ADDING DIFFERENT LEVELS OF TURMERIC POWDER AND CURCUMIN IN THE DIET ON SOME SERUM BIOCHEMICAL OF BROILER REARED UNDER NORMAL AND HEAT STRESS CONDITIONS

M. M. Mustafa [(1)] F. Karadas[(2)] I. T. Tayeb[(1)]
Researcher Prof. Assistant Prof.
[1]Dep. Of Animal Sci.-Coll. Agric. Engine. Sci. University of Duhok. Iraq
[2]Yuzuncu Yil University, Faculty of Agriculture, Dep. of Animal Science. Van/ Turkey
E-mail: merkhan@uod.ac

ABSTRACT

This study was carried out to elucidate the effect of supplementing different levels of turmeric powder and curcumin on serum lipid profile, protein, thyroid hormones (T3 and T4), ALT, AST enzymes, uric acid, creatine kinase and glucose. Seven-hundred and fifty chicks Ross 308, received from a local hatchery. Chicks divided into two groups, normal and heat stressed conditions, with 5 treatments and 3 replicates in which 25 chicks for each. The dietary treatments composed of basal diet (control), 50 g curcumin/ton, 75 g curcumin/ton, 1.65 kg turmeric powder/ton and 2.5 kg turmeric powder/ton. Results showed that adding turmeric powder and curcumin had significant effects (P<0.05) on serum lipid profile, protein profile, T3, T4, ALT enzyme, creatine kinase, uric acid and glucose. Concerning the rearing condition, which had a significant effect (P<0.05) on the serum cholesterol, LDL, total protein, albumin, T3 hormone, ALT, AST enzymes, creatine kinase, uric acid and glucose.

Key words: heat stress, turmeric powder, curcumin, broiler, serum profile.

مجلة العلوم الزراعية العراقية -2021 :52 (1):10-19 مصطفى وآخرون

اضافة مستويات مختلفة من مسحوق الكركم الخام و الكركم المحورفي عليقة فروج اللحم على الاداء الانتاجي , صفات الذبيحة , مستوى المناعة و صحة الامعاء تحت التربيه الطبيعية و الاجهاد الحراري.

ميرخان مهدي مصطفى[(1)] فلز كاراداش[(2)] احسان توفيق طيب[(1)]
الباحث استاذ استاذ مساعد
[1] قسم الانتاج الحيواني–كلية علوم الهندسة الز ا رعية – جامعة دهوك– عراق
[2] قسم الانتاج الحيواني–فاكولتي الزراعة – جامعة يوزنجيل –وان–تركيا

المستخلص

اجريت هذة التجربة في حقول كلية علوم الهندسه الزراعية/ قسم الانتاج الحيواني / جامعة دهوك لمعرفة تاثير اضافة مستويات مختلفة من مسحوق الكركم الخام و الكركم المحور على الاداء الانتاجي,صفات الذبيخة, مستوى المناعة و مورفولوجية الصائم. حصلت على 750 فرخة من مفقس محلي ووزعت على ضروفين للتربية (طبيعى و الاجهاد الحراري) مع خمسة معاملات 3 مكررات لكل واحذ(25 فرخة) . اضهرت النتائج ان المعاملات تحسنت معنويا(P<0.05) دهنيات مصل الدم مستوى بروتينات مصل الدم T3, T4 , انزيم ALT , كيناز الكيراتين , حامض اليوريك والكلوكوز. بالنسبة لظروف التربية , الاجهاد الحراري تاثر بشكل معنوي (P<0.05)على نسبة الكوليسترول, LDL البروتين الكلي , البومين, هورمون T3 , انزيم ALT و AST, كيناز الكيراتين , حامض اليوريك والكلوكوز في مصل الدم . ادى الاجهاد الحراري معنويا (P<0.05) الى نقص نسبه الامعاء الدقيقة من الوزن الحي مقارنة مع التربية الطبيعية ولكن صفات الذبيحة و الاعضاء الداخلية الاخرى لم تتاثر بظروف التربية. تاثرت الاجهاد الحراري بشكل معنوي (P<0.01) على نقص مستوى المناعة ضد مرض النيوكاسل و الكمبورو. كذلك , الاجهاد الحراري تاثرت بشكل معنوي (P<0.01) على صفات الصائم

