Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

Effect of Adding Mixture of Mint, Cinnamon and Astragalus to Broiler Diets on Physiological Traits Under Heat Stress

Ali Mohammed A.R. S. Al-Azzawi [1], Hasanain N. Ezzat [2]

[1] Agricultural Research Directorate – Ministry of Agriculture - Baghdad - Iraq.

[2] Department of Animal Production - College of Agricultural Engineering Sciences – University of Baghdad, Baghdad, Iraq.

ABSTRACT

This experiment was conducted to investigate the effect of adding mixture of medical plant to broiler diets on some physiological traits under heat stress conditions. 300 Ross308/Portuguese broiler chicks were used with initial weight 48.91 g, and randomly distributed about five treatments with four replicates for treatment (15birds/replicate), and the treatments included: T1(control treatment), T2, T3, T4 and T5 to which a mixture of mint, cinnamon and astragalus powder was added as 2, 4, 6 and 8 g/kg diets respectively. The birds reared under heat stress conditions until 42 days. from results show a significant improvement($P \leq 0.01$)in core body temperature and internal organs weights in the birds of all supplementation treatments compared by T1, Also significant increase($P \leq 0.01$) was observe in some tissues measurements as in jejunum and the immune response, Also significant increased($P \leq 0.05$) in glucose, HDL, AST, ND, IBD, and Fabricius index, As well as significant decreased($P \leq 0.05$) in triglycerides, VLDL, and Atherogenic Index(AI), while there were no significant difference between the treatments in blood proteins, PCV, Hb, Cholesterol, LDL, and ALT.

Keywords: blood lipids, blood proteins,immune response, internal organs, jejunum measurements, medicinal plants.

Received: 16/3/2025, Accepted: 22/6/2025, Published: 31/7/2026

INTRODUCTION

Poultry farmes are directly affected by climit conditions, like temperature which greatly affects on broiler, the body exposed to heat stress prodioted heat more than loses, that leads to an increase panting and the gas exchange process(AL-Daloe *et al.*, 2022), In addition its increasing the secretion of the hormones adrenaline, noradrenaline and corticosterone, also increasing free radicals. Thus, increases oxidative state affects of immune response of the birds. In addition, the damage caused by stress to cells stimulated phagocytes cells, and productes of oxidize fats, especially LDL and VLDL(Krauze *et al.*, 2021). heat stress can also affect integrity of intestines in the intestinal epithelium, which causes intestinal inflammation. That increase pathogens and an imbalance in the microbial in intestines, which is reflected in the digestion of consumed feed materials and causes a decrease in the availability of some essential nutrients that effected on body growth, and also reflected on meat quality, causing economic losses(AL-Jaryan *et al.*, 2023 ; Al-Jebory *et al.*, 2023). Recently, several medicinal plants and their extracts where used in poultry diets as antioxidants and natural growth promoters (as alternatives to antibiotics), because its containe many active compounds such as flavonoids, phenols, menthol, saponins, menthone, cholines, sulfites, carotenoids, polyphenolics ..etc (Abdelli *et al.*, 2021; Pashaei *et al.*, 2024). Medicinal herbs and plants also have significant effects on physiological and reproductive performance in poultry, improved the immunity of body against pathogenic microbes and also its resistance to high temperatures. The most important medicinal plants that used in poultry diets are mint, cinnamon and astragalus. Peppermint (*Mentha*

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

spicata) improves digestion and absorption processes (Jaman *et al.*, 2024), It also works under high temperatures conditions to removing the free radicals and reduce body temperature, that could be led to its content of flavonoids, phenols, and menthol (AL-Daloe *et al.*, 2022), The Cinnamon (*Cinnamomum cassia*) contains the volatile oil cinnamaldehyde, polyphenol, camphor and eugenol, it acts like antibacterial, antifungal, anti-inflammatory and antioxidant (Khedkar *et al.*, 2023; Saied *et al.*, 2022). also its reducing lipid profile in serum blood, Acording its ability to decrease free radicals as well as reduce the levels of uric acid, creatinine, cholesterol and malondialdehyde (Lagha *et al.*, 2021). Astragalus (*Astragalus membranaceus*) contains many active compounds including triterpenes, polysaccharides, flavonoids, saponins, antioxidant, anti-inflammatory and anti-microbial effects, and its reducing blood fat and sugar (Han *et al.*, 2024), Therefore, this study aimed to investigate the effect of adding different livels of a mixture of medicinal plants to the diet on the physiological performance of broiler under heat stress conditions, and to determine the best proportion of addition.

MATERIALS AND METHODS

This experiment was conducted in the poultry field in Abu Ghraib, affiliated with the University of Baghdad - College of Agricultural Engineering Sciences, from 7/3/2024 to 18/4/2024, In this study, 300 chicks one day-old (Ross308) with 48.91 g initial weight were used, Chicks were randomly distributed into five treatments with four replicates in each treatment (15birds/ replicate), under heat stress conditions, Chicks fed a balanced diet with energy and protein. Feed and water were *ad-libitum* to the chicks. Table (1) shows the chemical composition of the diet, Also the Suitable conditions and health care were provided for rearing the chicks untel 42 day, and the treatments are distributed as follows: T1 control diet(diet without any additives), T2,T3, T4 and T5 represented additives of 2, 4, 6 and 8 gm of plant mixture(mint, cinnamon and astragalus powder)/kg diet.

