

Original Research Article

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Effect of Dietary Vitamin C and Corn Oil Supplementation on Broiler Performance under Heat Stress

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ABSTRACT

Four feeding trials were conducted to investigate the influence of vitamin C and corn oil supplementation on broiler performance under heat stress. In the first and second experiments, a total of 180 one-day broiler chicks were randomly distributed into three groups. The chicks were raised on open house system during summer season. The birds were fed three levels of vitamin C; 0, 500 and 1000 mg/kg diet, respectively (experiment 1), and corn oil; 0%, 3% and 5%, respectively (experiment 2). The two trials were lasted to 8 weeks. In experiment 3, a total of 180 three-week old broiler chickens were randomly distributed into six combination treatments in environmental chambers at 24° C and constant 35°C. The birds fed diet supplemented with 0%, 5% corn oil and 5% corn oil with 500 mg/kg diet, respectively. In the fourth experiment, the broiler chickens were randomly distributed into six combination treatments as mentioned in the 3rd trial. The birds were fed diet supplemented with 500 mg vitamin C/kg diet, 3% corn oil and 3% corn oil with vitamin C, respectively. The experiment was lasted to five weeks. Feed intake, body weight gain, and feed conversion ratio were measured. The findings showed that high ambient temperature had negative effect ($P<0.05$) on broiler performance. The supplementation of vitamin C or corn oil led to a significant improvement ($P<0.05$) in broiler performance. In general, the supplementation of corn oil or vitamin C improved the BWG and FCR for those birds raised under heat stress.

Keywords

Broiler, Heat stress,
Vitamin C,
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Introduction

The high ambient temperature may lead to decrease the broiler performance. The high temperature leads to reduce feed intake (FI) and body weight (BW) (Rafiee *et al.*, 2016;

Al-Sultan *et al.*, 2019) as well as body weight gain (BWG) for broiler chickens under cyclic high temperature (Attia *et al.*, 2017), and constant high temperature (Zeferino *et al.*, 2016). In addition, the temperature may reduce the feed conversion ratio (FCR) (Attia

et al., 2017; Al-Sultan *et al.*, 2019). It is also lead to increase the level of corticosterone hormone in blood (Rafiee *et al.*, 2016).

The studies showed that supplementation of vitamin C or corn oil to broiler diets under heat stress may alleviate the negative effects of high temperature. It was mentioned by (Rafiee *et al.*, 2016; Attia *et al.*, 2017; Al-Sultan *et al.*, 2019) that FI and BWG were improved in broiler chickens raised on high constant temperature when fed diet supplemented by vitamin C.

In addition, the productive performance could be improved for those birds fed diet containing high levels of vegetable oil. It was reported by (Pesti and Smith, 1984; Hussein, 1996) that FI, BWG and FCR were improved in broilers fed diet containing high levels of vegetable oil under heat stress. Since the supplementation of corn oil or vitamin C have beneficial effects under heat stress (Hussein, 1996), the objective of the current study was to investigate the influence of supplementation vitamin C and corn oil together to broiler diet under heat stress.

Materials and Methods

Four feeding trials were conducted at the Poultry Research Center, Faculty of Agriculture, University of Tripoli, Libya. In the first two experiments, a total of 180 one-day old broiler chickens (Shiver) were purchased from local hatchery and raised for eight weeks. The birds were wing-banded, weighed and randomly distributed into six dietary treatments.

Each treatment was divided into three replicates with 10 birds each. The birds were fed basal diets based on NRC (1994) recommendation (Table 1), and supplemented with 0, 500 and 1000 mg vitamin/ kg diet, respectively (experiment 1), and 0%, 3% and

5% corn oil, respectively (experiment 2). The birds were randomly distributed as mentioned previously.

The birds were raised in an open house system during summer season (August and September). The temperature was measured twice a day (8.00 am and 1.00 pm) inside and outside the building. The average temperature was 31°C and 29.50°C inside and outside the building, respectively.

In the third experiment, a total of 180 three-week old broiler chickens (Shiver) were individually weighed and randomly distributed into six combination treatments with six replicates and five birds each. The birds were fed basal diet supplemented with 0%, 5% corn oil and 5% corn oil with 500 mg vitamin C/ kg diet, respectively. The same procedures were applied for the 4th experiment.