الكلمات المفتاحية:الاجهاد الحراري , كركم خام , كركم محور , مصل الدم

Received:22/2/2020, Accepted:3/5/2020

INTRODUCTION

In the poultry production, high ambient temperature is an important stress factor in tropical countries (19). Under heat stress circumstances, birds tend to maintain homeostasis through several strategies, for instance, biochemical, physiological and behavioral (25). Different experimental situations should be undertaken to indicate the serum biochemical levels in which the variation in this aspect is directly related to the climate factors (6). Economic losses in poultry production are caused through marked deviation in the level of blood biochemical and growth rate. This may be due to the effect of high ambient temperature on the performance and productivity by reducing the feed intake and nutrient utilization (27). Triglyceride, serum cholesterol, packed cell volume, total white blood cells and hemoglobin are the main biochemical parameters that are altered by heat stress (7). Many studies have been carried out on this trend through the manipulation of specific parameters, including biochemical and electrolyte. Researchers stated that these parameters may be useful through realistic evaluation of health conditions, nutritional status, organ function and management practices. Out of these, light has been placed on some specific parameters such as total protein, aspartate aminotransferase (AST), albumin, alkaline phosphatase (ALP), creatine kinase (CK), glucose, sodium, chloride, and potassium (16; 30). Hence, in nutritional factors, particularly turmeric powder had favorable effects on heat stress in poultry through various feeding experiments. Overall, researchers found that feeding turmeric powder at pre- and post-application of heat stress led to high cholesterol HDL fraction, low concentrations of blood total cholesterol and LDL-cholesterol. Additionally, they observed a decrease in the activity of several enzymes during heat stress. An improvement has been obtained by the activity of GPx and SOD by supplementing turmeric powder. These led to a protection in the organism from the increase of malondialdehyde (MDA) concentrations, oxidative damage, which indicate an enhancement of antioxidant and detoxifying status of birds (9; 15; 30). Research on this area had used pure curcumin and its effect on heat stress in quails. In the findings, heat stress alleviation was observed through modification of the heat shock protein 70 and hepatic nuclear transcription factors (27). Therefore, the aim of present study was to elucidate the effect of supplementing different levels of turmeric powder and curcumin on serum lipid profile, protein, thyroid hormones (T3 and T4), ALT, AST enzymes, uric acid, creatine kinase and glucose under normal and heat stress conditions.

MATERIALS AND METHODS

Subjects and experimental design

Seven-hundred- and fifty-day old chicks (Ross 308) were provided by a local hatchery. After arrival, chicks were weighed. They were equally and randomly placed in two halls, which were stressed and normal condition. Under each condition, five groups were made with three replicates (25 chicks each) for each group. Floor cages (1.6 m x 2 m) were used to keep the birds. The halls were equipped with essential equipment including heating facilities and adjustable setting of temperature. In stresses hall, the temperature was set in 37 ^{o}C for the first day before gradual decrease to reach 33 ±1^{o}C at the 3rd week of age and this was left constant until the end of the experiment. However, the temperature of 34 ^{o}C was used on the first day then it was decreased gradually to 24 ^{o}C – 25 ^{o}C until the end of the experiment. In both halls, continuous incandescent white light was used.

Ethical consideration

Rearing of the birds was undertaken according to the Animal Ethical Guidelines of Department of Animal Production, College of Agricultural Engineering Sciences, University of Duhok as a part of the PhD thesis. Therefore, the study was ethically approved.

Feed and treatments

To meet the nutrient requirements of the broilers, the chickens were fed a basal diet, which was prepared according to National Research Council (1994) (Table 1). Dry and fresh roots of turmeric were purchased from local markets and were powdered by a mechanical instrument. Additionally, a prepared commercial curcumin (Force 6® Poultry) was obtained from Phode Company, France. For better homogenization, at first, an

appropriate amount of turmeric powder or curcumin was mixed with a small amount of the basal diet; then, a small amount of it was mixed with larger amounts of the basal diet. The starter diet was provided to birds from 1-17 days of age. Later, from 18-35 days, the birds were fed on the finisher diet. Food and water were provided to the birds *ad libitum.* The experimental groups were: T1: basal diet, T2: 50g of curcumin powder/ton of feed, T3: 75g of curcumin powder/ton of feed, T4: 1.65 kg of turmeric powder/ton of feed and T5: 2.5kg of turmeric powder/ton of feed.

Data collection: serum biochemical parameters and hormone level measurements

The serum biochemical parameters were measured according to (3). For this purpose, at 35 days of the experiment, two blood samples were taken from each cage. Immediately, the samples were saved on ice and transferred to the laboratory. Later, they were centrifuged for 10 minutes at 1500g to separate the serum and stored at -20 °C until they analeysed.. The measured parameters were triglyceride, glucose, globulin, albumin, total protein, cholesterol, HDL, LDL, VLDL, AST, ALT, uric acid, creatine kinase T3 and T4. The Auto analyzer (Cobas 6000, Roche Diagnostics. Germany) was used for measuring data.

Table 1. the composition of the basal diets

Ingredients (kg)	Starter (kg/ton) 1- 17 days	Grower (kg/ton) 18 – 35 days
Corn	472	495
Wheat flour	50	50
Wheat bran	40	50
Soybean meal 46%	370	340
Vegetable oil	23	24
limestone	10	8
Dicalcium phosphate	7	6
DL methionine	0.200	0.200
L- lysine	1	0.5
Anti-toxin	1	1
Salt	1	1
Premix [1]	25	25
Anti coccidial	0.250	0.250
Enzyme	0.5	0.5
Analyzed chemical composition		
Moisture (%)	11.57	11.78
Crude protein (%)	22.49	20.65
Energy Kcal/kg	2966	3055
Fat (%)	2.97	3.36
Fiber (%)	2.18	2.64
Ash (%)	4.83	3.34
Starch (%)	44.22	46.29
Sugars (%)	4.02	3.87
Calcium (%)	1.12	0.97
Available phosphorous (%)	0.58	0.53

[1]**18.4% crud protein%, 73.4 %crud ash, 0.82 % crud fiber, 0.4 % crude fat, 14.4% calcium, 0.21% magnesium, 6.40 % sodium, 4.53% phosphorus .Additive per kg of premix, lysine 73.8g/kg, methionine 82.7 g/kg, threonine 1.3 g/kg, tryptophan 0.4g/kg , Fe 2400 mg, potassium iodine80 mg, Cu 600 mg, Mn 3200 mg, Zn 2400 mg, Se 13 mg, Vit A 400000 IU, D3 12000 IU, E 2000 mg, K3 100 mg, B1 120 mg, B2 300 mg, B5 600 mg, B3 2000 mg, B6 200 mg, B12 1200 mcg, B9 60 mg, B4 20000 mg, Vit H 6000 mcg.**

Statistical analysis

The data were placed in Microsoft Excel spreadsheet so as to be prepared for analysis. Then, they were projected to SAS statistical software program. In the SAS statistical package (PROC GLM) was used to determine the significance of the main effects (SAS, 2013). Duncan's multiple range test was used to detect the differences between individual treatment means.

