

Rectal Temperature and Blood Parameters of Sasso T44 and Koekoek Chickens Exposed to Temperature Variation with Supplementary Coriander Seed Powder

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Summary

This experiment was conducted to evaluate the effects of ambient temperature and coriander seed supplementation on blood parameters and rectal temperature of Sasso T44 and Koekoek. Two experiments were conducted. The first (growers) experiment was conducted from 9 to 20 weeks of age and the second (layers) experiment was continued from week 21 to 40. In both experiments, breeds were exposed to two temperature rooms, heated and normal ones. Breeds were also further randomly allocated to three levels of (0 g·kg⁻¹, 5 g·kg⁻¹ and 10 g·kg⁻¹) coriander seed powder supplementation. The data for both experiments were subjected in a 2 × 2 × 3 factorial arrangement. Exposing growers to the heated room showed a significantly higher ($P < 0.05$) level of creatinine, alanine aminotransferase and mean corpuscular hemoglobin concentration than those in a normal room. However, the temperature had no effect ($P > 0.05$) on blood serum and hematological parameters of layers. Decreased glucose and cholesterol levels were observed in growers supplemented with 10 g·kg⁻¹ of coriander seed. Similarly, the 10 g·kg⁻¹ of coriander seed supplementation reduced ($P < 0.01$) white blood cells in growers but increased hemoglobin in layers. The results indicated that temperature and coriander seed supplementation varied some of serum and hematological parameters with the effect being more observed in growers than in layers.

Key words

blood hematological indices, serum parameters

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Received: February 25, 2023 | Accepted: November 24, 2025 | Online first version published: December 19, 2025

Introduction

Birds under stress exhibit abnormal physiological and behavioral changes (Syafwan et al., 2011; Zhu et al., 2014). The thermo-neutral region for most poultry species ranges from 18 to 20 °C as described by Ensminger et al. (1990). Birds exposed to temperatures above this range could exhibit abnormal physiological and behavioral changes. As a result, several blood parameters are known to change due to heat stress. For instance, short-term or long-term heat stress alters the blood concentrations of uric acid, aspartate aminotransferase (AST), creatine kinase, total protein, albumin, and globulin (Liu et al., 2016; Attia et al., 2017; Luo et al., 2018). Moreover, studies have shown that blood serum biochemical indexes can partly reflect the metabolism and health status of the organism (Geng et al., 2021). Thus, blood biochemical indices indicate the metabolic and physiological responses of chickens to various dietary and environmental situations (Zhu et al., 2014; Xie et al., 2015).

According to Bílková et al. (2017) different breeds have evolved diverse immune responses that reflect their original requirement to combat infections and physiological constraints brought on by different physiological trade-offs. Breeds tolerant to heat stress may use blood plasma fluid to control their body temperature and reduce the severity of hyperthermia (Habibu et al., 2018). This can be helpful in revealing information about a bird's immune health, which could also be taken into account when planning genetic improvement programs (Ilori et al., 2011).

Rectal temperature is another physiological parameter that is considered a reliable indicator for the evaluation of heat resistance in chickens (Chen et al., 2013). Heat exposure significantly increases rectal and skin temperatures (Kutlu and Kutlu Forbes, 1993). According to Donkoh (1987), rectal temperatures were markedly increased by ambient temperature in birds reared at 30 °C and 35 °C. However, dietary supplementation for heat stressed birds significantly reduced their body temperature (Kutlu and Kutlu Forbes, 1993). Coriander seed is one of the locally available natural additives reported to have a positive effect on the production and health status of chickens exposed to heat stress. Al-jaff (2011) found a beneficial effect on the immune system of broilers treated with coriander seed and exposed to high ambient temperatures. Moreover, a recent study by Gazwi et al. (2022) found increased hemoglobin concentration and hematocrit percentage in broilers supplemented with coriander extracts. Therefore, this experiment was conducted to evaluate blood serum, hematological and rectal temperature responses of Sasso T44 and Koekoek chickens reared under two ambient temperatures with a supplement of coriander seed powder.

Material and Methods

Experimental Site

The experiment was carried out at Haramaya University poultry farm, Ethiopia. The area's average annual rainfall is 790 mm with an average temperature of 16 °C (Mishira et al., 2004).

