Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Could Moringa (*Moringa olifera*) Mitigate the Consequences of Heat Stress in Broilers?

Abdelalim F. Abdelalim[1], Naglaa Z.H. Eleiwa[1], Arafa M.M.[2], AbdElfattah I. El-Zanaty[2] and Mohamed A. Abo Elfadl[1]

[1]*Pharmacology Department, Faculty of Veterinary Medicine, Zagazig University, 44519, Egypt.*

[2]*Animal Health Research Institute, (AHRI-ARC), Dokki, Egypt.*

Abstract

Moringa olifera is used to improve the health and performance of chickens under heat stress (40:41˚C) . The purpose of this study was to examine how *Moringa olifera* affected the growth performance metrics, antioxidant status blood biochemical result and relative mRNA expression of two protein (HSP70,IL6) in broiler under heat stress. In this study, 80 one-day-old chicks were divided into four dietary groups at random, each consisting of 20 chicks. The chicks were given a baseline diet for 35 days. The negative control group, which was not exposed to heat stress, was Group 1. Group 2 was the positive control group that was exposed to heat stress. Groups 3 un exposed to heat stress and supplemented with *Moringa olifera* and Groups 4 s heat stressed group and supplemented with *Moringa olifera*. The findings demonstrated that adding *Moringa olifera* to groups 3, 4, baseline diet led to improved body performance parameters (increasing final B.W, BWG, F.C and F.C.R), improved liver and kidney function (lowering serum AST, ALT, creatinine and uric acid level), improved protein level (total protein & albumin & globulin), improved oxidant, antioxidant status (lowering serum MDA levels, Cortisol and raising serum CAT, SOD, TAC and GPx activities), raising antibody titer against IB& ND, lowering level of glucose, PH, Haptoglobin, CRP and down regulated of HSP70 and IL6 relative mRNA expressions as compared to birds in group 2.

Keywords: Heat stress, Growth performance, Antioxidant capacity, *Moringa olifera*.

Introduction

The poultry industry has become an important economic activity all over the world. The output of chicken meat has expanded throughout Africa in recent years [1].

The poultry industry, which is considered an important source of meat for humans, has grown into one of the world's most active and constantly growing sectors during the last 20 years. Higher ambient temperatures that might cause heat stress provide a significant obstacle to poultry farming in tropical nations [2]. Concern and understanding of Heat stress's negative impacts on chicken welfare have been worse recently. Significant financial losses have been documented as a result of higher mortality and worse productivity in reaction to HS [3].

One of the most significant climate issues facing tropical and subtropical regions of the world is heat stress (HS), which has a detrimental impact on livestock and poultry productivity. In summary, endocrine problems, immunosuppression, intestinal microbial dysbiosis, lower metabolic rate, lipid peroxidation, decreased feed consumption, decreased BW growth, and a greater feed conversion ratio (FCR) are the hallmarks of HS [4].

Birds raised on huge farms are exposed to stressful conditions, which can result in significant financial losses. Among the most significant environmental stressors affecting poultry production is heat stress. The adverse heat stress's implications on the health of chickens have drawn a lot of attention recently. Birds under heat stress spent more time sleeping, less time moving or walking, more time drinking, panting, and stretching their wings [5]. Moreover, heat stress increases the cortisol level [6] and elevated the heterophil to lymphocyte ratio [7]. In the production of broilers, these changes in behavior, welfare metrics, and health could result in significant financial losses. As a result, scientists are always trying to develop a remedy or practical tool to mitigate the harmful effects of heat stress.

*Corresponding authors: Mohamed A. Abo Elfadl, E-mail: ma3993703@gmail.comTel.: 01025315171
(Received 01 December 2024, accepted 05 January 2025)
DOI: 10.21608/EJVS.2025.339301.2534

By enhancing the production of free radicals, heat stress additionally promotes lipid peroxidation. Another major factor contributing to the decline in meat quality is lipid peroxidation, which alters the meat's texture, flavor, color, and nutritional value [9]. When exposed to high ambient temperatures, animals use a variety of strategies to maintain thermoregulation and homeostasis, such as boosting radiative, convective, and evaporative heat loss through vasodilatation and perspiration [10].

HSP70 are among the most significant acute HS markers (HSPs). During periods of heat stress, these highly preserved proteins energize cellular defense and start cellular heat tolerance in various organs and tissues [11]. By restoring damaged or misfolded proteins and boosting cell survival, the HSPs also maintain the integrity of the organs [12]. Transcription factors generated by heat stress that are connected to the promoters of heat-shock-related genes enhance the expression of HSP genes and, in turn, the generation of HSPs [13]. The HSPs have a variety of molecular weights and are members of many protein families. With more constitutively produced and inducible components with varying roles, HSPs 70 and 90 are the most well-researched and preserved.

In this situation, meal manipulation is also crucial for improving the composition and quality of poultry meat [14]. Some plants are famous to have natural antioxidants [15, 16]. Due to the availability of antioxidant flavonoids and other phenolic compounds that have anti-oxidative effects on poultry products, adding natural plant extracts to animal meals improved the oxidative stability, shelf life, and meat color. Therefore, it became imperative to find new, efficient herbal feed additives as plant secondary metabolites to combat heat stress caused by the environment. As a result, using antioxidants in food may be advantageous.