Table 1. Percentage of feed ingredients and chemical composition.

Components	Starter diet % 1-10 day	Growth diet % 11-24 day	Finisher diet % 25-42 day
Corn	43.8	44.6	46.5
Wheat	14	15.4	16
Soybean 48%	32.7	29.1	26
Protein Concentrated(1)	5	5	5
Sun flower Oil	2.2	3.5	4.4
Limestone	1.1	1.5	1.3
D.C.P 18%	0.7	0.4	0.3
NaCl	0.3	0.3	0.3
Vitamin and Mineral Mixture(2)	0.2	0.2	0.2
Total	100	100	100
Chemical compositions (3)			
Protein (%)	23.03	21.53	20.27
Metabolism Energy(Kilogram/Kilocalorie)	3005.83	3105.47	3193.20
Energy to protein ratio (P:C)	1 : 130.52	1 : 144.24	1 : 157.53
Lysine %	1.30	1.22	1.13
Methionine + Cystine %	0.88	0.84	0.80
Ca %	0.82	0.93	0.86
P %	0.44	0.46	0.52

(1)- Brocon-5 Special W protein concentrate. Each kg contains: 40% c.p, 5% fat - 2.2% fiber, 24.52% ash, 3.53% ca, 5.35% p., 3.85% lysine, 3.7% meth, 4.12% meth + cy, 0.43% Trp, 2.57% Arg, 2.4% Na, 2107 kcal/kg metabolized energy, 200,000 IU of A, 60,000 IU of D3, 600 mg of E, 50 mg of K3, 60 mg B1, 140 mg of B2, 80 mg B6, 700 mcg B12, 800 mg niacin, 20 mg Folic acid, 1 mg iron, 200 mg copper, 1.6 mg manganese, 1.2 mg zinc, 20 mg iodine, 5 mg selenium. (2)- Vitamin and mineral mixture, each kg contains: 500 IU A, 600 IU D3, 10 mg 20 E, 2 mg B1, 2 mg K3, 2 mg B2, 2 mg B6, 5 mcg B12, 10 mg of C, 15 mg niacin, 500 mcg folic acid. (3)- Chemical composition of feeding diet calculated according to NRC (1994).

Chemical analysis of medicinal plants

The Plants mixture of mint, cinnamon and astragalus powder chemical analysis was conducted in the laboratories of the Ministry of Science and Technology (Table 2). The DPPH test conducted (Table 3) by dissolving

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

0.04 g DPPH in 100 ml methanol (Note: The DPPH concentration is 400 µg/ml), then the solution preparation and test process was carried out as follows: (1) Taked 0.5 g of each the standard solution(vitamin C) and samples(mint, cinnamon, astragalus and the triple mixture) and mix each sample with (100 ml) of methanol and distilled water. (2) The concentration of the standard solution was (5000 ppm) and using the dilution law, the other concentrations(30, 60, 120, 250, 500 ppm) of vitamin C and samples(30, 60, 120, 250, 500 ppm) were prepared. (3) The mixture was shaken vigorously until it reached room temperature for 30 minutes. (4) Measure the absorbance at 517 nm. (5) Using a spectrophotometer(UV-VIS Shimadzu), the IC 50 for the samples was calculated, which is the concentration of the sample required to inhibit 50% of DPPH free radicals. (6) Using the logarithmic dose-inhibition curve, low absorption of the reaction mixture indicates high free radical activity.

Table 2. Chemical analysis of plant mixture (mint, cinnamon and astragalus)

Name (ppm)	Mentha	Cinnamomum	Astragalus	Mix
Total phenolic content (mg Gallic/ mg)	32.9	41.5	85.9	71.6
Total flavonoid content (mg Rutin/mg)	13.6	15.9	44.5	32.6
Total alkaloid content %	1.4	2.5	4.5	3.2
Total glycoside content %	1.0	1.5	3.6	2.5
Total tannin content %	1.3	3.6	2.8	2.0
Total saponine content %	0.14	0.25	1.2	0.41
Total terpenoid %	3.8	2.6	3.4	3.8
Protocatechuic acid	-	41.5	-	33.5
Qurcetine	54.9	-	69.8	87.4
Apigenin	-	-	55.8	41.6
Caffeic acid	26.9	33.6	70.6	97.9
Syringeic acid	-	51.4	-	41.5
Rutin	35.1	49.8	56.9	74.8
Kaempferol	29.7	-	41.5	58.9
Isorhamnetin	-	-	47.8	26.5
Ferulic acid	-	62.6	-	41.8
Genstic acid	-	74.5	-	57.9
Rosemaric acid	33.1	-	-	20.1
p-coumaric acid	-	66.9	78.9	112.5
Chlorogenic acid	-	-	66.9	41.9

Table 3. DPPH text of plant mixture (mint, cinnamon and astragalus)

AA %	30 (ppm)	60 (ppm)	120 (ppm)	250 (ppm)	500 (ppm)	IC 50%(ppm)
Vit. C	12.1	24.5	41.5	66.5	75.9	188
Mentha	22.5	35.6	52.4	74.9	91.5	114.5
Cinnamomum	23.9	33.5	49.8	71.6	88.9	120.5
Astragalus	24.6	37.9	56.9	77.9	93.5	105.5
Mix	33.6	43.6	69.1	84.5	95.9	86.8

Studied Characteristics: At 42 days of age, four birds from each treatment were sampled and weighed individually, slaughtered and cleaned, then weighed their internal organs and the body temperature of the birds was measured through the Cloaca.