Experimental Animals and Management

Growers (experiment 1)

Growers experiment was conducted from the age of week 9-20 with a total of 756 healthy two dual-purpose chickens of Koekoek and SassoT44 chickens (378 of each breed). These two breeds were randomly divided into two temperature rooms of 189 chickens each. Each of the two groups were further sub-divided into nine groups each with 21 chicks (6 males and 15 females) and housed in an individual pen. Finally, each group of each breed was randomly assigned to three different levels of coriander seed powder.

Layers (experiment 2)

Layers experiment was conducted from the age of week 21 to 40, which was the continuation of grower's experiment with a similar experimental setup. However, for each replicate, 14 pullets and two cockerels per pen were used for each breed. In both experiments all groups of the experimental chickens were housed in concrete floors covered with wood shavings (deep litter system). Other management practices were carried out as described by Kiros et al. (2022). Diets for growers and layers experiment were formulated to meet or exceed National Research Council (NRC, 1994) recommendations. The ingredients and calculated composition of the experimental diets are presented in Table 1.

Table 1. Matrix of Spearman's correlation coefficient for Chemical

Ingredients (g·kg ⁻¹)	Coriander seeds supplementation(g·kg ⁻¹)					
	Growers			Layers		
	0	5	10	0	5	10
White maize	545	545	545	517	517	518.2
Wheat short	130	125	120	160	155	148.8
Soybean meal (roasted)	184	184	184	154	154	154
Noug cake ¹	106	106	106	106	106	106
Vitamin/mineral premix	5	5	5	7.6	7.6	7.6
Coriander seed powder ²	0	5	10	0	5	10
Limestone	12	12	12	35	35	35
Lysine	0.8	0.8	0.8	1	1	1
Methionine	0.2	0.2	0.2	0.4	0.4	0.4
Di-Calcium phosphate	13	13	13	14	14	14
Salt	4	4	4	5	5	5
Calculated composition (g·kg⁻¹)						
ME (kcal·kg ⁻¹)	2950	2950	2950	2800	2800	2800
Crude protein	180	180	180	170	170	170
Ether extract	43	44	45	41	41.7	42.6
Crude fiber	70	71	71	71	71.6	72.1

Note:

¹ *Guizotia abyssinica* (L.f.) Cass.;

² coriander seed powder dry matter was 93.7% and crude protein, crude fiber, crude fiber, ether extract and ash were, 13.6%, 24.2%, 18.2%, and 6.85%, respectively expressed as percentage of dry matter.

Dried coriander seeds were purchased from a local market, milled into a powder at Haramaya University feed mill, and stored in plastic polyethylene bags until required for feeding trial. The dried and milled coriander seeds were mixed into the basal diet at the rate of 0 g·kg⁻¹ (control), 5 g·kg⁻¹ and 10 g·kg⁻¹. In growers (experiment 1), the average high and low ambient temperature for normal (unheated) room was 23.8 ± 3 °C and 16.6 ± 1.6 °C, respectively. In layers (experiment 2), the average high and low ambient temperature under normal (unheated) room was 24.3 ± 3.2 °C and 15.8 ± 2.2 °C, respectively. In both experiments, the average heated room temperature was maintained at 32 ± 1.2 °C for five hours daily (11:00 am to 16:00 pm), followed by normal ambient temperature during the other times of the day. In both experiments, relative humidity was ranging between 34.5 ± 4 and 48.4 ± 4% and similar natural lighting system was maintained in all the experimental pens. The cyclic heat exposure in the heated room was performed to mimic the local weather patterns in most lowland areas of Ethiopia. Infrared electric lamps were used as the heat source in the heated room during the five hours' exposition. Temperature and relative humidity were recorded every 12:00 h using a min-max thermo-hygrometer.