Moringa oleifera (MO), a fast-growing tree that grows to a height of 5 to 10 meters in tropical and subtropical regions, is one of the most well-known medicinal herbs. Almost all plant parts have some sort of value [17].

Moringa oleifera is a great addition to animal feed. The most nutrient-dense portion of M. oleifera is its leaves, which are a major source of protein, manganese, vitamin K, vitamin B complex, vitamin C, and pro-vitamin A as beta-carotene [18].

Moringa oleifera is said to be a fantastic source of vitamins and amino acids. Strengthen the immune systems [19]. Polyunsaturated fatty acids are abundant in moringa seed extracts [20].

In avian production, *Moringa oleifera* can be added to diets as a supplement and as a source of micronutrients [21]. Its anti-oxidant properties can stop the production of free radicals and reactive oxygen species (ROS) [20], protecting cellular biomolecules from oxidative damage caused by free radicals [22]. Red blood cell (RBC), packed cell volume (PCV), and hemoglobin (HB) levels rose in broilers fed Moringa leaf meal at both dietary levels. Lastly, the authors recommended that broiler diets contain no more than 10% *Moringa oleifera* leaf meal. Because *Moringa oleifera* contains selenium, carotenoids, flavonoids, and vitamins C and E, it is recognized to have some antioxidant qualities [23].

Material and Methods

Dietary interventions

Starter (0–21 day) and finisher (21–35 day) basal feeds were produced to satisfy the birds' nutritional needs as part of the broiler feeding program [24]. Four groups were established based on each basal diet, and they were prepared as follows: G1 is the negative control, which is a basal diet without supplements, G2 is the positive control, which is a basal diet without supplements with heat stress, G3 is a basal diet supplemented with *Moringa olifera* without heat stress and G4 is a basal diet supplemented with *Moringa olifera* under heat stress.

Management of birds and experimental design

Eighty healthy, one-day-old, unsexed broiler (Arbor Ecars) chicks were used in this experiment. The chicks were divided into four groups at random. A well-balanced ration was supplied to the broiler chicks. The starter diet was administered until day 20 of the trial and finisher diet was administered from day 21 to the end of the trial. Adlibitum food and drink were provided. The chicks were kept in separate experimental rooms that were clean, well-ventilated, and had previously been fumigated with formalin and potassium permanganate. Fresh, cleanly chopped wheat straw was used to bed the floor, creating a 3.5-cm-deep litter. There were enough feeders and water utensils in each chamber. Broilers are vaccinated against most viral infections to which they are susceptible.

Ethical statement

Every chicken used in this study was cared for in accordance with the rules set forth by the Agriculture Research Center's Institutional Animal Care Committee's Animal Ethics Committee (ARC-IACUC) (Approval Number: ARC-AH-22-14), and good animal practices were carried out in accordance with the guidelines of the research code of ethics (ARC-IACUC). Every attempt was made to reduce the birds' suffering and discomfort.

Moringa olifera

Moringa oleifera Lam is a slender softwood tree that belongs to the family *Moringaceae* was obtained from Agriculture researcher center (ARC), Dokki, Giza, Egypt. The MO leaves were dried in the air during the day without direct exposure to sunlight,

with continuous turning over to avoid growth of fungi. Then after 5 days of drying, the leaves were powdered through grinding to a fine powder to pass via a 0.15-mm sieve. Finally, the powdered leaves meal was packaged in plastic bags made of polythene, tightly closed and stored at room temperature until used.
Dose: 1gm/kg b.wt [25].
Route: on ration.

Blood sample (serum):

Serum was extracted from five birds at 15 and 35 days of age and placed in a simple, clean, well-dried centrifuge tube for use in serological research and biochemical parameter evaluation.

Statistical Analysis:

Data statistical analysed & each reading represents means ± standard deviation. The statistical evaluation of all data done using one-way analysis of variance (ANOVA) followed by dunnett's lest using a computer program (Statistical Package for Social science, version 16) P value $\leq$ 0.05 & P value $\leq$ 0.001 regarded as statistically significant SPSS program (2008).

Extraction, quantification and quality of total RNA
A. RNA extraction

The QIA ampRNeasy Mini kit (Qiagen, Germany, GmbH) was used to extract RNA from breast muscle tissue samples. 30 mg of the tissue sample was added to 600 µl RLT buffer that contained 10 µl β-mercaptoethanol per 1 ml. The adapter sets, which are fastened to the clamps of the Qiagen tissue lyser, were filled with tubes. for sample homogenization. High-speed (30 Hz) shaking step disruption was completed in two minutes. One volume of 70% ethanol was added to the cleared lysate, and the procedures were carried out in accordance with the QIAampRNeasy Mini kit's protocol for total RNA purification from animal tissues (Qiagen, Germany, GmbH).
Note: The column was subjected to DNase digestion in order to remove any leftover DNA.

B. Oligonucleotide Primers
The primers described in table (1) were provided by Metabion (Germany).

C. RT-PCR with SYBR green

1.25 µl of the 2x QuantiTect SYBR Green PCR Master Mix (Qiagen, Germany, GmbH), 0.25 µl of Revert Aid Reverse Transcriptase (200 U/µL) (Thermo Fisher), 0.5 µl of each primer at a concentration of 20 pmol, 8.25 µl of water, and 3 µl of RNA template were used in the 25 µl reaction. A Stratagene MX3005P real-time PCR equipment was used to conduct the reaction.