Blood tests: Blood samples were collected from the wing vein. Then, the blood was directly drained into two types of tubes. The first tubes contained the anticoagulant Potassium-Ethylene Diamin Tetra Acid K- (K-EDTA) which was used to conduct tests for packed cell volume (PCV) and hemoglobin Hb. The second tubes did not contain an anticoagulant with a capacity of 10 ml. After 24 hours, they were placed in a centrifuge at

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

3000 rpm for 15 minutes to separate the serum from the cellular part. Then, the serum was drained into V-Tube tubes with tight, pre-numbered caps and the blood serum was stored at a temperature of -18°C until tests are conducted:

Biochemical measurements: Measurement conducted of the concentrations of glucose, total protein, albumin, globulin, triglycerides, cholesterol , HDL, LDL and VLDL, ALT and AST by Automated Hematology Analyzer type sysmex, while the PCV and hemoglobin Hb according to Doumas and Biggs (1972). also The Atherogenic Index(AI) was calculated as using the equation mentioned by Jamil *et al.* (2017):

$$\text{First Atherogenic Index} = \frac{\text{Colestrol (TC)}}{\text{HDL}}$$

$$\text{Second Atherogenic Index} = \frac{\text{LDL}}{\text{HDL}}$$

$$\text{Third Atherogenic Index} = \frac{\text{VLDL+ LDL}}{\text{HDL}}$$

Immunity: used The enzyme-linked immuno-sorbent assay (ELISA) to measure the titer of antibodies directed against Newcastle Disease virus (ND) and Infectious Bursal Disease virus (IBD).

Small intestine measurements: The intestinal sample was taken from the jejunum region by cutting 2 cm from it, and placed in tubes containing 10% formalin and left for 24 hours to ensure good washing of the samples. After that the formalin was changed, then the tissue sectioning process was carried out and the slices were prepared, After that all the prepared tissue slices were examined using a Chinese Compound Binocular Microscope (Creahub) at a magnification of 40X. All measurements were recorded using the microscope's microscope scale after calibrating it with the microscope platform's microscope scale. villus width, villus height, crypt depth, the distance between the villi and the thickness of the intestinal wall were measured, noting that the villus height extends from the tip of the villus to its connection to the crypt. The width of the villi equals the average width at the tip and base of the villi, which is the distance between the two ends of the villi, and crypt depth is the distance from the base of the villi to the end of the villus (El Sabry and Abd El-Ghany, 2021), and villus height/ crypts depth (Nguyen *et al.*, 2021).

Statistical Analysis: The data was analyzed statistically by SPSS program(SPSS, 2011) following a completely randomized design(CRD) with 4 replicates. The differences between the means were examined using Duncan multiple range tests (Duncan, 1955) and statistical significance was carried out at $P \leq 0.05$.

RESULTS AND DISCUSSION

Table (4) shows that there were no significant differences between the treatments in the concentrations of PCV, Hb, Total Protein, Albumin, Globulin, Cholesterol, LDL, and ALT, while a significant increase ($P \leq 0.05$) was observed in glucose in T3 compared to T1 and T5. Also T5 showed a significant decrease ($P \leq 0.05$) in triglycerides compared to T1 and T3. T4 and T5 recorded a significant superiority ($P \leq 0.01$) over the rest of the treatments in HDL, while VLDL decreased significantly ($P \leq 0.01$) in T4 and T5. In addition, the T5 significantly outperformed the rest of the experimental treatments in the average AST enzyme concentration.

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

Table 4. Effect of adding plant mixture powder (mint, cinnamon and astragalus) to the feed on the concentration biochemical characteristics in the blood of broiler under heat stress conditions (mean ± standard error)

characteristics	Units	Treatments					Sig
		T_1	T_2	T_3	T_4	T_5	
PCV	gm/100ml	32.25±1.65	32.25±1.11	32.75±1.11	30.00±1.47	33.25±1.89	N.S
Hb	gm/100ml	10.75±0.28	10.75±0.37	10.92±0.37	10.00±0.49	11.08±0.63	N.S
Glucose	mg/100ml	212.75±9.29 ^{b}	232.00±6.54 ^{ab}	253.75±8.38 ^{a}	231.25±12.23 ^{ab}	220.75±8.62 ^{b}	*
Total Protein	gm/100ml	3.01±0.20	2.97±0.10	2.78±0.08	3.23±0.15	3.14±0.22	N.S
Albumin	gm/100ml	1.55±0.05	1.45±0.03	1.54±0.08	1.61±0.06	1.55±0.03	N.S
Globulin	gm/100ml	1.46±0.04	1.52±0.07	1.49±0.11	1.62±0.09	1.60±0.15	N.S
Triglyceride	mg/100ml	80.25±6.05 ^{a}	66.00±5.99 ^{ab}	72.50±8.45 ^{a}	61.25±9.89 ^{ab}	45.50±5.61 ^{b}	*
Cholesterol	mg/100ml	108.75±5.27	106.75±8.23	109.75±1.60	115.75±3.94	122.25±5.20	N.S
HDL	mg/100ml	28.00±1.96^{c}	33.00±1.87 ^{bc}	36.25±1.93 ^{b}	54.50±1.19 ^{a}	55.25±1.60 ^{a}	**
LDL	mg/100ml	64.75±3.15	60.50±5.91	59.25±4.48	48.75±3.75	57.75±7.12	N.S
VLDL	mg/100ml	16.00±1.08 ^{a}	13.50±1.04 ^{ab}	14.25±0.85 ^{ab}	12.50±0.87 ^{b}	9.25±0.85 ^{c}	**
AST	U/L	266.0±16.75 ^{b}	275.75±24.24 ^{b}	284.75±27.96 ^{b}	467.50±19.96 ^{a}	249.00±25.27 ^{b}	**
ALT	U/L	7.25±0.48	7.50±0.87	7.00±0.91	9.00±0.41	8.50±0.65	N.S