Blood Sampling

At the end of the experimental period 1 and 2 (in week 20 and 40, respectively), blood samples were randomly collected from two female chickens per replicate after 5 hours of feed deprivation for analysis of hematological parameters and serum biochemical analysis. About 3-5 ml blood samples were collected from the wing vein using a sterile disposable syringe. Half of the blood was transferred into a tube containing Ethylene diamine tetra acetate (EDTA), for the hematological assay. The non-heparinized blood was allowed to clot and the serum was separated by centrifugation at 2500 rpm for 15 minutes, and the clear serum was separated and stored in a deep freezer at -20 °C for later biochemical analysis. The haematological indices analyzed were haemoglobin (Hb), packed cell volume (PCV), red blood cell count (RBC), white blood cell count (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). The serum biochemical indices were glucose, total protein, albumin, cholesterol, creatinine, urea, alanine aminotransferase (ALT), aspartate transaminase (AST) and Globulin. The Hb concentration, RBC and WBC counts were determined according to the methods of Dacie and Lewis (1991). Mean cell volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were calculated as described by Jain (1986). Serum total proteins, glucose and albumin were determined using the procedures outlined by Tietz (1995). Globulin value is obtained by subtracting albumin concentration from total protein.

Rectal Temperature

Rectal temperature was taken randomly from two female chickens per replicate in both experiments at the time between 13:00 to 15:00 hr, following the procedures outlined by Illori et al. (2011). Rectal temperature was measured in week 12, 16, 20 in growers and in week 26, 32, and 38 in layers' experiment. A digital thermometer (± 0.01 °C accuracy) was used to measure the rectal temperature by inserting in a distance of maximum 5 cm inside the rectum of each bird.

Statistical Analysis

The data for both experiments were subjected in a 2 × 2 × 3 factorial arrangement with two breeds of chicks (Sasso T44 and Koekoek), two temperature rooms (heated and normal) and three levels of supplementary coriander seed powder (0, 5 and 10 g·kg⁻¹). R-statistical package R version 4.0.2 (R Core Team, 2020) was for the data analysis with fixed factors of ambient temperature, breed and coriander seed powder supplementation and their interactions. Each replicate was considered as an experimental unit. Significant differences were evaluated at probability values of $P < 0.05$.

Data were analyzed using the following three-way factorial ANOVA model:

$$y_{ijkl} = \mu + B_i + C_j + T_k + (BC)_{ij} + (BT)_{ik} + (CT)_{jk} + (BCT)_{ijk} + e_{ijkl}$$

where y_{ijkl} = the dependent variable, μ is the overall mean effect, B_i is the i th fixed effect of breed ($i = 1$ is Sasso T44 and $i = 2$ is Koekoek), C_j is the j th fixed effect of coriander seed powder supplement; ($j = 1$ is 0 g·kg⁻¹, $j = 2$ is 5 g·kg⁻¹ and $j = 3$ is 10 g·kg⁻¹ of coriander seed powder), T_k is the k th fixed effect of ambient temperature ($k = 1$ is normal or unheated room and $k = 2$, heated room), $(BC)_{ij}$, $(BT)_{ik}$, $(CT)_{jk}$, and $(BCT)_{ijk}$ are the two- and three-way interaction terms among these factors, and e_{ijkl} = is the random error term.

Results

Blood Serum Parameters

The results for the serum biochemical parameters for growers and layers are given in Tables 2 and 3, respectively. The temperature significantly ($P < 0.05$) affected creatinine and alanine aminotransferase (ALT) in the growers' experiment (Table 2), with groups placed in the heated room having higher creatinine and ALT than those in the normal room. Moreover, glucose, albumin, cholesterol, and globulin varied significantly ($P < 0.05$) due to coriander seed supplementation in growers (Table 2). The 10 g·kg⁻¹ of coriander seed supplementation decreased glucose and cholesterol, while groups fed with 5 g·kg⁻¹ of coriander supplementation showed higher albumin but lower globulin compared to control (non coriander supplemented groups). Moreover, a breed effect was observed for glucose in growers, with Koekoek having higher glucose than Sasso T44. In the growers' experiment, an interaction between temperature and coriander supplementation influenced ($P < 0.05$) the aspartate transaminase (AST). Non-coriander supplemented groups in a heated room had higher AST than non-coriander seed supplemented control groups in the normal room (Table 2). None of the studied serum biochemical parameters were affected by temperature or coriander seed supplementation in layers. The interaction between breed and coriander seed, on the other hand, revealed that non-coriander seed supplemented Koekoek groups had higher cholesterol levels than non-coriander seed supplemented Sasso T44 layers (Table 3).