D. PCR result analysis

CT values and amplification curves were calculated using the stratagene MX3005P program. Using the "ΔΔCt" method described by Yuan et al. [27], the CT of each sample was compared with that of the positive control group in order to estimate the variation of gene expression on the RNA of the various samples using the following ratio.
Whereas ΔCt reference – ΔCt target = ΔΔCt
Ct control – Ct treatment = Δ*Ct t*arg*et* and *Ct control- Ct treatment*= Δ*Ct reference*

Results

Saccharomyces's impact on growth performance

a) Body weight (B.W)

The effect of supplementation of moringaon the B.W in broiler chicken is presented in Table (2). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced a significant (P < 0.05) increase in body weight compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant (P < 0.05) decrease in body weight all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant (P < 0.05) increase in Body weight compared with heat stressed group all over the experimental period.

b) B.W.G

The effect of supplementation of *Moringa* on the B.W.G in broiler chicken is presented in Table (2). Feeding of chicken on diet supplemented with *moringa* (1gm/kg) induced a significant (P < 0.05) increase in body weight gain compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant (P < 0.05) decrease in body weight gain all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant (P < 0.05) increase in body weight gain compared with heat stressed group all over the experimental period.

c) Food consumption (F.C):

The effect of supplementation of *Moringa* on the F.C in broiler chicken is presented in Table (3). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced a significant (P < 0.05) increase in food consumption compared with control group on 15th days of age and significant (P < 0.05) decrease on 35st days of age. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant (P < 0.05) decrease in food consumption all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant (P < 0.05) increase in food consumption compared with heat stressed group all over the experimental period.

D) Feed conversion ratio (F.C.R):

The effect of supplementation of *Moringa*on F.C.R of heat stress exposed chicken was illustrated in table (3).Feeding of chicken on diet supplemented with *moringa* (1gm/kg) induced non-significant ($P < 0.05$) change in food conversion ratio compared with control group on 15th days of age and significant ($P < 0.05$) decrease on 35st days of age. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in food conversion ratio on 15th days of age and significant ($P < 0.05$) decrease on 35st days of age. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in food conversion ratio compared with heat stressed group all over the experimental period.

Effect of Moringa on liver function test (ALT & AST)

The effect of *Moringa* on ALT & AST of heat stress exposed chicken was illustrated in table (4). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease in ALT, AST compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in ALT & AST all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in ALT, AST compared with heat stressed group all over the experimental period.

Effect of Moringa on kidney function test (creatinine & uric acid)

The effect of *Moringa* on creatinine & uric acid of heat stress exposed chicken was illustrated in table (5). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease in creatinine, uric acid compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in creatinine & uric acid all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in creatinine, uric acid compared with heat stressed group all over the experimental period.

Effect of Moringa on protein level (total protein & albumin & globulin)

The effect of *Moringa* on total protein & albumin & globulin of heat stress exposed chicken was illustrated in table (6). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) increase in total protein, albumin and globulin compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) decrease in total protein, albumin and globulin all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) increase in total protein, albumin and globulin compared with heat stressed group all over the experimental period.

Effect of Moringa on glucose & pH

The effect of *Moringa* on glucose& pH of heat stress exposed chicken was illustrated in table (7). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease in glucose & pH compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in glucose & pH all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in glucose & PH compared with heat stressed group all over the experimental period.

Effect of Moringa on Haptoglobin & CRP

The effect of *Moringa* on Haptoglobin & CRP of heat stress exposed chicken was illustrated in table (8). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease on heptoglobin & CRP compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in haptoglobin & CRP all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in heptoglobin & CRP compared with heat stressed group all over the experimental period.

Effect of Moringa on oxidant & anti-oxidant stress (MDA & SOD & GPX & catalase & Total antioxidant capacity & Cortisol)

The effect of *Moringa* on oxidant & anti-oxidant stress of heat stress exposed chicken was illustrated in tables (9,10,11)

-MDA

Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease on MDA compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in MDA all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in MDA compared with heat stressed group all over the experimental period.

-SOD & GPX & catalase & Total antioxidant capacity (TAC)

Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) increase on SOD & catalase & GPX &TAC compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) decrease in SOD & catalase & GPX &TAC all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in SOD & catalase & GPX &TAC compared with heat stressed all over the experimental period.

- *Cortisol*

Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) induced significant ($P < 0.05$) decrease on cortisol compared with control group all over the experimental period. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) increase in cortisol all over the experimental period. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) decrease in cortisol compared with heat stressed group all over the experimental period.

Effect of Moringa on Antibody titer by ELISA against ND &IB

The effect of *Moringa*on Antibody titer against ND &IB of heat stress exposed chicken was illustrated in table (12).Feeding of chicken on diet supplemented with *Moringa*(1gm/kg) induced significant ($P < 0.05$) increase on antibody titeraganist ND & IB compared with control group. Chicks experimentally exposed to heat stressed and fed on basal diet evoked a significant ($P < 0.05$) decrease on antibody titer against ND & IB compared with control group. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) displayed a significant ($P < 0.05$) increase on antibody titer of ND & IB compared with heat stressed group.