T1= diet without additives, T2, T3, T4, T5 diet to which 8, 6, 4, 2 g of the plant mixture (mint, cinnamon and astragalus)/kg diet were added respectively. Sig. = Significance level in analysis of variance.
***Means with different letters within a rows indicate significant differences between the means of the coefficients at the level of P ≤ 0.05. **Means with different letters within a rows indicate significant differences between the means of the coefficients at the level of P ≤ 0.01. N.S.= No significant differences between the coefficients.**
PCV :Packed cell volume ،Hb :Hemoglobin ،HDL :High Density Lipoprotein ،LDL :Low Density Lipoprotein ،VLDL :Very Low Density Lipoprotein ،AST :Aspartate Amino Transferase ،ALT :Alanine Amino Transferase

Table (5) indicates that T4 and T5 significantly (P≤0.01) outperformed the rest of the experimental treatments in Atherogenic Index, and feed supplementation treatments recorded the highest values in the volumetric standard of antibodies directed to Newcastle virus, thus outperforming T1, while there are no significant differences between the treatments in the volumetric standard of antibodies directed to the Camporo virus, while the table shows an increase in the Fabricia index in treatment T1 compared to the rest of the treatments. Table (6) shows a significantly (P≤0.01) superiority of the feed addition treatments over T1 in weight of the small intestine. As T4 recorded significantly outperformed (P ≤ 0.05) compared to T1, T2 and T3 in spleen, heart and liver weights, while there were no significant differences between experimental treatments in gizzard weight, as well as T1 recorded the highest significant weight of the Fabricia gland compared to other treatments. It is noted that weight of abdominal fat in T2 and T3 recorded the highest significant increase (P ≤ 0.05) compared to T1.

Table 5. Effect of adding plant mixture powder (mint, cinnamon and astragalus) to the diet on the level of immune response of broilers under heat stress conditions (mean ± standard error)

T.	First AI	Second AI	Third AI	ND	IBD	Fabricia index
T_1	3.91±0.16 ^{a}	2.33±0.10 ^{a}	2.91±0.16 ^{a}	5006.25±383.32 ^{b}	14029.25±876.26	1.00±0.00 ^{a}
T_2	3.22±0.08 ^{b}	1.83±0.11 ^{b}	2.24±0.10 ^{b}	9743.75±131.05 ^{a}	15919.75±606.58	0.68±0.04 ^{b}
T_3	3.05±0.15 ^{b}	1.64±0.09 ^{b}	2.03±0.06 ^{b}	9800.00±302.20 ^{a}	16235.25±1093.89	0.63±0.11 ^{b}
T_4	2.13±0.09 ^{c}	0.90±0.08 ^{c}	1.13±0.07 ^{c}	11548.50±837.25 ^{a}	16325.50±348.99	0.40±0.06 ^{c}
T_5	2.22±0.13 ^{c}	1.06±0.15 ^{c}	1.22±0.15 ^{c}	11436.75±882.03 ^{a}	16348.50±964.73	0.52±0.06 ^{bc}
Sig.	**	**	**	**	N.S.	**

T1= diet without additives, T2, T3, T4, T5 diet to which 8, 6, 4, 2 g of the plant mixture (mint, cinnamon and astragalus)/kg diet were added respectively. Sig. = Significance level in analysis of variance. T. = Treatments IBD= volumetric standard of antibodies directed to IBD, ND= volumetric standard of antibodies directed to ND. AI= Atherogenic Index. **Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.01. N.S.= No significant differences between the coefficients.

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

Table 6. Effect of adding plant mixture powder (mint, cinnamon and astragalus) to the diet on the average weight of internal organs (g) of broilers under heat stress conditions (mean ± standard error)

T.	small intestine	liver	heart	gizzard	spleen	Fabricia gland	abdominal fat
T_1	128.50±4.50 ^{c}	47.02±1.58 ^{b}	11.80±0.63 ^{c}	29.18±0.80	2.31±0.15 ^{b}	1.80±0.01 ^{a}	20.47±0.50 ^{b}
T_2	166.50±3.77 ^{a}	46.38±1.56 ^{b}	12.34±0.46 ^{bc}	31.64±1.04	2.85±0.20 ^{ab}	1.23±0.08 ^{b}	24.28±0.89 ^{a}
T_3	167.50±2.87 ^{a}	47.31±2.24 ^{b}	10.85±0.64 ^{c}	29.65±0.67	2.75±0.18 ^{ab}	1.13±0.19 ^{b}	25.24±1.85 ^{a}
T_4	151.00±7.14 ^{b}	55.74±1.13 ^{a}	15.52±0.30 ^{a}	29.57±1.37	3.12±0.18 ^{a}	0.72±0.11 ^{c}	23.72±1.38 ^{ab}
T_5	162.50±2.99 ^{ab}	50.22±3.09 ^{ab}	13.84±0.74 ^{ab}	29.90±0.69	2.86±0.17 ^{ab}	0.94±0.12 ^{bc}	23.24±0.43 ^{ab}
Sig.	**	*	**	N.S.	*	**	*