Haematological Indices

The haematological parameters for the grower and layer studies are shown in Tables 4 and 5, respectively. Variations due to temperature and coriander seed supplementation were seen in growers' mean corpuscular hemoglobin concentration (MCHC) and white blood cells (WBC), respectively (Table 4).

Table 2. Effect of breed (B), temperature (T) and coriander seed powder supplementations(C) on growers' serum biochemical parameters of Koekoek and Sasso T44

B	T	C	Glucose (mg· dL ⁻¹)	TP (g·dL ⁻¹)	Creatinine (mg·dL ⁻¹)	Albumin (g·dL ⁻¹)	Urea (mg·dL ⁻¹)	Cholesterol (mg· dL ⁻¹)	ALT (IU·L ⁻¹)	AST (IU·L ⁻¹)	Globulin (g·dL ⁻¹)
Sasso T44			136 ^b	3.68	0.804	2.59	10.6	80.1	22.3	143	1.09
Koekoek			154 ^a	3.76	0.806	2.64	10.9	87.3	21.4	147	1.12
P			0.01	0.29	0.97	0.45	0.39	0.14	0.49	0.60	0.45
	Normal room		148	3.74	0.743 ^b	2.63	10.9	87.8	20.3 ^b	140	1.11
	Heated room		141	3.63	0.867 ^a	2.53	10.6	79.7	23.3 ^a	151	1.10
	P		0.16	0.06	0.01	0.07	0.38	0.10	0.03	0.14	0.45
		C1	154 ^a	3.67	0.792	2.48 ^b	10.7	93.1 ^a	23.5	142	1.19 ^a
		C2	145 ^{ab}	3.74	0.808	2.72 ^a	10.5	80.4 ^{ab}	22.1	152	1.02 ^b
		C3	136 ^b	3.75	0.815	2.64 ^{ab}	11.0	77.7 ^b	19.8	141	1.11 ^{ab}
		P	0.02	0.65	0.90	0.03	0.34	0.03	0.08	0.34	0.01
SEM			8.72	0.12	0.07	0.12	0.48	8.23	2.25	12.7	0.06
Interaction terms											
B*T			0.38	0.76	0.97	0.67	0.06	0.39	0.19	0.21	0.88
B*C			0.25	0.38	0.37	0.37	0.07	0.49	0.27	0.07	0.91
T*C			0.17	0.39	0.08	0.60	0.06	0.06	0.06	0.02	0.53
B*T*C			0.23	0.06	0.16	0.06	0.40	0.84	0.08	0.09	0.53

Note:

a-b Means within a column of the main effects lacking a common superscript differ significantly ($P < 0.05$),B*T = interaction between B and T, B*C = interaction between B and C, T*C = interaction between T and C, B*T*C = interaction between B, T, and C, C1 = 0 g·kg⁻¹ of coriander seed, C2 = 5 g·kg⁻¹ of coriander seed, C3 = 10 g·kg⁻¹ of coriander seed supplementation, SEM = standard error of mean, P = probability value

Table 3. Layers blood serum biochemical parameters as affected by breed (B), temperature (T) and coriander seed powder supplementations(C)

B	T	C	Glucose (mg· dL ⁻¹)	TP (g·dL ⁻¹)	Creatinine (mg·dL ⁻¹)	Albumin (g·dL ⁻¹)	Urea (mg·dL ⁻¹)	Cholesterol (mg· dL ⁻¹)	ALT (IU·L ⁻¹)	AST (IU·L ⁻¹)	Globulin (g·dL ⁻¹)
Sasso T44			193	3.31	0.71	2.02	9.98	106	21.8	178	1.29
Koekoek			194	3.47	0.68	2.22	9.99	110	22.8	182	1.24
P			0.91	0.10	0.61	0.06	0.97	0.36	0.42	0.61	0.13
	Normal room		200	3.42	0.68	2.14	10.21	107	22.8	179	1.28
	Heated room		187	3.36	0.70	2.10	9.77	109	21.8	182	1.26
	P		0.10	0.53	0.32	0.73	0.26	0.61	0.41	0.69	0.09
		C1	188	3.40	0.64	2.14	10.53	109	22.4	175	1.26
		C2	203	3.44	0.66	2.18	9.35	111	23.2	189	1.26
		C3	189	3.32	0.78	2.04	10.09	105	21.3	177	1.27
		P	0.20	0.56	0.06	0.51	0.06	0.39	0.40	0.25	0.87
SEM			13.6	0.12	0.08	0.17	0.65	6.94	2.01	13.1	0.07
Interaction terms											
B*T			0.51	0.60	0.32	0.86	0.16	0.31	0.26	0.39	0.28
B*C			0.86	0.85	0.36	0.86	0.95	0.05	0.16	0.85	0.99
T*C			0.07	0.36	0.38	0.72	0.81	0.13	0.34	0.94	0.17
B*T*C			0.99	0.12	0.38	0.33	0.11	0.10	0.64	0.40	0.22