Histopathological investigation:

The effect of *moringa*on tissue histology (Liver- Heart- Lung- Intestine) of heat stress exposed chicken was illustrated in table (13)

Gene expression

HSP70 & IL6

The effect of *Moringa* on the transcription levels of HSP70 & IL6 of heat stress exposed chicken was illustrated in table (14). Feeding of chicken on diet supplemented with *Moringa* (1gm/kg) revealed down regulated on the transcription levels of HSP70 & IL6 compared with control group. Chicks experimentally exposed to heat stressed and fed on basal diet led to a notable increase in the transcription level of HSP70& IL6 compared with control group. Feeding of heat stressed chicken on diet supplemented with *Moringa* (1gm/kg) revealed reduction in gene expression of HSP70 & IL6 compared with heat stressed group.

Discussion

The impact on growth performance Decreased body weight, body weight gain, feed intake, and enhanced feed conversion rate in the broiler chickens reared under HS conditions showed in the current study.

Heat stress results from a negative balance between the net amounts of energy flowing from the animal's body to its surrounding environment and the amount of heat energy produced by the animal. This imbalance may be caused by variations of a combination of environmental factors (e.g: sunlight, thermal irradiation, and air temperature, humidity and movement) and characteristics of the animal (e.g: species, metabolism rate and thermoregulatory mechanisms). Environmental stressors, such as heat stress, are particularly detrimental to animal agriculture [29, 30].

Due to its negative impact on productivity and health, heat stress is a major issue in the chicken business that causes large financial losses [31]. According to Salles*et al*. [32], animals exposed to HS have reduced nutrient uptake because their intestines are less able to absorb nutrients and have reduced digestibility. This is probably due to an excess of reactive oxygen species (ROS), which oxidizes and destroys biological molecules in cells, resulting in varying degrees of intestinal damage [32].Additionally, a change in blood flow from the colon to the periphery [34] may result in higher energy expenditure because of heat dissipation, which further lowers the feed conversion rate (FCR) in broiler chickens [35].

Akhavan-Salamat and Ghasemi [36] have documented that the negative impact of HS on broiler growth performance. Numerous factors have contributed to the decline in performance of poultry exposed to HS, including decreased appetite and feed intake as a means of reducing heat increase [4], poor digestion due to intestinal morphology damage and decreased digestive enzyme activity [37], impaired metabolism due to decreased thyroid hormone activity [38], and altered endocrine status due to elevated corticosterone hormone levels [4].

Heat Stress significantly decreased body weight, body weight gain, food consumption and markedly elevated mortality and FCR in broiler chickens. According to reports, HS causes stress hormones to be secreted. which alter the chickens' neuroendocrine system by activating the hypothalamic-pituitaty-adrenal axis and thereby increasing the plasma corticosterone levels [39]. Corticosterone is associated with a higher degree of body protein breakdown [40], which affects the digestive system,

nutrient utilization, and digestibility [41]. Moreover, HS has been shown to impair performance, trigger inflammatory reactions, and disrupt intestinal barrier function. According to a research by Alhenaky *et al*. [42], HS, whether acute or chronic, increased intestinal permeability to endotoxins and Salmonella spp. and compromised intestinal integrity.

Due to leaves of MOL have been shown to contain a number of necessary amino acids and are thought to be a rich source of alpha linoleic acid [44], the beneficial effects of MOL may be attributed to its high nutritional properties [43]. Overall, the study's findings supported previous findings that suggested adding MOL to poultry diets had beneficial effects on the growth and productivity of the birds, possibly as a result of the plant's minerals and phytochemicals [45].The high vitamin C content of MO, which can counteract the negative effects of HS and promote the productive responses, may be the cause of the performance improvement in heat-stressed MOL treated groups. El-Moniary *et al*.[46] found that adding vitamin C to chicken broiler feeds raised under heat stress circumstances enhanced the animals' growth performance. The addition of MOL helped the chicks use more feed and, as a result, improve more weight by lessening the negative effects of HS. The improvement in crude protein digestibility and the use of nutrients due to the presence of flavonoids, which have antibacterial and antioxidant properties, may be the cause of the increase in BWG and FCR. Additionally, this improvement could be ascribed to MOL's positive impact on gut microorganisms, which may enhance nutrient absorption, use, and digestion [47].

The effect on Liver function (ALT & AST)

Measurement of serum transaminase ALT, AST activities are standard test for hepatocellular damage. It's well known that the enzyme are intracellular substances being located in the mitochondria and the cytoplasm, consequently, circulating levels increase following liver cell damage [48]**.**

In terms of the biochemical results, HS considerably increased the levels of serum AST and ALT activities in comparison to the NHS bird group. A change in the hepatocellular membrane due to blood hypoxia, exposure to toxins and toxemia, inflammation from metabolic diseases, or proliferation of hepatic cells can result in elevated serum AST and ALT values. Additionally, elevated AST and ALT levels were noted in conjunction with intestinal and liver injury [49].

These results appeared to be consistent with those of Tang *et al*. [50], who noted that broiler chicks exposed to heat stress for one or two weeks had necrotic spots on their liver surface. Furthermore, inflammatory cell infiltration was triggered by hepatic histological testing. These findings suggested that hepatic tissue damage was caused by heat stress. The combination of antioxidant components and phytochemicals present in plants may work more effectively to reduce ROS levels. Better liver function and an improved picture of hepatic enzymes in birds fed diets supplemented with MOL may be the cause of this effect [51].This is supported by Divya *et al*. [52], who reported that adding up to 1.5% MOL to the broiler feed significantly decreased serum ALT and AST activity. These results implied that MOL might improve liver function.