T1= diet without additives, T2, T3, T4, T5 diet to which 8, 6, 4, 2 g of the plant mixture (mint, cinnamon and astragalus)/kg diet were added respectively. Sig. = Significance level in analysis of variance. T. = Treatments. *Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.05. **Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.01. N.S.= No significant differences between the coefficients

Table (7) indicates that the addition treatments were significantly superior (P ≤ 0.01) in villus height compared to T1. T5 recorded a significantly superior (P ≤ 0.05) to T1 and T2 in villus width, in addition to superiority of T5 over all experimental treatments in crypt depth. T4 and T5 showed a significant superiority (P ≤ 0.01) over the rest of treatments in distance between villi and thickness of the jejunal wall. As for villus height/ crypt depth, T4 recorded a significant superiority (P≤0.05) over T1. Despite the high environmental temperature, which may affect the activity and vitality of birds, affecting their ability to control the thermal balance between the internal and external environment, we find in Table (8) that the feed addition helped maintain the thermal balance in the body, as table shows the superiority of the feed addition treatments over T1 significantly (P≤0.01) throughout the breeding period and until the birds were marketed.

Table 7. Effect of adding herbal mixture powder (mint, cinnamon and astragalus) to the diet on tissue measurements of the jejunum (micrometer) of broiler under heat stress conditions (mean ± standard error)

T.	villi		depth of the crypts	distance between villi	thickness of intestinal wall	villus height/ crypt depth
	height	width				
T_1	884.70±59.40 ^{c}	130.50±3.63 ^{c}	166.50±7.69 ^{c}	40.82±2.81^{d}	146.70±10.08 ^{d}	5.48±0.84 ^{b}
T_2	1051.20±39.24 ^{b}	140.40±6.91^{bc}	168.30±7.46 ^{c}	45.50±0.81^{c}	163.80±2.92 ^{c}	6.41±0.73 ^{ab}
T_3	996.30±63.07 ^{b}	145.80±5.72 ^{abc}	169.20±10.15^{c}	47.64±0.59 ^{bc}	171.00±2.2b ^{c}	6.08±0.77 ^{ab}
T_4	1358.10±16.18 ^{a}	152.10±6.71^{ab}	196.20±5.77 ^{b}	51.82±1.48 ^{ab}	185.40±5.29 ^{ab}	7.01±0.48 ^{a}
T_5	1295.10±22.81 ^{a}	159.30±6.66 ^{a}	222.30±9.25 ^{a}	52.92±1.14 ^{a}	189.90±4.30 ^{a}	5.90±0.32 ^{ab}
Sig	**	*	**	**	**	*

T1= diet without additives, T2, T3, T4, T5 diet to which 8, 6, 4, 2 g of the plant mixture (mint, cinnamon and astragalus)/kg diet were added respectively. Sig. = Significance level in analysis of variance. T. = Treatments. *Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.05. **Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.01

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

Table 8. Effect of adding plant mixture powder (mint, cinnamon and astragalus) to the diet on the average body temperature (Celsius) of broilers under heat stress conditions (mean ± standard error)

	Age(Week)					
T.	**1**	**2**	**3**	**4**	**5**	**6**
T_1	41.53±0.10 ^{a}	41.83±0.09 ^{a}	41.40±0.08 ^{a}	41.83±0.14 ^{a}	42.00±0.09 ^{a}	41.88±0.05 ^{a}
T_2	41.28±0.06 ^{b}	41.45±0.06 ^{b}	41.15±0.05 ^{b}	41.53±0.05 ^{b}	41.53±0.09 ^{b}	41.65±0.03 ^{b}
T_3	41.25±0.03 ^{b}	41.33±0.03 ^{bc}	41.15±0.03 ^{b}	41.45±0.03 ^{b}	41.35±0.06 ^{b}	41.53±0.05 ^{c}
T_4	41.10±0.04 ^{b}	41.23±0.05 ^{cd}	41.05±0.06 ^{b}	41.18±0.03 ^{c}	41.10±0.07 ^{c}	41.43±0.05 ^{c}
T_5	41.18±0.05 ^{b}	41.10±0.04 ^{d}	41.05±0.03 ^{b}	41.13±0.06 ^{c}	40.98±0.08 ^{c}	41.43±0.03 ^{c}
Sig.	**	**	**	**	**	**

T1= diet without additives, T2, T3, T4, T5 diet to which 8, 6, 4, 2 g of the plant mixture (mint, cinnamon and astragalus)/kg diet were added respectively. Sig. = Significance level in analysis of variance. T. = Treatments.
**** Means with different letters within a column indicate significant differences between the means of the coefficients at the level of P ≤ 0.01**