RESULTS AND DISCUSSION

Serum lipid profile :The interaction of the experimental factors according to Duncan significantly increased the cholesterol content of blood serum in T1S (141.16 ±1.55). Whereas, the lowest cholesterol content was detected in T2N (120.83 ±3.87) followed by T3N and T5N (123.16 ± 2.78) (Table 2). There was a significant ($P<0.01$) interaction between the experimental factors indicating the lower HDL in control birds under both rearing conditions. Furthermore, the interaction of the experimental factors revealed the highest ($P<0.05$, Duncan test) LDL in T1S. However, the lower LDL content was found in T5N followed by T2N and T1N. A significant interaction was between the experimental factors indicating the higher ($P<0.05$, Duncan

test) VLDL and triglycerides in control birds in both rearing conditions. Whereas, the lowest VLDL and triglycerides were in T5N. Considering as a main factor, the level of the additives had significant effects on serum biochemistry parameters that investigated in this experiment. The concentration of serum cholesterol, LDL, VLDL and triglyceride were significantly decreased (P<0.01); while, that of HDL was significant increased (P<0.01) in all treatments compared to the control. These results were in line with the findings of (15) who found that adding different levels of turmeric powder significantly decreased cholesterol, LDL and increased HDL in broiler at 42 days of age. Moreover, (11) recorded that adding turmeric powder in broiler diet had significant effect on total cholesterol, HDL and LDL in comparison with the control diet. Furthermore, (29) estimated that adding different levels of curcumin in broiler diet had a significant effect on the broiler serum total cholesterol, HDL, LDL VLDL and triglyceride evaluated on the basis of normal diet.However, results of this study were in contrast of (28), who found that turmeric powder had no significant effect on the serum cholesterol level compared to the control diet. Furthermore, (1) stated adding different levels of turmeric had no significant effect on the broiler serum total cholesterol, HDL and LDL compared to the normal diet. Significantly the higher cholesterol and LDL contents were recorded in stressed birds than those that were reared under normal conditions (Table 2). Our results were in line with the findings of (5), who reported that rearing chicken under heat stressed conditions significantly increased serum content of total cholesterol and LDL; while, it had no significant effect on the serum HDL, VLDL and triglyceride compared to normal condition. Moreover, (17) mentioned that heat stress conditions significantly increased serum total cholesterol in dealing with stress compare to normal condition. Results of serum colesterol were contrary to the findings of (16) who found that exposure of chicken to the heat stress had no significant effect on the serum cholesterol level.

Serum protein profilf: The interaction of the experimental factors according to Duncan test significantly increased the albumin, globulin and total protein content of blood serum in T2S which were 1.281 ± 0.012, 2.488 ± 0.201 and 3.770 ± 0.211, respectively. On the other hand, the lower albumin, globulin and total protein contents were recorded in T1N being 1.106 ± 0.026, 1.860 ± 0.070 and 2.966 ± 0.080, respectively (Table 3). Regarding the effect of main factor, the level of the additives had significantly (P<0.01) increased albumen, globulin, total protein and albumin to globulin ratio referring to control. Results were in line with findings of (26), who found that adding different levels of turmeric powder had no significant effect on total protein and globulin of broiler serum at 35 days of age compared to the control diet. Furthermore, (10) claimed that there was no significant effect on total protein concentrations in broiler chickens treated with different levels of turmeric powder in comparison to control. Additionally, (1) found that adding different levels of turmeric powder in broiler diet had no significant effect on serum albumin to globulin ratio compared to control. On the other hand, results were in contrast with the findings of (2) who found a significant increase in serum total protein concentration in broiler chickens that received a diet containing different levels of turmeric powder reared under normal conditions. Moreover, (21) reported that using turmeric powder in broiler diet had significantly (P<0.02) effect on the serum total protein and globulin of broiler birds compared to control diet. Chicken with stressed conditions had significantly (P<0.01) higher albumin, total protein and increased albumin to globulin ratio (P<0.05) compared to control (Table 3). These results were consistent with the findings of (5 ; 16), who reported that heat stressed conditions has significant effect on the serum globulin and albumin to globulin ratio compared to the normal condition. Whereas, our results were not in line with the findings of (5;16), who reported that heat stressed conditions had no significant effect on broiler serum total protein and albumin content compared to the normal thermal condition

Table 2. Effect of adding different levels of turmeric powder and curcumin in broiler diet on serum lipid profile of chicken reared under normal and heat stress condition