Note:

a-b Means within a column of the main effects lacking a common superscript differ significantly ($P < 0.05$),B*T = interaction between B and T, B*C = interaction between B and C, T*C = interaction between T and C, B*T*C = interaction between B, T, and C, C1 = 0 g·kg⁻¹ of coriander seed, C2 = 5 g·kg⁻¹ of coriander seed, C3 = 10 g·kg⁻¹ of coriander seed supplementation, SEM = standard error of mean, P = probability value

Table 4. Effect of breed (B), temperature (T) and coriander seed powder supplementations(C) on growers' haematological parameters of Koekoek and Sasso T44

Breed	T	C	Hb	PCV (%)	RBC ($10^6 \cdot \mu\text{L}^{-1}$)	WBC ($10^3 \cdot \mu\text{L}^{-1}$)	MCV (fi)	MCHC (%)	MCH (Pg)
Sasso T44			10.09	33.7	2.48	42.8	132	31.3	41.1
Koekoek			9.93	33.4	2.46	44.4	133	31.3	41.2
P			0.06	0.08	0.07	0.42	0.09	0.83	0.51
	Normal room		9.88	33.4	2.65	43.1	133	31.1 ^b	41.2
	Heated room		10.13	33.8	2.63	44.1	133	31.5 ^a	40.1
	P		0.82	0.63	0.72	0.62	0.90	0.04	0.28
		C1	10.13	34.1	2.69	46.8 ^a	133	31.2	39.7
		C2	9.86	33.2	2.62	41.5 ^{ab}	134	31.4	41.0
		C3	10.03	33.5	2.61	38.5 ^b	133	31.2	41.2
		P	0.27	0.14	0.45	0.001	0.71	0.38	0.73
SEM			0.24	0.59	0.09	3.32	1.5	0.28	0.44
Interaction terms									
B*T			0.95	0.96	0.97	0.22	0.71	0.73	0.84
B*C			0.53	0.34	0.70	0.12	0.40	0.42	0.44
T*C			0.71	0.54	0.52	0.76	0.91	0.19	0.97
B*T*C			0.06	0.07	0.08	0.43	0.64	0.52	0.63

Note:

^{a,b} Means within the column of the main effects lacking a common superscript differ significantly ($P < 0.05$), B*T = interaction between B and T, B*C = interaction between B and C, T*C = interaction between T and C, B*T*C = interaction between B, T and C, C1 = 0 g·kg⁻¹ of coriander seed, C2 = 5 g·kg⁻¹ of coriander seed, C3 = 10 g·kg⁻¹ of coriander seed supplementation, SEM = standard error of mean, P = probability value

Table 5. Layers' haematological parameters as affected by breed (B), temperature (T) and coriander seed powder supplementation (C)