High temperatures not only affect on broiler's performance, but also the quality of carcasses and their specific characteristics and reduce the weights of some edible parts (liver, heart and gizzard), However, the results indicate that the active compounds in the plant mixture (mint, cinnamon and astragalus) improved the physiological characteristics of broilers. It was observed that immunity response had improved, which is due to the cumulative effect of the active compounds present in the plant mixture on improving feed intake by improving digestion and absorption processes. Previous studies have indicated that high environmental temperature affects the concentrations of proinflammatory cytokines, including Interleukin-6 (IL-6), Interferon gamma (IFN-γ), Tumor necrosis factor α (TNF-α) and anti-inflammatory, which causes an imbalance in the internal balance (Chen, 2024). High environmental temperature also causes an increase in the production of heat shock protein, which leads to stimulation of the nervous system. Sympathetic to stimulate the secretion of adrenal glucocorticoids into the peripheral blood via the HPA axis of the hypothalamus-pituitary-adrenal cortex, and the secretion of the hormones Corticosterone, Epinephrine and norepinephrine into the blood causes a reduction in the secretion of the hormones Triiodothyronine (T3) and Thyroxine (T4) and thus reduces the metabolic activity in the body (Huang *et al.*, 2024), In addition to stimulating sympathetic nerves, it causes a decrease in the secretion of digestive enzymes Trypsin, Chymotrypsin and Amylase, which reduces feed intake as a result of poor digestion and absorption or as a result of poor appetite and increased water intake, thus reducing the benefit from feed materials and reducing the intake of protein that the body needs for growth, which leads to a decrease in body weight and health. However, despite this, the results indicated an improvement the internal organs weights , especially the spleen, liver and Fabricius gland, as well as histological measurements of the intestines and blood characteristics, This is due to the effective role played by the active compounds in the mixture in increasing the production of immune bodies such as B and T cells and phagocytic cells, which led to improved immune indicators and increased body weight despite the high temperature of the environment. The significant improvement in physiological performance despite the high environmental temperature is due to the effect of active substances in enhancing the birds' resistance to heat stress, result their effect on the enzymatic activities that enter into the body's metabolic processes, especially their effect on the small intestine since it is the site of digestion and food absorption, so it is the most important part of the digestive system (Li *et al.*, 2020). In addition, active compounds such as flavonoids, phenols, and others in the synergistic mixture positively help to benefit from food through their participation in the metabolism of carbohydrates, fats, and proteins, which enhanced the work of the digestive system of broilers through the effect of some active compounds in enhancing the stimulation of salivary gland secretions and the activity of pancreatic and intestinal enzymes, in addition to increasing the length and width of the villi, which indicates an increase in the

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

surface area of the villi, which leads to increased benefit from the diet by increasing the surface area exposed to digestion and absorption, which means greater activity of the digestive mucosal enzyme, thus improving the process of digesting nutrients (Nguyen *et al.*, 2021). Heat stress stimulates the decomposition of fats in adipose tissues and releases free fatty acids to be used as energy sources and build triglycerides, in addition to the role of the liver, which takes large amounts of fatty acids to increase its production of VLDL, which leads to an increase in serum cholesterol. This is what we observed in the control treatment, but in the addition treatments, the plant mixture containing many active groups such as saponins, terpenes, phenols, alkaloids, glycosides, p-coumaric acid, Caffeic acid, Rutin, cinnamaldehyde, eugenol, and APS (Luo *et al.*, 2023) played a role in reducing the level of fats by reducing cholesterol synthesis and reducing the oxidation of LDL inside the body of the living organism by preventing LDL from oxidation(Metwally, 2023), Which led in our study to a decrease in the signs of atherogenesis, which is a result of the increase in HDL and the decrease in LDL and VLDL, a decrease in the sources of cholesterol in the body, while in the T1 treatment we notice the opposite, and this indicates the effect of stress on the production of free radicals, which led to an increase in the index of atherogenesis in the control treatment (Ali *et al.*, 2021 ; Pavlíková, 2022), This also explains the synergistic role of the plant mixture in protecting the intestinal villi from oxidation, in addition to the role it plays in reducing pathogenic bacteria in the intestine, which improved the shape of the intestine (Krauze *et al.*, 2021), Thus, improved immunity and intestinal tissue lead to an improvement in the secretion of internal enzymes and stimulating appetite, digestion and absorption of nutrients as a result of improving the ratio of villi/crypt depth, which had a significant effect on Increased intestinal activity and thus improved the digestion process by reducing the speed of food passage through the digestive tract, which led to an increase in the rate of decomposition of amino acids and proteins in the digestive fluids, thus increasing their absorption and improving the quality of the carcass and reducing the conversion of protein into fats (Nantapo and Marume, 2025), which was ultimately reflected in improving the body growth. Thus, it can be concluded that the plant mixture treatments improved the birds' resistance to heat stress, in addition increasing their ability to feed intake, which increases digestion and absorption processes, Then it leads to improved the immunity response of broiler.

CONCLUSION

This study showed that the use of these plants (mint, cinnamon, and astragalus) in broiler feed has a positive effect on the health and growth of birds, acting as an effective natural strategy to alleviate the detrimental impacts of heat stress.

