.35±0.001b
Level of significance	**	**	**	**	**	**

Different letters within a single column mean that there are significant differences between the averages of the treatments.
** Means significant differences at (P <0.01) between the mean treatments.
(1) treatments include the following: - (T1) control treatment without addition, (T2) addition of Astaxanthin 10 mg / kg feed, (T3) addition of Astaxanthin 20 mg / kg feed, (T4) Add Astaxanthin 30 mg / kg feed, (T5) add Astaxanthin 40 mg / kg for feed.

whose values were 1.17 and 1.17, respectively, In the third week, treatment T3 and T5 recorded a significant improvement on the control treatment (T1), where it reached 1.30 and 1.30 compared to 1.50 respectively, followed by treatment of T4 and T2, where it reached 1.31 and then 1.32, respectively. In the fourth week, the treatments T2, T3, T4 and T5 significantly improved (P <0.01) in the value of that trait on the control treatment (T1), as it reached 1.44, 1.44, 1.45 and 1.46 compared to 1.56, respectively. In the fifth week, the T2 and T5 treatment recorded a significant improvement on the control treatment (T1), where it reached 1.55 and 1.55 compared to 1.65 and The treatment of T4 did not significantly differ from treatment T3 and gave the value 1.56 and 1.57 respectively, while the total feed conversion ratio, the treatments of T2, T3, T4 and T5 recorded a significant improvement (P <0.01) on the control treatment (T1) and gave the value 1.35, 1.34, 1.34 and 1.35, compared to 1.44, respectively. The improvement in feed consumption and feed conversion ratio of the birds of the addition treatments is due to the appetite for birds to eat the feed to increase its glasses and a reddish color after a mixture with Astaxanthin, as well as its contribution to increasing the activity of useful microbial organisms in the digestive system of birds and their digestive enzymes, which leads to improved rate of digestion and absorption And increase its readiness from the nutrients present in the diet, which reflects positively on improving productive performance by increasing feed consumption rate Yonei *et al.,* (2013), (Senar *et al.,* 2010; Walker *et al.,* 2014) indicated that Carotenoid stimulate the appetite of birds and their average feed consumption increases, and this is reflected positively on the weight gain and the feed conversion efficiency of the bird, where there is an increase in weight an increase in feed consumption and that The significant increase in the rate of live body weight, weight gain , and rate of growth average may be due to the increase in the amount of feed consumption (Teeter and Smith, 1985) indicated a positive correlation (r = 0.87) between feed consumption and the rate of growth in broilers chickens.

Table 6 shows the effect of adding different levels of Astaxanthin to the diet in the percentage of weekly and total mortality of broilers chickens. The results of the statistical analysis showed that there was no mortality during the first three weeks of breeding for all treatments. While it was 0.66 and 3.33% in favor of the control treatment (T1), In the fourth and fifth weeks respectively,

Table 6: Effect of adding different levels of Astaxanthin to the diet in the percentage of weekly and total consumables of broilers chickens reared under high environmental temperatures (mean ± standard error).

Treatments (1)	The first week	second week	the third week	fourth week	The fifth week	total mortality rate
T1	0±0.00a	0±0.00a	0±0.00a	0.66±0.33a	3.33±0.88a	4.0±1.00a
T2	0±0.00a	0±0.00a	0±0.00a	0±0.00b	0±0.00b	0±0.00b
T3	0±0.00a	0±0.00a	0±0.00a	0±0.00b	0±0.00b	0±0.00b
T4	0±0.00a	0±0.00a	0±0.00a	0±0.00b	0±0.00b	0±0.00b
T5	0±0.00a	0±0.00a	0±0.00a	0±0.00b	0±0.00b	0±0.00b
Level of significance	N.S	N.S	N.S	**	**	**

Different letters within a single column mean that there are significant differences between the averages of the treatments.
**Means significant differences at (P <0.01) between the mean treatments.
(1) treatments include the following: - (T1) control treatment without addition, (T2) addition of Astaxanthin 10 mg / kg feed, (T3) addition of Astaxanthin 20 mg / kg feed, (T4) Add Astaxanthin 30 mg / kg feed, (T5) add Astaxanthin 40 mg / kg for feed.

the value of the total mortality ratio was 4.00% for the control treatment (T1) and there was no loss in all addition treatments. The reason for the absence of declines in the adding treatments may be the role of Astaxanthin in improving the immunity of the bird by increasing the levels of T and B lymphocytes and the production of interleukin and interferon-producing immunoglobulins (Nagayama *et al.,* 2014; Baralic *et al.,* 2015; Lin *et al.,* 2015), In addition to the effective role of Astaxanthin in increasing the proportion of beneficial microorganisms in the intestinal flora and its spread on the surface of the mucus layer spread on the network of myosin fibres covering the intestinal cells, it works to exclude and inhibit pathogenic bacteria that compete for their food and their binding sites, and to maintain the microbial balance in favor of beneficial bacteria inside the gut For birds early, which positively affects the general health of birds and reduces the occurrence of losses. The results of this study were consistent with the results of previous studies, which indicated that the addition of Astaxanthin to poultry diets contributed to a significant increase in production performance (Elwan *et al.,* 2019; Ao and Kim, 2019).

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