Breed	T	C	Hb	PCV (%)	RBC ($10^6 \cdot \mu\text{L}^{-1}$)	WBC ($10^3 \cdot \mu\text{L}^{-1}$)	MCV (fi)	MCHC (%)	MCH (Pg)
Sasso T44			11.0	36.9 ^a	2.69	43.7	138	29.8 ^b	41.0 ^b
Koekoek			11.1	35.4 ^b	2.59	45.5	137	31.4 ^a	42.9 ^a
P			0.59	0.04	0.06	0.35	0.84	0.01	0.03
	Normal room		11.0	36.2	2.65	44.6	137	30.6	41.2
	Heated room		11.0	36.2	2.63	44.6	138	30.6	40.1
	P		0.90	0.97	0.72	0.97	0.79	0.96	0.84
		C1	10.8 ^b	36.2	2.69	44.8	135	29.9	41.2 ^a
		C2	10.9 ^{ab}	35.7	2.62	45.2	136	30.6	41.0 ^a
		C3	11.4 ^a	36.6	2.61	43.8	140	31.2	39.7 ^b
		P	0.03	0.58	0.45	0.82	0.36	0.22	0.01
SEM			0.32	1.25	0.09	3.34	5.61	1.02	1.47
Interaction terms									
B*T			0.91	0.98	0.97	0.14	0.68	0.67	0.95
B*C			0.19	0.34	0.70	0.82	0.21	0.53	0.27
T*C			0.13	0.58	0.52	0.99	0.60	0.06	0.07
B*T*C			0.06	0.08	0.06	0.13	0.74	0.07	0.07

Note:

a-b Means within the column of the main effects lacking a common superscript differ significantly ($P < 0.05$), B*T = interaction between B and T, B*C = interaction between B and C, T*C = interaction between T and C, B*T*C = interaction between B, T, and C, C1 = 0 g·kg⁻¹ of coriander seed, C2 = 5 g·kg⁻¹ of coriander seed, C3 = 10 g·kg⁻¹ of coriander seed supplementations, SEM = standard error of mean, P = probability value

MCHC was higher in groups placed in the heated room than in those placed in the normal room (Table 4). The 10 g·kg⁻¹ of coriander seed supplemented groups had lower WBC compared to non-coriander seed supplemented groups. In layers, hemoglobin (Hb) and mean corpuscular haemoglobin (MCH) varied significantly due to coriander seed supplementation, with 10 g·kg⁻¹ coriander seed supplemented groups having higher Hb and lower MCH compared to non-coriander seed supplemented groups (Table 5). None of the studied hematological parameters were affected due to temperature in layers. Similarly, there was no interaction effect ($P > 0.05$) between breed, temperature, and coriander seed supplementation on the studied haematological parameters (Tables 4 and 5). However, breed effect in layers showed a higher PCV % but lower MCHC and MCH in Sasso T44 (Table 5).

Rectal Temperature

Temperature and coriander seed supplementation had no effect ($P > 0.05$) on rectal temperature (Table 6), except in the layers in week 26, where higher rectal temperatures were observed in groups placed in a heated room. Similarly, there was no interaction effect ($P > 0.05$) among breed, temperature, and coriander seed supplementation on rectal temperature (Table 6) in both experiments.

However, we found an interaction effect ($P < 0.05$) between temperature and breed in layers in week 26 on rectal temperature, with Sasso T44 placed in a heated room having a higher rectal temperature than the other groups.

Table 6. Effects of breed (B), temperature (T) and coriander seed supplementations (C) on rectal temperature of Koekoek and Sasso T44 growers and layers

Breed	Temperature	C	Rectal temperature					
			Growers		Layers			
			W16	W20	W26	W32	W38	
Sasso T44	Heated room	C1	41.4	41.4	41.6	41.7	41.5	41.7
		C2	41.1	41.5	41.6	41.5	41.6	41.3
		C3	41.1	41.2	41.5	41.8	41.4	41.3
	Normal room	C1	41.5	41.4	41.4	41.5	41.3	41.4
		C2	41.4	41.5	41.4	41.5	41.4	41.6
		C3	41.2	41.3	41.2	41.4	41.4	41.3
Koekoek	Heated room	C1	41.4	41.3	41.6	41.3	41.6	41.4
		C2	41.0	41.2	41.5	41.4	41.5	41.5
		C3	41.4	41.5	41.5	41.4	41.4	41.6
	Normal room	C1	41.3	41.2	41.3	41.4	41.4	41.4
		C2	41.5	41.4	41.5	41.5	41.6	41.2
		C3	41.4	41.4	41.3	41.3	41.3	41.4
SEM		0.18	0.13	0.12	0.07	0.11	0.17	
Source of variations			<i>P</i> values					
	T	0.33	0.65	0.10	0.03	0.07	0.64	
	C	0.52	0.50	0.57	0.35	0.13	0.44	
	B	0.87	0.55	0.94	0.07	0.79	0.69	
	T*C	0.95	0.62	0.52	0.24	0.73	0.38	
	T*B	0.79	0.88	0.82	0.01	0.93	0.24	
	B*C	0.09	0.15	0.83	0.53	0.06	0.84	
	B*T*C	0.09	0.32	0.20	0.14	0.23	0.70	