	Cholesterol mg/dl	HDL mg/dl	LDL mg/dl	VLDL mg/dl	Triglyceride mg/dl
Mean	129.05 ± 1.25	88.80 ± 0.94	29.61 ± 0.68	6.58 ± 0.13	32.93 ± 0.66
T1 N	135.16 ± 1.83 ab	79.66 ± 1.54 c	30.66 ± 0.80 abc	8.24 ± 0.15 a	41.20 ± 0.79 a
T2 N	120.83 ±3.87 d	93.16 ± 1.60 a	26.00 ± 1.46 cd	6.10 ± 0.27 bc	30.50 ± 1.36 bc
T3 N	122.16 ± 2.38 cd	90.16 ± 1.10 a	27.00 ± 1.80 cd	6.36 ± 0.35 bc	31.83 ± 1.77 bc
T4 N	129.83 ± 6.77 bcd	89.83 ± 2.60 a	29.00 ± 3.56 bcd	6.06 ± 0.17 bc	30.33 ± 0.88 bc
T5 N	123.16 ± 2.78 cd	87.50 ± 3.33 ab	24.50 ± 2.09 d	5.66 ± 0.33 c	28.33 ± 1.66 c
T1 S	141.16 ±1.55 a	81.00 ± 1.57 bc	35.33 ± 1.38 a	8.16 ±0.38 a	40.83 ± 1.90 a
T2 S	126.50 ± 2.37 bcd	94.83 ± 3.91 a	28.33 ± 1.05 bcd	6.26 ± 0.12 bc	31.33 ± 0.61 bc
T3 S	128.16 ± 2.79 bcd	93.50 ± 2.53 a	32.83 ± 0.87 ab	5.96 ± 0.20 bc	29.83 ± 1.01 bc
T4 S	132.66 ± 2.27 abc	88.33 ± 2.47 a	33.83 ± 1.53 ab	6.66 ± 0.18 b	33.33 ± 0.91 b
T5 S	130.83±4.02 abcd	90.00 ± 2.28 a	28.66 ± 1.89 bcd	6.36 ± 0.22 bc	31.83 ± 1.1 bc
Normal	126.23 ± 1.92 b	88.06 ± 1.24	27.43 ± 0.98 b	6.48 ± 0.20	32.44 ± 1.01
Stress	131.86 ± 1.47 a	89.53 ± 1.42	31.80 ± 0.77 a	6.68 ± 0.17	33.43 ±0.87
T1	138.16 ± 1.46 a	80.33 ± 1.06 b	33.00 ± 1.03 a	8.20 ± 0.19 a	41.01± 0.98 a
T2	123.66 ± 2.33 c	94.00 ± 2.03 a	27.16 ± 0.92 b	6.18 ± 0.14b	30.91 ± 0.72 b
T3	125.16 ± 1.97 bc	91.83 ±1.41 a	29.91 ± 1.29 ab	6.16 ±0.20 b	30.83 ±1.02 b
T4	131.25 ± 3.43 b	89.08 ± 1.72a	31.41 ±1.99 a	6.36 ±0.15 b	31.83 ±0.75 b
T5	127.00 ± 2.60 bc	88.75 ± 1.96 a	26.58 ±1.48 b	6.01 ±0.21 b	30.08 ± 1.09 b
P values					
Interaction	0.969	0.888	0.907	0.185	0.185
Environment	0.011	0.34	0.0004	0.22	0.22
Treatments	0.0006	0.0001	0.003	0.0001	0.0001

T1 control, T2 50g curcumin per ton, T3 75g curcumin per ton, T4 1.65 kg turmeric powder per ton, T5 2.5 kg turmeric powder per ton .N = normal condition. S= heat stress condition

Table 3. Effect of adding different levels of turmeric powder and curcumin in broiler diet on albumen, globulin, total protein and albumin to globulin ratio of chicken serum reared under normal and heat stress condition

	Albumen mg/dl	Globulin mg/dl	Total protein mg/dl	Albumen to globulin ratio
Mean	**1.188 ± 0.010**	**2.104 ± 0.038**	**3.293 ± 0.044**	**0.57 ± 0.007**
T1 N	**1.106 ± 0.026 e**	**1.860 ± 0.070 c**	**2.966 ± 0.080 e**	**0.59 ±0.024**
T2 N	**1.203 ± 0.017abcd**	**2.346 ± 0.138 ab**	**3.550 ± 0.153 ab**	**0.52 ± 0.024**
T3 N	**1.151 ± 0.022 cde**	**2.123 ± 0.118 bc**	**3.275 ± 0.127 bcde**	**0.55 ± 0.030**
T4 N	**1.116 ± 0.037 de**	**1.933 ± 0.061 c**	**3.050 ± 0.090 ed**	**0.57 ± 0.016**
T5 N	**1.193 ± 0.016 bcd**	**1.965 ± 0.039 c**	**3.158 ± 0.050 cde**	**0.60 ± 0.009**
T1 S	**1.146 ± 0.010 cde**	**1.958 ± 0.031 c**	**3.105 ± 0.028 cde**	**0.58 ± 0.012**
T2 S	**1.281 ± 0.012 a**	**2.488 ± 0.201 a**	**3.770 ± 0.211 a**	**0.52 ± 0.033**
T3 S	**1.261 ± 0.053 ab**	**2.175 ± 0.077 bc**	**3.436 ± 0.096 abc**	**0.58 ± 0.031**
T4 S	**1.230 ± 0.011 abc**	**2.165 ± 0.083 bc**	**3.395 ± 0.075 bcd**	**0.57 ± 0.027**
T5 S	**1.195 ± 0.031 bcd**	**2.033 ± 0.080 bc**	**3.228 ± 0.099 bcde**	**0.59 ± 0.022**
Normal	**1.154 ± 0.012 b**	**2.045 ± 0.050**	**3.200 ± 0.058 b**	**0.57 ± 0.010**
Stress	**1.223 ± 0.015 a**	**2.168 ± 0.056**	**3.387 ± 0.064 a**	**0.57 ± 0.011**
T1	**1.126 ± 0.014 c**	**1.909 ± 0.039 c**	**3.035 ± 0.045 c**	**0.59 ± 0.013 a**
T2	**1.242 ± 0.015 a**	**2.417 ± 0.11 a**	**3.660 ± 0.12 a**	**0.52 ± 0.019 b**
T3	**1.206 ± 0.032 ab**	**2.149 ± 0.067 b**	**3.355 ± 0.097 b**	**0.56 ± 0.021 ab**
T4	**1.173 ± 0.025 bc**	**2.049 ± 0.060 bc**	**3.222 ± 0.076 bc**	**0.57 ± 0.015 a**
T5	**1.194 ± 0.016 ab**	**1.999 ± 0.043 bc**	**3.193 ± 0.054 bc**	**0.59 ± 0.011 a**
P values				
Interaction	**0.21**	**0.90**	**0.793**	**0.852**
Environment	**0.0002**	**0.073**	**0.011**	**0.92**
Treatments	**0.0021**	**0.0001**	**0.0001**	**0.02**