Melesse *et al*. [53], who reported that MOL had a positive effect on improving intestinal health in broilers and boosting immunological responses. Additionally, this may provide insight into the protective impact of MOL addition on hepatic tissues. As compared to the NHS group, heat stress in the current study significantly raised serum creatinine and uric acid levels.

Regarding the kidney function, several changes were recorded uric acid is the primary catabolic product of protein catabolism in birds [54].The avian kidney excretes uric acid primarily by tubular excretion, unlike the mammalian system that excretes urea entirely by filtration therefore the elevation of serum uric acid level indicate impaired renal function [55].

As compared to the NHS group, heat stress in the current study significantly raised serum creatinine and uric acid levels. Measurements of serum uric acid and creatinine levels are the most sensitive ways to assess renal functions, and they are frequently regarded as crucial measures for assessing kidney health. The results of the current investigation appeared to be consistent with those of Tang et *al*. [56], who reported that birds exposed to HS showed elevated plasma levels of urea and uric acid, indicating renal impairment.

Huang *et al*. [57] who reported that acute HS led to elevated levels of some hemato biochemical markers, including creatinine, blood urea nitrogen, ALT, and creatine kinase, which could indicate damage to vital organs including the liver and kidney.

However, when compared to the HS nontreated group, the dietary usage of MOL in the hens' ration raised under HS considerably decreased the levels of uric acid and creatinine in their serum. This finding is supported by Divya *et al*. [52], who found that adding MOL to broiler diets significantly decreased creatinine and uric acid.

Effect on protein level

Serum protein, of which albumin is the most prevalent, is the total amount of protein in the blood. In addition to carrying certain medications and other substances through the blood that are essential for tissue growth and repair, albumin also helps prevent blood from leaking out of blood vessels. Low

amounts of total protein may indicate a problem with the kidneys, liver, or with the appropriate digestion or absorption of protein.

Compared to the NHS group, heat stress dramatically reduced serum levels of albumin, globulin, and total protein. The current study's findings appeared to be consistent with those of Sahin *et al.* [58], who also noted that heat stress reduced protein and albumin levels and that adding MOL to the diet improved its effects.

According to the current study, chicks under heat stress reveal a considerable rise in their serum glucose levels. A rise in glucocorticoid levels, which can be caused by a number of stressors, including heat stress, is directly correlated with an increase in glucose concentration [59]. The main way that glucocorticoids affect metabolism is by promoting the production of gluconeogenesis from proteins found in muscle tissue.

Habibian *et al*. [60] found that elevated ambient temperatures raised cholesterol and plasma glucose levels. When compared to the heat-stressed group, heat-stressed birds fed a basal diet supplemented with MOL had lower glucose levels, according to Owens et al. [61].

Lactic acid production was greatly increased by HS, which accelerated the rate of pH decrease and, in turn, reduced the quality of the breast muscle. This, in turn, causes chicken to produce pale, mushy, and exudative meat, or PSE-like meat [62]. HS may cause birds' metabolisms to rapidly slow down, leading to potentially harmful side effects as color changes, a drop in muscle pH, and a reduction in the meat's water-holding capacity (WHC). [63]. Rehman *et al*. [64] observed that when compared to the non-supplemented group, the breast muscles of the birds fed a basal diet supplemented with MOL had higher pH levels.

In chicks, haptoglobin, an alpha-2 globulin, is referred to as PIT 54. The primary function of haptoglobin is to bind free hemoglobin generated by erythrocytes and reduce its oxidative activity [65]. It also binds hemoglobin to minimize iron losses via urine after hemolysis, therefore protecting tissues from injury caused by free haemoglobin [66]. It has been determined that haptoglobin is a strong angiogenic agent that is necessary for the differentiation and proliferation of endothelial cells during the formation of new blood vessels.

One of the main APP in both humans and chicken, CRP was the first APP to be described [67]. CRP can attach itself directly to degenerating cells, residues, and polysaccharides on bacteria, fungi, and parasites. When attached to one of its ligands, it can activate the complement system. It can also attach to phagocytic cells, engaging with the humoral and cellular systems of inflammation [68].

In terms of the biochemical results, HS considerably increased the levels of serum heptoglobin and c-reactive protein activity in comparison to the NHS bird group. Heptoglobin and CRP rise during HS as a result of non-clinical illnesses and infections. CRP is thought to be a possible biomarker for birds since the non-clinical chronic respiratory disease causes a considerable rise in both CRP and heptoglobin concentrations in these birds. [69]. Conversely, when compared to the HS non treated group, the addition of MOl powdered leaves to the bird feed raised under HS significantly decreased the blood heptoglobin and c-reactive protein activity.

As a result, the current study's findings of a decrease in serum heptoglobin and c-reactive protein levels across MOL-supplemented groups may collectively point to the livers of hens fed MOL-containing feeds functioning normally under HS conditions. The findings of Olugbemi *et al.* [19] and Melesse *et al*.[53], who claimed that MOL has a positive effect on boosting immune responses and reducing inflammation in broilers, further support this conclusion.

In terms of antioxidant status, broilers raised under HS conditions and fed basal diets in the current study show a significant decrease in the activities of glutathione peroxidase (Gpx), catalase (CAT), superoxide dismutase (SOD), and total antioxidant capacity (TAC) in addition to elevated MDA and cortisol levels.