However, the birds were fed basal diet supplemented with 500 mg vitamin C, 3% corn oil or 3% corn oil with 500 mg vitamin C/ kg diet. The 1st and 2nd experiments were lasted to eight weeks, whereas, the 3rd and 4th experiments were lasted to five weeks. FI, BWG and FCR were measured and calculated. All birds were vaccinated against Gumboro and Newcastle diseases at 14 and 21 day, respectively as described by (Alshelmani *et al.*, 2017).

Statistical analysis

Data were analyzed using completely randomized design in the 1st and 2nd experiment, whereas factorial completely randomized design was applied for the 3rd and 4th experiment. The procedure was done by statistical analysis software (SAS, 2003). The differences between the treatments were separated and compared by Duncan multiple range test at significant level at 0.05.

Results and Discussion

Table 2 shows the broiler performance in experiment 1. The supplementation of vitamin C to a significant improvement ($P < 0.05$) on FI, BWG and FCR. On the other hand, no significant differences ($P > 0.05$) were observed in comparison between the two levels of vitamin C on broiler diet. The positive improvement on broiler performance could be attributed to the compensation of vitamin C levels in their bodies as a result of

high temperature. These findings are consistent with (Pardue *et al.*, 1985; Pardue and Thaxton, 1986; McKee and Harrison, 1995; McKee *et al.*, 1997), who reported vitamin C supplementation led to minimize the negative effects in broiler chickens under heat stress.

The effect of corn oil on broiler performance is shown in Table 3. The addition of 3% or 5% corn oil to broiler diets led to a positive improvement ($P < 0.05$) in BWG and FCR.

Table.1 Ingredients of basal diet and nutrient composition

Ingredient (%)	Corn oil (%)		
	0	3	5
Yellow corn	65.000	57.815	51.500
Soybean meal (44%)	30.816	33.550	34.500
Wheat bran	0	1.500	4.930
Corn oil	0	3.000	5.000
Dicalcium phosphate	1.818	1.775	1.730
Limestone	1.330	1.340	1.340
Iodized salt	0.300	0.300	0.300
Vitamin and minerals premix¹	0.500	0.500	0.500
DL-methionine	0.236	0.220	0.200
Total	100.000	100.000	100.000
	Calculated analysis (%)		
Metabolizable energy (kcal/ kg)	2873.83	3001.76	3048.05
Crude protein	19.22	20.04	20.43
Calcium	1.00	1.00	1.00
Phosphorus	0.46	0.46	0.45
Lysine	1.07	1.15	1.16
Methionine + Cystine	0.90	0.90	0.90
Protein: Energy ratio	1:149.52	1:149.78	1:149.20

¹The vitamin and mineral premix provided per kg of diet: vitamin A, 4000000 IU; vitamin D3, 833333 IU; vitamin E 6666 mg; vitamin K3, 666 mg; vitamin B1, 666 mg; vitamin B2, 1666 mg; vitamin B6, 1000 mg; vitamin B12 5 mg, Folic acid, 33.3 mg; Biotin, 17 mg; Iron, 10 ; Copper, 2.167; Zinc, 18.334; Manganese 20.0; Iodine, 0.167; Cobalt, 0.034 and Selenium, 0.034.

Table.2 Effect of vitamin C supplementation (mg/ kg diet) on feed intake, body weight gain and feed conversion ratio in experiment 1*

Vitamin C (mg/ kg diet)	Feed intake (g)	BWG ¹ (g)	FCR ² (g Feed:g Gain)
0	4913.28 ± 75.09 ^a	2204.88 ± 25.35 ^a	2.05 ± 0.14 ^a
500	5402.00 ± 89.62 ^b	2627.04 ± 32.89 ^b	1.84 ± 0.13 ^b
1000	5502.72 ± 89.52 ^b	2590.96 ± 33.08 ^b	1.93 ± 0.14 ^b

*Mean ± SE. ^{a,b}values with different superscript in the same column are significantly different (P<0.05).

¹BWG: Body weight gain

²FCR: Feed conversion ratio

Table.3 Effect of added corn oil on feed intake, body weight gain and feed conversion ratio in experiment 2*

Corn oil (%)	Feed intake (g)	BWG ¹ (g)	FCR ² (g Feed:g Gain)
0	4913.28 ± 75.09 ^a	2204.88 ± 25.35 ^a	2.05 ± 0.14 ^a
3	5088.00 ± 79.40 ^b	2444.56 ± 26.24 ^b	1.87 ± 0.15 ^b
5	5098.40 ± 89.15 ^b	2651.20 ± 32.84 ^b	1.73 ± 0.13 ^b

*Mean ± SE. ^{a,b}values with different superscript in the same column are significantly different (P<0.05).