T1 control, T2 50g curcumin per ton, T3 75g curcumin per ton, T4 1.65 kg turmeric powder per ton, T5 2.5 kg turmeric powder per ton .N = normal condition. S= heat stress condition

Thyroid hormones and alt, ast enzymes

The interaction of the experimental factors significantly increased (P<0.05) T3, and T4 (according to Duncan test) contents of blood serum in T2N being 2.76 ± 0.14 and 24.16 ± 1.07, respectively (Table 4). Whereas, the lowest contents of T3 and T4 were 1.53 ± 0.10 and 14.63 ± 0.99, respectively. Interaction among experimental factors according to Duncan test had significantly decreased the level of ALT in blood serum compared to control under both rearing conditions. The higher level of ALT was for T1S (7.15 ± 0.19); while, the lower content of ALT was for T2N (3.53 ± 0.17). Regarding the main factor of experiment, adding different levels of turmeric powder and curcumin significantly (P<0.01 increased T3 and T4 content of serum although, significantly (P<0.01) decreased the content of ALT enzyme in blood serum in opposition to control. Results were in agreement with the finding of (32), who stated that adding turmeric powder in broiler diet reared under heat stressed conditions significantly increased T4 in serum compared to normal diets. Furthermore, (20) claimed that adding turmeric powder under heat stress significantly decreased ALT enzyme levels and had no significant effect on AST level in broiler serum compared to control diets. In addition, (10; 15) announced that supplementing different levels of turmeric powder significantly decreased the concentration of ALT enzyme in serum compared to control ration. Moreover, (18) reported that using various levels of curcumin had no significant effect on the AST enzyme in serum compared to control. (1) Declared that using different levels of turmeric powder had no significant effect on serum AST enzyme levels in comparison to control. On the other hand, results obtained were against

the findings of (18) who found that chicken fed diets containing different levels of curcumin had no significant effect on ALT enzyme concentration in serum. Additionally, (1) stated that chicken fed different doses of turmeric powder had no significant effect on serum ALT enzyme concentration compared to chicken fed normal diet. Similarly, (32) mentioned that adding turmeric powder in broiler diet reared under heat stressed conditions had significantly decreased T3 hormone concentration in serum compared to control. Heat stressed conditions significantly ($P<0.01$) decreased the content of T3 in blood serum compared to normal condition being 2.04 ± 0.07 and 2.49 ± 0.07, respectively. On the other hand, chicken reared under heat stress conditions had significantly higher ALT being 5.81 ± 0.17 and4.00 ± 0.12 and AST content of blood serum being 384.76 ± 8.20 and 343.86 ± 13.36), respectively (Table 4). Results recorded in the present study are in line with the results of (13 and 4). They found that heat stress conditions significantly reduced the concentration of T3. Furthermore, (22) reported that chicken reared under heat stressed conditions at the age of 28 days, had significantly lower concentration of T3 hormone compared to normal condition. Moreover, (16) reported that heat stress conditions had significant effect in increasing the levels of AST and ALT enzymes in broiler serum with reference to normal condition. (5) claimed that AST level was significantly higher for broiler reared under heat stress condition. On the other hand, the results of this study are contrary to the findings of (23), who found that heat stress conditions significantly increased T3 and decreaseT4 concentrations in serum compared to natural conditions. Furthermore, (5) indicated that heat stress conditions had no significant effect on the ALT level of broilers compared to normal condition. Ultimately, (8) reported that adding turmeric powder in broiler diet reared under heat stress significantly decreased AST enzyme in serum measured against the control diet.