ACKNOWLEDGEMENT

The authors are grateful for the assistance provided by the College Dean, and Head of the Animal Production Department, College of Agricultural Engineering Sciences, University of Baghdad, Iraq. We would also like to thank My professors in the Department of Animal Production for Their valuable scientific support in conducting this research.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

We confirm that all Tables in the manuscript are original to us.

AUTHOR'S CONTRIBUTION STATEMENT

Author 1: Review and editing. All authors have read and agreed to the published version of the manuscript

REFERENCES

Abdelli, N., Solà-Oriol, D., & Pérez, J. F. (2021). Phytogenic Feed Additives in Poultry: Achievements, Prospective and Challenges. Animals : an open access journal from MDPI, 11(12), 3471. https://doi.org/10.3390/ani11123471

AL-Daloe, N. N., Shanoon, A. Q., & Mustafa, N. A. (2022). The use of local mint leaf powder compared to Vit C to reduce heat stress and its effect on the productive performance of broiler. Kirkuk University Journal for Agricultural Sciences (KUJAS),

13(3), 175–185. https://doi.org/10.58928/ku22.13314

Ali, A., Ponnampalam, E., Pushpakunara, G., Cottrell, J., Suleria, H., & Dunshea, F. (2021). Cinnamon: A natural feed additive for poultry health and production- A review. Animals, 11(7), Article 2026. https://doi:10.3390/ani11072026

AL-Jaryan, I. L., AL-Thuwaini, T. M., & AL-Jebory, H. H. (2023). Heat Shock Protein 70 and its role in alleviating heat stress and improving livestock performance. Reviews in Agricultural Science, 11(1), 234–242. https://doi.org/10.7831/ras.11.0234

Al-Jebory, H. H., Al-Saeedi, M. K. I., Al-Jaryan, I. L., & Al-Khfaji, F. R. (2023). Impact of Neem (Azadirachta indica) leaves powder on growth performance of broiler (Ross 308) exposed to heat stress. Research Journal of Agriculture and Biological Sciences, 15(2), 1–5. \https://doi.10.22587/rjabs.2023.15.2.1

Chen, H., Wang, F., Wu, X., Yuan, S., Dong, H., Zhou, C., Feng, S., Zhao, Z., & Si, L. (2024). Chronic heat stress induces oxidative stress and induces inflammatory injury in broiler spleen via TLRs/MyD88/NF-κB signaling pathway in broilers. Veterinary Sciences, 11(7), Article 293. https://doi.org/10.3390/vetsci11070293

Doumas, B. T., & Biggs, H. G. (1972). Determination of serum albumin. In Standard Methods of Clinical Chemistry (Vol. 7, pp. 175–188). Academic Press.

Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11(1), 1–42. https://doi.org/10.2307/3001478.

El Sabry, M. I., & Abd El-Ghany, W. A. (2021). A mathematical model for calculating intestinal villus surface area in broiler chickens. International Journal of Veterinary Science, 10(4), 317–322. https://doi.org/10.47278/journal.ijvs/2021.062

Han, S., Xu, G., Zhang, K., Ahmad, S., Wang, L., Chen, F., Liu, J., Gu, X., Li, J., & Zhang, J. (2024). Fermented astragalus powder, a new potential feed additive for broilers to improve the growth performance and health. Animals, 14(11), Article 1628. https://doi.org/10.3390/ani14111628.

Huang, Y., Cai, H., Han, Y., & Yang, P. (2024). Mechanisms of Heat Stress on Neuroendocrine and Organ Damage and Nutritional Measures of Prevention and Treatment in Poultry. Biology, 13(11), 926. https://doi.org/10.3390/biology13110926

Jaman, A., Tahera, Y., Ummay, S., Nurul, A., Deloara, B., Sabuz, S. H., Habib, A., Ahamed, E., & Hasan, M. (2024). Influence of spearmint (Mentha spicata) growth performance, hematological and lipid profile of broiler. Journal of Istanbul Veterinary Sciences, 8(3), 221–229. https://doi.org/10.30704/http-www-jivs-net.1525192

Jamil, Q. Y., Naji, I. Z., & Al-Azzawi, F. F. H. (2017). The role of some food in reducing the physiological and biochemical effect of Ɣ and X rays. Iraqi National Journal of Chemistry, 17(1), 23–41. https://search.emarefa.net/detail/BIM-958061

Khedkar, S., & Ahmad Khan, M. (2023). Aqueous Extract of Cinnamon (Cinnamomum spp.): Role in Cancer and Inflammation. Evidence-based complementary and alternative medicine : eCAM, 2023, 5467342. https://doi.org/10.1155/2023/5467342

Krauze, M., Pinkosz, M., Matusevičius, P., Stępniowska, A., Jurczak, P., & Ognik, K. (2021). The effect of administration of a phytobiotic containing cinnamon oil and citric acid on the metabolism, immunity, and growth performance of broiler chickens. Animals, 11(2), Article 399. https://doi.org/10.3390/ani11020399

Lagha, B.A., Azelmat, J., Vaillancourt, K., & Grenier, D. (2021). A polyphenolic cinnamon fraction exhibits anti-inflammatory properties in a monocyte/macrophage model. PLoS ONE, 16(1), Article e0244805. https://doi.org/10.1371/journal.pone.0244805