One of the most crucial elements that can increase the generation of ROS is HS [70]. By altering ROS levels and influencing mitochondrial activity, these processes led to oxidative stress, which in turn caused lipid and protein oxidative damage as well as changes in oxidative stress markers as MDA, GPx, catalase, and SOD [71].

An imbalance between the body's natural antioxidant defenses and the generation of free radicals causes oxidative stress in cells and tissues, which leads to lipid peroxidation, protein nitration, DNA damage, and apoptosis. Free radicals produced during physiological oxygen metabolism are constantly present in cells [72].

Conversely, the current study found that broiler chickens raised in heat stress and fed a basal diet supplemented with MOL had improved antioxidant capacity, as evidenced by a significant decrease in the lipid peroxidation estimated parameter (MDA) and a significant increase in the activities of the enzymes SOD, CAT, and GPx. In fact, the antioxidant qualities of MOL supplementation are responsible for his increase in antioxidant effectiveness. Glycosides, tannins, polyphenols, anthocyanin, beta-carotene, vitamins C and E, thiocarbamates, and high concentrations of zinc, manganese, copper, and selenium are just a few of

the many active ingredients that give MOL its antioxidant efficacy. These ingredients can combat free radicals, activate antioxidant enzymes, and inhibit oxidases [64, 73].

Poultry are susceptible to Newcastle disease (ND), a highly contagious viral illness. Chickens, turkeys, pigeons, and other birds are susceptible to Newcastle disease (ND). It is brought on by the filterable Newcastle disease virus (NDV). In susceptible birds that are not vaccinated, the disease's extreme stages can cause 90–100% morbidity and mortality. The illness manifested as neurological, gastric, and respiratory symptoms. According to current estimates, the overall average losses in poultry due to ND are between 40 and 60 percent, even with vaccination and treatment programs [74]. However, there are some disadvantages to vaccination, such as the lengthy time it takes to develop protective immunity and the high expense of vaccines. For these reasons, it was discovered that employing medicinal plant extracts as antiviral medications is an effective method of protecting flocks against NDV [70, 75].

One way to protect flocks from NDV is to use extracts from medicinal plants as antiviral medications. In this work, we examine the impact of *Moringa oleifera*, a medicinal plant with antiviral qualities that is essential to the body's immune system's defense against the Newcastle disease virus [76]. Other advantages include its simplicity of handling, affordability for bird breeders, and ability to compare the effectiveness of *Moringa oleifera* extract in preventing Newcastle disease virus in hens with and without NDV vaccination. Clinical indications were noted in infected groups, including greenish diarrhea, huddle together, respiratory signs, anxious signs, and drop in appetite. The identical symptoms that of Nnabuike & Olu [77]

Elevated heart rate and increased blood flow to the heart, brain, and muscles were prime indicators of heat stress [78]. This may result in lung, liver, and kidney congestion. Severe and widespread hyperemia, which was particularly severe in the respiratory tract, particularly in the lung, tracheal, and bronchial mucosae, dominated the effects of heat stroke on the gross lesions. Additionally, the lungs may be edematous and occasionally have focal bronchopneumonia consolidations. Severe congestion may also affect other organs like the kidney and heart. Both the microscopic and gross lesions are consistent. There is edema in the alveoli and significant engorgement of the lung's vasculatures. The liver frequently exhibits congestion, hepatocyte dissociation, and centriolar necrosis. There are subendocardial and in the subepicardial hemorrhages are found in the heart. Besides, capillary congestion is evident in kidney and other structures [79].

All living things react to environmental stressors, such as hyperthermia, by producing a class of proteins called heat shock proteins (HSPs)[80]. One distinct feature of heat stress is the upregulation of HSP70 [81]. As HS considerably increased HSP70 mRNA expressions in the breast muscle of the heat-stressed group compared to the control bird group, this does, in fact, validate the results we got in this investigation. These findings also appeared to be consistent with those of earlier research by Estevez [73], Song *et al*. [82], Wang *et al*. [83].

In contrast to the heat-stressed group, the administration of MOL to heat-stressed broilers dramatically reduced these up-regulations in a dose-dependent manner, bringing them down to levels that were comparable to the control. According to earlier reports, HS causes oxidative damage to the various tissues of broilers [64, 84]. The generation of ROS is thought to be one of the elements that influences how HSPs react and, in turn, leads to the development of various HSP types. Therefore, it has been proposed that oxidative stress is a primary mechanism responsible for the induction and production of HSPs [85].

Tiloke *et al.* [86], who reported that in lung carcinoma cells, MOL gold nanoparticles reduced the expression of HSP70 at the mRNA and protein levels. The expression of HSP70 in the liver of heat-stressed broiler chicks fed a baseline diet supplemented with vitamin C was reduced [87].