Serum creatin kinase, uric acid and glucose:

Experimental factor interacted to affect significantly ($P<0.01$) on the level of serum creatin kinase, uric acid and glucose (according to Duncan test). The higher levels of creatin kinase, uric acid and glucose were recorded for T1S, which were 6881.67 ± 84.34, 7.38 ± 0.09 and 236.66 ± 4.14, respectively. The lower serum contents of creatin kinase, uric acid and glucose were for T2N being 4516.67 ± 216.66 and 4.76 ± 0.13. Turmeric powder and curcumin significantly ($P<0.01$) deceased the serum creatin kinase, uric acid and glucose compared to control. The results of this study are similar to the findings of (20), who declared that adding turmeric powder in broiler diets reared under heat stressed conditions had significantly reduced the uric acid in serum compared to control diet. Furthermore, (24) stated that adding different levels of turmeric had significantly decreased serum glucose, uric acid and creatin kinase of chicken reared under heat stressed conditions measured against normal diet. In contrary, our results were in a disagreement with the finding of (15; 26), who investigated that adding different levels of turmeric powder had no significant effect on serum creatin kinase of broilers reared under heat stressed conditions as compared to control. In addition, some researchers reported that using turmeric powder in broiler diet had no significant effect on the serum uric acid compared to control (12). Moreover, it was found that serum glucose levels were not significantly affected by adding different levels of turmeric in broiler diet compared to control (28 ; 26). Concerning the rearing conditions, heat stress conditions had significantly ($P<0.01$) increased serum creatin kinase, uric acid and glucose compared to normal condition. These results are in agreement with the finding of (16) who reported that serum creatin kinase level of broiler reared under heat stressed conditions significantly was higher than those reared under normal conditions. Whereas, the results of present study are in contrast to the findings of (5) who claimed that heat stress conditions had no significant effect on the serum glucose and uric acid levels.

Table 4. Effect of adding different levels of turmeric powder and curcumin in broiler diet on thyroid hormone and liver enzymes of chicken reared under normal and heat stress condition

	T3 nmol/ml	T4 nmol/ml	ALT U/L	AST U/L
Mean	2.26 ± 0.05	20.82 ± 0.46	4.90 ± 0.15	364.31 ± 8.22
T1 N	2.01 ± 0.14 cd	17.26 ± 1.54 d	5.13 ± 0.07 c	379.16 ± 49.42
T2 N	2.76 ± 0.14 a	24.16 ± 1.07 a	3.53 ± 0.17 d	316.50 ± 24.31
T3 N	2.50 ± 0.08 ab	21.90 ± 1.00 ab	3.75 ± 0.07 d	323.33 ± 12.99
T4 N	2.60 ± 0.14 ab	20.75 ± 0.77 bc	4.00 ± 0.18 d	354.16 ± 36.76
T5 N	2.56 ± 0.15 ab	22.81 ± 1.19 ab	3.61 ± 0.19 d	346.16 ± 11.09
T1 S	1.53 ± 0.10 e	14.63 ± 0.99 e	7.15 ± 0.19 a	422.83 ± 31.27
T2 S	2.27 ± 0.06 bc	23.63 ± 0.22 ab	4.91 ± 0.20 c	371.33 ± 1.78
T3 S	2.31 ± 0.05 bc	22.65 ± 0.29 ab	5.21 ± 0.26 c	373.66 ± 7.28
T4 S	1.72 ± 0.05 de	18.40 ± 0.51 cd	6.33 ± 0.12 b	379.00 ± 23.37
T5 S	2.37 ± 0.09 b	22.05 ± 0.37 ab	5.43 ± 0.29 c	377.00 ± 1.91
Normal	2.49 ± 0.07 a	21.38 ± 0.64	4.00 ± 0.12 b	343.86 ± 13.36 b
Stress	2.04 ± 0.07 b	20.27 ± 0.65	5.81 ± 0.17 a	384.76 ± 8.20 a
T1	1.77 ± 0.11 c	15.95 ± 0.96 c	6.14 ± 0.31 a	401.00 ± 28.65
T2	2.52 ± 0.1 a	23.9 ± 0.53 a	4.22 ± 0.24 c	343.91 ± 14.26
T3	2.40 ± 0.05 a	22.27 ± 0.51a	4.48 ± 0.25 c	348.50 ± 10.39
T4	2.16 ± 0.15 b	19.57 ± 0.56 b	5.16 ± 0.36 b	366.58 ± 21.10
T5	2.47 ± 0.09 a	22.43 ± 0.60 a	4.52 ± 0.32 c	361.58 ±7.09
P values				
Interaction	0.02	0.324	0.097	0.97
Environment	0.0001	0.057	0.0001	0.012
Treatments	0.0001	0.0001	0.0001	0.18

T1 control, T2 50g curcumin per ton, T3 75g curcumin per ton, T4 1.65 kg turmeric powder per ton, T5 2.5 kg turmeric powder per ton .N = normal condition. S= heat stress condition

Table 5. Effect of adding different levels of turmeric powder and curcumin in broiler diet on serum creatine kinase, uric acid and glucose of chicken reared under normal and heat stress conditions