Li, S., Sun, Y., Huang, J., Wang, B., Gong, Y., Fang, Y., Liu, Y., Wang, S., Guo, Y., Wang, H., Xu, Z., & Guo, Y. (2020). Anti-tumor effects and mechanisms of Astragalus membranaceus (AM) and its specific immunopotentiation: Status and prospect. Journal of ethnopharmacology, 258(1), 112797. https://doi.org/10.1016/j.jep.2020.112797

Luo, G., Gebeyew, K., Zhou, C., Tan, Z., Yang, W., Niu, D., Ran, T., & Liu, Y. (2023). The ileal microbiome and mucosal immune profiles in response to dietary supplementation of ultragrinded Astragalus membranaceus in weaned goats. Frontiers in Microbiology, 14(1), Article 1309520. https: //doi.org/10.3389/fmicb.2023.1309520

Metwally, M. M. (2023). Impact of crushed celery seeds and cinnamon powder supplementation as natural additives on the performance, carcass parameters, some blood criteria and economical efficiency of Japanese quail. Journal of Desert and Environmental Agriculture, 3(1), 41–61. https://doi.org/10.21608/jdea.2023.193053.1016

Nantapo, C. W. T., & Marume, U. (2025). Strategic technologies to improve phytogenic feed additive efficacy in pigs and poultry. Animal nutrition (Zhongguo xu mu shou yi xue hui), 23, 286–303. https://doi.org/10.1016/j.aninu.2024.06.010

Nguyen, D. T., Le, N. H., Pham, V. V., Eva, P., Alberto, F., & Le, H. T. (2021). Relationship between the ratio of villous height: crypt depth and gut bacteria counts as well production parameters in broiler chickens. The Journal of Agriculture and Development, 20(3), 1–10. https://doi.10.52997/jad.1.03.2021.

NRC .1994. Nutrient requirements of poultry. (9th rev. ed.). National Research Council. National Academy Press, Washington, DC, USA. pp: 1-173. https://www.nap.edu/catalog/2114.html

Pashaei, M. ., Fayçal, Z. ., Kahrizi, D. ., & Ercisli, S. (2024). Medicinal Plants and Natural Substances for Poultry Health: A Review. Journal of Poultry Sciences and Avian Diseases, 2(2), 36-49. https://doi.org/10.61838/kman.jpsad.2.2.5

Pavlíková, N. (2022). Caffeic acid and diseases—mechanisms of action. International Journal of Molecular Sciences, 24(1), Article 588. https://doi.org/10.3390/ijms24010588

Saied, A. M., Attia, A. I., El-Kholy, M. S., Reda, F. M., & El Nagar, A. G. (2022). Effect of cinnamon oil supplementation into broiler chicken diets on growth, carcass traits, haemato-biochemical parameters, immune function, antioxidant status and caecal microbial count. Journal of Animal and Feed Sciences, 31(1), 21–33. https://doi.org/10.22358/jafs/146921/2022

SPSS. 2011. IBM Statistical Package for Social Science version 20 for window LEAD Technologies. Inc. USA. pp: 1- 446.

Iraqi Journal of Agricultural Sciences –2026:57(7):1935-1945
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/n0dhmr60

تأثير إضافة خليط مسحوق النعناع، القرفة والاستراغالوس إلى علائق فروج اللحم في الصفات الفسلجية تحت الإجهاد الحراري

علي محمد عبدالرحيم سعيد العزاوي[1] ، حسنين نشأت عزت [2]
[1] دائرة البحوث الزراعية، وزارة الزراعة، بغداد، العراق
[2] قسم الانتاج الحيواني، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق.

المستخلص

أجريت هذه التجربة بهدف دراسة تأثير إضافة نسب من خليط مسحوق النباتات الطبية الى علائق فروج اللحم في الصفات الفسلجية تحت ظروف الاجهاد الحراري. استعمل 300 فرخ فروج لحم Ross308/برتغالي بوزن ابتدائي 48.91 غم، وزعت عشوائياً على خمس معاملات وبواقع أربع مكررات لكل معاملة (15 طير/مكرر)، شملت المعاملات على:T1(معاملة السيطرة)، و T2، T3،T4،T5 عليقة أضيف اليها خليط من مسحوق النعناع، القرفة والاستراغالوس وبالنسب 2، 4، 6 و 8 غم/كغم علف على التوالي، وتم تربية الطيور تحت ظروف الاجهاد الحراري لمدة 42 يوما. أظهرت النتائج حصول زيادة معنوية($P\leq0.01$) في درجة حرارة الجسم وأوزان الأحشاء الداخلية في جميع معاملات الإضافة مقارنة مع T1، كما لوحظ زيادة معنوية($P\leq 0.01$) في القياسات النسيجية للصائم والاستجابة المناعية، إذ لوحظ ارتفاع معنوي($P \leq 0.05$) في تراكيز الكلوكوز، HDL وAST وND وIBD ومؤشر دليل فابريشيا كذلك لوحظ انخفاض معنوي($P\leq0.05$) في تراكيز الدهون الثلاثية و VLDL ودلائل التعصد، بينما لم يظهر أي فرق معنوي بين المعاملات في تراكيز بروتينات الدم، PCV، Hb، Cholestrol، LDL و ALT.

الكلمات المفتاحية: دهون الدم، بروتينات الدم، الاستجابة المناعية، الاعضاء الداخلية، قياسات الصائم، النباتات الطبية.