One of the primary pyrogenic and inflammatory cytokines, IL-6 is controlled by a number of transcription factors, such as the repressor ATF3 [91] and activators NF-κB and NF-IL6 [90]. HSF1 is unique in that it regulates the expression of IL-6 in mammals in at least two ways. In order to assist the binding of the other transcription factors to these promoters [93], HSF1 first constitutively binds to a large number of its target genes [92], including IL-6. Consequently, depending on the type of cell, HSF1 deletion or knockdown may cause either increased or decreased IL-6 expression [93,94]. Second, activated HSF1 directly triggers the production of ATF3, a repressor of genes that produce inflammatory cytokines, such as IL-6, when cells are exposed to high temperatures [95]. This HSF1–ATF3 pathway is a feedback mechanism of the febrile response in mammals since IL-6 itself causes fever or elevated temperature [95]. On the other hand, we first show that when cells are exposed to high temperatures, the avian master regulator HSF3 directly binds to and strongly activates the avian pyrogenic cytokine gene [96], IL genes for inflammatory cytokines, like IL-6 [95]. When broilers were exposed to heat stress, MOL treatment significantly ($p < 0.001$) reduced these upregulations in a dose-dependent manner compared to the heat-stressed group and brought them back to levels that were comparable to the control [64].

Conclusion

It could be concluded that supplementation of chickens with *Moringa* had a significant effect on growth performance & some biochemical parameters (ALT, AST, Creatinine, Uric acid, total protein, albumin, globulin, glucose, Ph, Haptoglobin, CRP) & oxidant and antioxidant parameter (GSH, SOD, Catalase, Total antioxidant capacity, cortisol) & histopathological condition and gene expression (HSP70 & IL6) Based on the result of present study.

Acknowledgments

Not applicable.

Funding statement

This study didn't receive any funding support

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethics guidelines of the Faculty of Veterinary Medicine, *Zagazig University,* University, Egypt.

TABLE 1.Primer sequence

Gene	Primer sequence(5'-3')	Reference
IL6	GCTCGCCGGCTTCGA GGTAGGTCTGAAAGGCGAACAG (FAM) AGGAGAAATGCCTGACGAAGCTCTCCA (TAMRA)	Suzuki *et al*. [26]
28S rRNA	GGCGAAGCCAGAGGAAACT GACGACCGATTTGCACGTC (FAM) AGGACCGCTACGGACCTCCACCA (TAMRA)	
B. actin	CCACCGCAAATGCTTCTAAAC AAGACTGCTGCTGACACCTTC	Yuan *et al*. [27]
Hsp70	AACCGCACCACACCCAGCTATG CTGGGAGTCGTTGAAGTAAGCG	Ebrahimi *et al*. [28]

TABLE 2. The effect of *Moringa* on body weight and body weight gain in broiler chicken exposed to heat stress on the15th and 35st days of age.

Days / Groups	15th			35st	
	Initial B.W	B.W. (gm)	B.W.G (gm)	B.W. (gm)	B.W.G (gm)
Group 1	70.86±1.79	386.00±4.30^{de}	315.4±4.65^{ed}	1823.6±66.97^{e}	1437.6±66.43^{d}
Group 2	72.88±1.62	244.4±4.69^{f}	171.52±3.53^{f}	1493.4±34.61^{f}	1249.0±30.88^{e}
Group 3	72.9±1.72	428.4±4.77^{a}	355.5±5.86^{a}	2145.8±14.02^{b}	1717.4±13.60^{b}
Group 4	75.28±1.69	377.2±7.93^{e}	301.92±8.62^{e}	1976.00±25.01^{cd}	1598.8±17.25^{c}

TABLE 3.The effect of *Moringa* on food consumption and food conversion ratio in broiler chicken exposed to heat stress on the 15th and 35st days of age.

Days / Groups	15th		35st	
	FC	FCR	FC	FCR
Group 1	1237.8±19.22^{c}	3.53±0.42^{c}	1816±10.29^{a}	1.272±0.05^{a}
Group 2	1086.8±12.40^{d}	6.332±0.16^{a}	1438±20.34^{e}	1.1536±0.03^{ab}
Group 3	1318.0±6.38^{ab}	3.708±0.06^{c}	1751±3.31^{bc}	1.018±0.01^{bc}
Group 4	1305.8±14.05^{ab}	4.332±0.11^{b}	1697±38.13^{bc}	1.061±0.02^{abc}

Letter differ at $p < 0.05$.

TABLE 4. The effect of *Moringa* on liver function test in broiler chicken exposed to heat stress on the15th and 35st days of age.

Days/ Groups	15th		35st	
	ALT (µl/ml)	AST (µl/ml)	ALT (µl/ml)	AST (µl/ml)
Group 1	74.6±0.92c	99.8±2.15c	78.6±1.20b	109.4 ±0.87b
Group 2	93.6±2.01a	231±9.92a	95.2±1.85a	238.6 ±0.92a
Group 3	70.8±0.73cd	93.8±1.24cd	60.4±0.50e	88.8 ±2.08cd
Group 4	78.4±1.20b	127.2±2.42b	73.4±1.20c	109.4 ±1.03b

Letter differ at $p < 0.05$.

TABLE 5. The effect of *Moringa* on Kidney function test in broiler chicken exposed to heat stress on the15th and 35st days of age.

Groups / Days	15th		35st	
	Creatinine (µl/ml)	Uric acid (µl/ml)	Creatinine (µl/ml)	Uric acid (µl/ml)
Group 1	0.604±0.03bc	2.86±0.06bcd	0.772±0.02bc	3.52±0.15d
Group 2	1.08±0.04a	5.52±0.48a	1.244±0.03a	7.32±0.27a
Group 3	0.532±0.02cd	2.2±0.07ef	0.552±0.03e	2.9±0.07ef
Group 4	0.606±0.02bc	3.44±0.15b	0.706±0.01cd	4.12±0.08b

Letter differ atp< 0.05.