	Creatin kinase U/L	Uric acid mg/dl	Glucose mg/dl
Mean	5045.59 ± 124.01	5.50 ± 0.11	207.40 ± 2.39
T1 N	4623.33 ± 189.09b	6.10 ± 0.10 b	214.33± 4.73 bc
T2 N	4516.67 ± 216.66 b	4.76 ± 0.13 d	185.33 ± 5.59 e
T3 N	4625.00 ± 240.05 b	4.86 ± 0.20 cd	193.16 ± 60.7ed
T4 N	4600.00 ± 317.28 b	5.91± 0.21 b	208.16 ± 1.85bcd
T5 N	4655.00 ± 227.89 b	4.91 ± 0.11 cd	191.66 ± 4.24 e
T1 S	6881.67 ± 84.34a	7.38 ± 0.09 a	236.66 ± 4.14 a
T2 S	4623.33 ± 336.18 b	4.85 ± 0.13 cd	199.50 ± 4.66cde
T3 S	4952.60 ± 74.79b	4.95 ± 0.10 cd	208.50 ± 9.41bcd
T4 S	6266.67 ± 272.41 a	5.98 ± 0.18 b	220.16 ± 1.70 b
T5 S	4696.17± 17916b	5.31 ± 0.21 c	216.50 ± 2.45 b
Normal	4604.00 ± 100.88 b	5.31 ± 0.12 b	198.53 ± 2.81 b
Stress	5502.41 ± 198.12 a	5.69 ± 0.18 a	216.26 ± 3.16 a
T1	5752.50 ± 354.48 a	6.74 ± 0.20 a	225.50 ± 4.50 a
T2	4570.00 ± 191.34 b	4.80 ± 0.09 c	192.41 ± 4.07 d
T3	4773.91 ± 139.26 b	4.90 ± 0.11 c	200.83 ± 5.81 cd
T4	5433.33 ± 320.74 a	5.95 ± 0.13 b	214.16 ± 2.17 b
T5	4675.58 ± 138.34 b	5.11 ± 0.13 c	204.08 ± 4.41 c
P values			
Interaction	0.0001	0.001	0.651
environment	0.0001	0.0004	0.0001
Treatments	0.0001	0.0001	0.0001

T1 control, T2 50g curcumin per ton, T3 75g curcumin per ton, T4 1.65 kg turmeric powder per ton, T5 2.5 kg turmeric powder per ton .N = normal condition. S= heat stress condition

CONCLUSION

From the present study, according to the results found, it can be concluded that adding different levels of turmeric powder and curcumin could improve serum biochemical parameters of broiler chicken reared under normal and hear stress condition for 35 days of age.

Acknowledgement

The authors are thankful to Dr. Dhia M.Sulaiman for his valuable technical help. We also would like to thank Mazi laboratory for providing facilities for achieving this work

REFRENCES

1. Alagawany, M.M., M.R Farag, and D., Kuldeep.2015. Nutritional and biological effects of turmeric (*Curcuma longa*) supplementation on performance, serum biochemical parameters and oxidative status of broiler chicks exposed to endosulfan in the diets. Asian Journal of Animal and Veterinary Advances, 10(2), 86-96

2. Al-Noori, M. A., A. B. Hossain, A. H. A. AI-Maahidy, and S. Th J. AI Rawi. 2011. The effect of dietary Curcuma longa powder (turmeric) supplementation on some blood parameters and carcass traits of broiler chickens." Al-Anbar Journal of Veterinary Sciences 4, :74-69

3. Beski, S.S.M. 2018. physiological and immunological responses of Japanese quail to oleobiotec. Iraqi journal of agriculture science.49 (1),194-199

4. Bowen, S. J., K. W. Washburn, and T. M. Huston. 1984. Involvement of the thyroid gland in the response of young chickens to heat stress." Poultry Science 63 (1): 66-69

5. Bueno, J.P.R., M.R.B., de Mattos Nascimento, J.M., da Silva Martins, C.F.P., Marchini, L.R.M., Gotardo, G.M.R., de Sousa, A.V., Mundim, E.C. Guimarães, and F.P., Rinaldi. 2017. Effect of age and cyclical heat stress on the serum biochemical profile of broiler chickens. Semina: Ciências Agrárias, 38(3), :1383-1392

6. De Sousabarbosa, T., Mori, C.K., Polônio, L.B., Ponsano, E.H.G. and P.C., Ciarlini, 2011. Perfil bioquímico sérico de galinhas poedeiras na região de Araçatuba, SP. Semina: Ciências Agrárias, 32(4), :1583-1587

7. Cristina, D., M., Pârvu, I.C., Andronie, N., Avram, D. Cucă, and I., Rădoi. 2007. Interaction between the diet, temperature and some blood components in roso layers. Bulletin USAMV-CN, 63, p.64

8. El-Maaty, A., M. A. Hayam, M. H. Rabie, and A. Y. El-Khateeb. 2014. Response of heat-stressed broiler chicks to dietary supplementation with some commercial herbs." Asian Journal of Animal and Veterinary Advances 9, (12) : 743-755

9- Emadi, M. and H., Kermanshahi. 2007. Effect of turmeric rhizome powder on the activity of some blood enzymes in broiler chickens. Int. J. Poult. Sci, 6(1), :48-51

10. Emadi, M., H., Kermanshahi, and E., Maroufyan. 2007. Effect of varying levels of turmeric rhizome powder on some blood parameters of broiler chickens fed corn-soybean meal based diets. Int. J. Poult. Sci, 6(5), pp.345-348

11. Fallah, R., and E. Mirzaei. 2016. Effect of dietary inclusion of turmeric and thyme powders on performance, blood parameters and immune system of broiler chickens." Livest. Sci 7, (1): 180-186

12. Gholami-Ahangaran, M., N., Rangsaz, and S., Azizi, 2016. Evaluation of turmeric *(Curcuma longa*) effect on biochemical and pathological parameters of liver and kidney in chicken aflatoxicosis. Pharmaceutical biology, 54(5), :780-787

13. Hosseini, E., J., Cheraghi, S.S., Taheri, K., Taherpour, K.Z. Kaviani, and L., Rezazadeh. 2013. Thyroid hormones investigation under heat stress in broilers administered with probiotic (BIO-SAF) and prebiotic (BIO-MOS). Eur. J. Exp. Biol, 3, :562-567