Note:

B*T= interaction between B, and T, B*C = interaction between B and C, T*C = interaction between T, and C, B*T*C = interaction between B, T and C, C1= 0 g·kg⁻¹ of coriander seed, C2 = 5 g·kg⁻¹ of coriander seed, C3 = 10 g·kg⁻¹ of coriander seed supplementations, W12 = age of week 12, W16 = age of week 16, W20 = age of week 20, W26 = age of week 26, W32 = age of week 32, W38 = age of week 38, SEM = standard error of mean, P = probability value

Discussion

The present study found that growers placed in the heated room observed higher levels of creatinine and ALT than those in the normal room. These results were also supported by Baghban et al. (2016) who found increased ALT and creatinine in broilers exposed to heat stress (32 °C). Similarly, Del Vesco et al. (2017) discovered that quails (42 days old) exposed to 38 °C for 24 hours had higher AST, ALT, and creatinine content than those exposed to 25 °C. Concerning creatinine, it shows kidney function and abnormal increase may imply kidney damage (Yalcin et al., 2012), while an elevated serum of ALT and AST can be related to liver injury or muscle damage (Valchev et al., 2014; Tang et al., 2022). In general, the creatinine and ALT values reported in the present study were within the range of thermo-neutral environment of broilers at different ages as described by Café et al. (2012). This suggests that the current higher levels of creatinine in a heated room may not be attributed to liver or muscle damage.

Growers supplemented with the 10 g·kg⁻¹ of coriander seed were found to have decreased glucose and cholesterol levels than those from non-coriander supplemented groups, while higher albumin but lower globulin were observed in groups supplemented with 5 g·kg⁻¹ of coriander seed compared to the control (non-coriander supplemented groups). The lower glucose level in the 10 g·kg⁻¹ coriander supplemented group in the current study could be attributed to coriander seeds' anti-hyperglycemic activity (Hosseinzadeh et al., 2014). This anti-hyperglycemic action of coriander may be associated with the presence of a higher concentration of total phenolic and flavonoid contents, which have the ability to promote insulin and reduce glucose levels (Sreelatha and Inbavalli, 2012). However, the glucose levels in the present study were within the normal reference range (130–270 mg·dL⁻¹) given by Reece et al. (2015). Similarly, Khubeiz and Shirif (2020) found lower cholesterol in groups fed with 2.5 % but higher in groups fed with 3.5% of coriander seed compared to control groups. Moreover, broiler chicks fed with 2% and 3% coriander seed showed lower cholesterol and glucose levels (Al-jaff, 2011). Concerning albumin, it was higher (by 9.7%) in growers due to coriander seed supplementation in the current study, indicating a positive impact on serum proteins. Serum proteins are responsible for maintaining oncotic pressure within blood vessels and serve as indicators of liver health (Escobar et al., 2022).

Among the current studied haematological parameters, the MCHC was only affected by temperature, and growers placed in the heated room had higher MCHC than in those placed in the normal room, which is consistent with Aengwanich (2007) who found higher MCHC in chickens maintained at 38±2 °C than that of chickens at 26 ± 2 °C. The MCHC is used to indicate the amount of haemoglobin relative to the size of the cell per red blood cell. According to Hocking et al. (1994) most heat stress-susceptible birds exhibit an increased haemoglobin concentration with a larger number of smaller erythrocytes and elevated MCHC values. However, the current MCHC values were within the normal reference range of avian MCHC (Bounous and Stedman, 2000).