¹BWG: Body weight gain

²FCR: Feed conversion ratio

Table.4 Effect of ambient temperature, vitamin C and corn oil on feed intake, body weight gain and feed conversion ratio in experiment 3*

Temperature (°C)	Treatments		Feed intake (g)	BWG ¹ (g)	FCR ² (g Feed: g Gain)
	Vitamin C (mg/ kg diet)	Corn oil (%)			
24	0	0	4580.85± 34.68 ^a	2134.00 ± 14.34 ^a	2.21 ± 0.12 ^a
	0	5	4542.10 ± 32.65 ^a	2417.65 ± 18.56 ^b	1.99 ± 0.13 ^{ab}
	500	5	4432.00 ± 36.24 ^a	2515.85 ± 16.03 ^b	1.81 ± 0.11 ^b
35	0	0	2581.90 ± 18.82 ^b	1140.85 ± 20.33 ^c	2.60 ± 0.20 ^a
	0	5	2658.00 ± 27.00 ^b	1416.40 ± 22.41 ^d	2.01 ± 0.12 ^{ad}
	500	5	2855.90 ± 18.69 ^c	1656.50 ± 17.75 ^e	1.85 ± 0.10 ^{bd}

*Mean ± SE. ^{a-e} values with different superscript in the same column are significantly different (P<0.05).

¹BWG: Body weight gain

²FCR: Feed conversion ratio

Table.5 Effect of ambient temperature, vitamin C and corn oil on feed intake, body weight gain, feed conversion ratio in experiment 4*

Treatments					
Temperature (°C)	Vitamin C (mg/kg diet)	Corn oil (%)	Feed intake (g)	BWG ¹ (g)	FCR ² (g Feed: g Gain)
24	500	0	3932.80± 29.05 ^a	1961.00 ± 16.00 ^a	2.07 ± 0.10 ^a
	0	3	3908.25 ± 27.48 ^a	1984.95 ± 12.88 ^a	2.00 ± 0.08 ^a
	500	3	3817.10 ± 34.30 ^a	1970.10 ± 17.66 ^a	1.99 ± 0.10 ^a
35	500	0	2337.30 ± 16.40 ^b	943.00 ± 14.14 ^b	2.92 ± 0.19 ^b
	0	3	2323.90 ± 16.47 ^b	1136.65 ± 12.12 ^c	2.23 ± 0.16 ^a
	500	3	2356.60 ± 22.27 ^b	1192.40 ± 16.33 ^c	1.19 ± 0.15 ^a

*Mean ± SE. ^{a-c} values with different superscript in the same column are significantly different (P<0.05).

¹BWG: Body weight gain; ²FCR: Feed conversion ratio

The effect of vitamin C and corn oil on broilers under heat stress is presented in table 4. The high temperature was negatively affected (P<0.05) broiler performance. There was improvement (P<0.05) in FI for those birds fed diet supplemented by 5% corn oil with 500 mg vitamin C/kg diet under heat stress.

There was significant improvement (P<0.05) in BWG and FCR for those birds fed diet supplemented with 5% corn oil with or without vitamin C at 24°C or 35°C. Birds fed diet supplemented with corn oil with vitamin C showed better (P<0.05) FI and BWG under heat stress. Table 5 shows the effect of diet supplemented with corn oil and vitamin C on broiler performance under heat stress.

The high temperature was negatively affected (P<0.05) broiler performance. There was significant improvement (P<0.05) in BWG and FCR for those birds fed diet supplemented with 3% corn oil with or

without vitamin C at 24°C or 35°C. The positive improvement in broiler performance for birds fed diet supplemented with corn oil (experiment 2,3 and 4) could be attributed to the energy utilization and decrease of heat increment (Rafiei-Tari *et al.*, 2018).

These findings are in agreement with (Mateos and Sell, 1981; Hussein, 1996), who mentioned that feeding diet containing high levels of vegetable oil can improve broiler performance under heat stress. The synergistic effect of vitamin C and corn oil may play an important role to alleviate heat stress on broiler which positively reflected in their performance.

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