14. Hosseini-Vashan, S. J., Abolghasem Golian, and A. Yaghobfar. 2016. Growth, immune, antioxidant, and bone responses of heat stress-exposed broilers fed diets supplemented with tomato pom-ace." International Journal of Biomet-orology 60.8: 1183-1192

15. Hosseini-Vashan, S. J., A., Golian, A., Yaghobfar, A., Zarban, N., Afzali, and P. Esmaeilinasab. 2012. Antioxidant status, immune system, blood metabolites and carcass characteristic of broiler chickens fed turmeric rhizome powder under heat stress. African Journal of Biotechnology, 11(94), 16118-16125

16. Huang, S., H., Yang, M. U., Rehman, and Z. Tong. 2018. Acute heat stress in broiler

chickens and its impact on serum biochemical and electrolyte parameters. Indian Journal of Animal Research, 52(5), 683-686

17. Jaiswal, S. K., M., Raza, and A. K. Chaturvedani. 2017. Effect of thermal stress on serum biochemical and haematological parameters in broiler chickens. The Indian Journal of Veterinary Sciences and Biotechnology, 12(3), 19-22

18. Johannah, N. M., A., Joseph, B., Maliakel, and I. M. Krishnakumar. 2018. Dietary addition of a standardized extract of turmeric (TurmaFEED TM) improves growth performance and carcass quality of broilers. Journal of animal Science and Technology, 60(1), 8

19. Kadim, I. T., B. H. A., Al-Qamshui, O., Mahgoub, W., Al-Marzooqi, and E. H. Johnson. 2008. Effect of seasonal temperatures and ascorbic acid supplementation on performance of broiler chickens maintained in closed and open-sided houses. International Journal of Poultry Science, 7(7), 655-660

20. Kanani, P. B., M., Daneshyar, and R. Najafi. 2016. Effects of cinnamon (*Cinnamomum zeylanicum*) and turmeric (*Curcuma longa)* powders on performance, enzyme activity, and blood parameters of broiler chickens under heat stress. Poultry Science Journal, 4(1), 47-53

21. Kumari, P., M. K., Gupta, R., Ranjan, K. K., Singh, and R. Yadava. 2007. Curcuma longa as feed additive in broiler birds and its patho-physiological effects. Indian. J. Exper. Biol. 45, 272-277

22. Lin, H., R. D., Malheiros, V. M. B., Moraes, C., Careghi, E., Decuypere, and J. Buyse, 2004. Acclimation of broiler chickens to chronic high environmental temperature. Archiv Fur Geflugelkunde, 68(1), 39-45

23. Mahmoud, U. T., M. A., Abdel-Rahman, & M. H. Darwish. (2014). Effects of propolis, ascorbic acid and vitamin E on thyroid and corticosterone hormones in heat stressed broilers. Journal of Advanced Veterinary Research, 4(1), 18-27

24. Mushawwir, A., U. H., Tanuwiria, K. A., Kamil, L., Adriani, R., Wiradimadja, and N. Suwarno 2018. Evaluation of hematological responses and blood biochemical parameters of heat-stressed broilers with dietary supplementation of Javanese Ginger Powder (*Curcuma xanthorrhiza*) and Garlic Extract (*Allium sativum*). Int. J. Poult. Sci, 17(3), 452-458

25. Oguntunji, A. O., and O. M Alabi,. 2010. Influence of high environmental temperature on egg production and shell quality: a review. World's poultry science journal, 66(4), 739-750

26- Qasem, M. A. A., M. S., Alhajj, A. J., El Nabi, and S. I. Al-Mufarre. 2016. Effects of dietary supplement of turmeric powder (Curcuma longa) on blood biochemistry parameters and antioxidant activity in chickens. South African Journal of Animal Science, 46(2), 204-213

27. Sahin, N., M., Tuzcu, C., Orhan, M., Onderci, Y., Eroksuz, and K. Sahin. 2009. The effects of vitamin C and E supplementation on heat shock protein 70 response of ovary and brain in heat-stressed quail. British poultry science, 50(2), 259-265

28. Ukoha, O. A., and D. N., Onunkwo. 2016. The effects of turmeric (*Curcuma longa*) on the haematology and blood chemistry of broiler chickens. Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

29. Ulaiwi, A. H., S. M., Odishio, and S. M., Hassan. 2015. Effect of Force 6® Poultry (Curcumin) on Lipid profile in Broiler chicken in presence of IBD vaccine. The Iraqi Journal of Veterinary Medicine, 39(1), 100-104

30. Wan, X., L., Jiang, H., Zhong, Y., Lu, L., Zhang, and T., Wang. 2017. Effects of enzymatically treated Artemisia annua L. on growth performance and some blood parameters of broilers exposed to heat stress. Animal Science Journal, 88(8), 1239-1246

31. Wang, S. H., C. Y., Cheng, P. C., Tang, C. F., Chen, H. H., Chen, Y. P., Lee, and S. Y. Huang. 2015. Acute heat stress induces differential gene expressions in the testes of a broiler-type strain of Taiwan country chickens. PLoS One, 10(5), e0125816

32. Zeinali, A., H., Kermanshahi, A., Riasi, H., Farhangfar, H., Sarir, and H. Ziaie. 2011. Effects of sodium selenite and turmeric powder on thyroid hormones and plasma lipids of broiler chickens reared under heat stress condition. Global Veterinaria, 6(3), 237-240.