White blood cells are an important haematological parameter which is frequently linked to inflammatory response or, in some cases, to infectious processes (Kokosharov, 1998). In the current study growers supplemented with 10 g·kg⁻¹ of coriander seeds had lower WBC compared to non-coriander seed supplemented

groups. This is in disagreement with Farag (2013) who reported that coriander seed supplementation increased levels of WBC compared to the control treatments. However, the current result was in line with Gazwi et al. (2022) who found reduced heterophil and heterophil to lymphocyte ratios in broilers at six weeks of age. The effect of coriander seed was also observed in Hb and MCH levels, with layers supplemented with 10 g·kg⁻¹ coriander seed having higher Hb but lower MCH compared to non-coriander seed supplemented groups. Haemoglobin is the protein in red blood cells that delivers oxygen to all tissues (Su et al., 2018). This implies that the increase in Hb due to coriander seed supplementation in the present study could be a good indication, which would result in improved availability of nutrients to the birds. In line with the current study, Farag (2013) and Taha et al. (2019) reported that coriander seed supplementation increased levels of Hb compared to the control treatments. The MCH is used to measure haemoglobin amount per blood cell and their normal ranges are between 33-47 pg·cell (Bounous and Stedman, 2000). This indicates the current MCH values in groups supplemented with 10 g·kg⁻¹ were within the normal reference range for poultry species as discussed by Pandian et al. (2012).

Breeds of poultry may have varying haematological indices (Pandian et al., 2012) which might be due to breed's intrinsic response to different environmental factors. Besides that, blood parameters may vary due to daily rhythms; particularly, haematological parameters showed daily rhythms with diurnal acrophases (Makeri et al., 2017). In the present study, a higher PCV % but lower MCHC and MCH were observed in Sasso T44 layers. However, the current haematological indices were within the normal reference range for healthy chicken reported by (Bounous and Stedman, 2000).

It has been reported by different authors that serum and hematological parameters can be disturbed by high ambient temperatures due to heat stress (Xie et al., 2015; Habibu et al., 2018), which may have influence on decreased total protein (Liu et al., 2016; Hosseini-Vashan et al., 2020), enhanced AST levels (Tang et al., 2022) and decreased serum cholesterol (Sands and Smith, 2002). However, our study in the layer's experiment failed to confirm this association, and no variations due to the high ambient temperature were found in the serum biochemical and hematological parameters conducted. Variations on creatinine, ALT, MCHC, and AST observed due to temperature in growers, though, did not indicate alterations from the normal serum biochemical and haematological status of birds. This may be a positive indication of the current breeds' immunity and health conditions.

Changes in the environment especially with higher temperatures can be seen by changes in a bird's rectal temperature (Zampiga et al., 2021). In the present study, except for layers at the age of week 26, there were no variations in rectal temperature between those placed in the heated room and those in the normal room. Similarly, coriander seed supplementation did not affect rectal temperature in the present study. This is in disagreement with the report of Kutlu and Forbes (1993) who found reduced body temperature due to ascorbic acid supplementation. Layers at the age of week 26 showed higher rectal temperature with groups placed in the heated room. Moreover, the interaction between temperature and breed in layers in week 26 showed higher rectal

temperature in Sasso T44 placed in the heated room than the other groups. This agrees with the study by Ilori et al. (2011) who found variations between genotype and age where the exotic turkeys showed a higher rectal temperature than the locals. However, the current result disagrees with Mutibvu et al. (2017), who found no variation in rectal temperature in Koekoek, Ovambo, and Naked Neck strains under diurnally cycling temperature in a hot environment.

Conclusions

Temperature had no effect on the studied haematological parameters except in growers, where the mean corpuscular haemoglobin concentration was higher in groups placed in the heated room. Similarly, temperature and coriander seed supplementation caused more variations in serum parameters in growers than in layers; however, these variations did not indicate a deviation from the normal reference range of the birds' serum biochemical and haematological status.

Acknowledgements

This study was financially supported by the Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation (ACE Climate SABC) at Haramaya University, Ethiopia.

CredIT Autorship Declaration

Kiros Welay: conceptualization, performed the experiment, analysis, writing—original draft, review and editing. **Negassi Amaha:** conceptualization, supervision, editing. **Solomon Demeke:** conceptualization, editing. **Legesse K. Debusho:** methodology and editing. **Meseret Girma:** supervision, and editing. All listed authors contributed to the study conception and design.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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