TABLE 6. The effect of *Moringa* on protein level (total protein, albumin and globulin) in broiler chicken exposed to heat stress on the15th and 35st days of age.

Days / Groups	15th			35st		
	Total protein	Albumin	Globulin	Total protein	Albumin	Globulin
Group 1	4.28±0.05b	2.32±0.03bc	1.96±0.04ab	4.58±0.07c	2.44±0.05bc	2.14±0.08cd
Group 2	3.17±0.05c	2.22±0.03cd	0.95±0.06d	3.38±0.03d	2.22±0.03d	1.16±0.04e
Group 3	4.74±0.05a	2.5±0.04a	2.24±0.08a	4.76±0.07b	2.7±0.02a	2.4±0.07b
Group 4	4.01±0.06b	2.12±0.03d	1.89±0.06ab	4.42±0.03c	2.5±0.04cd	2.08±0.03d

Letter differ at $p < 0.05$.

TABLE 7. The effect of *Moringa* on glucose & pH in broiler chicken exposed to heat stress on the15th and 35st days of age.

Groups / Days	15th		35st	
	Glucose	pH	Glucose	pH
Group 1	141.4±2.15cd	7.18±0.05d	135.4±2.35d	7.36±0.05d
Group 2	198.6±5.22a	8.392±0.03a	208.8±3.13a	8.38±0.07a
Group 3	137.8±1.68de	6.9±0.06e	129.8±1.93c	7.10±0.04e
Group 4	151.2±3.81b	8.16±0.03b	166.6±2.03b	8.02±0.04b

Letter differ at $p < 0.05$.

TABLE 8. The effect of *Moringa* on Haptoglobin & CRP in broiler chicken exposed to heat stress on the15th and 35st days of age.

Groups / Days	15th		35st	
	Heptoglobin	CRP	Heptoglobin	CRP
Group 1	40.4±0.50bc	4.86±0.47c	135.4±2.35bc	5.86±0.25c
Group 2	53.8±1.42a	13.38±0.66a	208.8±3.13a	17.66±1.29a
Group 3	39.2±0.58cd	2.88±0.12d	132.8±1.93d	2.26±0.10d
Group 4	40.8±0.86bc	6.24±0.05b	166.6±2.03b	7.7±0.50b

Letter differ at $p < 0.05$.

TABLE 9. The effect of *Moringa* on MDA & SOD in broiler chicken exposed to heat stress on the 15th and 35st days of age.

Groups / Days	15th		35st	
	MDA	SOD	MDA	SOD
Group 1	14.2±1.24cd	2.94±0.18f	19.6±0.67bc	3.62±0.14e
Group 2	24.4±1.68a	2.5±0.20d	27.00±2.23a	1.16±0.05f
Group 3	11.2±1.74d	6.88±0.13b	11.6±0.50e	6.98±0.06b
Group 4	15.2±0.58c	4.94±0.14de	21.00±0.83b	3.26±0.11e

Letter differ at $p < 0.05$.

TABLE 10. The effect of *Moringa* on catalase & GPX in broiler chicken exposed to heat stress on the 15th and 35stdays of age.

Groups / Days	15th		35st	
	CAT	GPX	CAT	GPX
Group 1	3.56±0.16e	21.00±0.83cd	3.9±0.12d	20.80±0.73ef
Group 2	2.6±0.17f	6.40±0.67f	2.04±0.05f	4.60±0.60g
Group 3	6.8±0.18a	28.6±1.43b	7.84±0.17a	36.60±0.51b
Group 4	4.22±0.10d	19.20±0.86d	4.02±0.08d	23.40±0.50e

Letter differs at $p < 0.05$.

TABLE 11. The effect of *Moringa* on total antioxidant capacity& cortisol in broiler chicken exposed to heat stress on the 15th and 35st days of age.

Groups / Days	15th		35st	
	TAC	Cortisol	TAC	Cortisol
Group 1	250.8±19.40cd	11.6±0.50cd	255.8±7.15d	12.00±0.70b
Group 2	191.4±5.30e	17.6±0.50a	168.4±3.90f	20.4±0.67a
Group 3	447.2±17.77a	9.4±0.74e	476.8±3.27b	10.00±0.70cd
Group 4	248.8±8.18cd	12.6±0.40bc	247.6±2.65ed	11.6±0.50bc

Letter differ at $p < 0.05$.

TABLE 12. The effect of *Moringa*on antibody titer estimated by ELISA against ND & IB in broiler chicken exposed to heat stress.

Groups	ELISA ND	ELISA IB
Group 1	4.14 ± 0.05^{d}	3.6 ± 0.11^{d}
Group 2	2.2 ± 0.07^{f}	2.44 ± 0.05^{g}
Group 3	5.14 ± 0.09^{c}	4.76 ± 0.09^{b}
Group 6	3.62 ± 0.03^{e}	3.17 ± 0.06^{e}

Letter differ at $p < 0.05$.

TABLE 13. Histopathological condition

Groups	Liver	Heart	Lung	Intestine
Group (1)	Normal tissue histology	Normal tissue histology	Normal tissue histology	Normal tissue histology
Group (2)	1) Severe degree of congestion of blood vessels 2) perivascular edema 3) Degeneration of hepatic cells 4) multiple necrotic foci replaced with leukocytes' aggregation	1) Severe degree of congestion 2) Thickening of blood vessels wall 3) Perivascular edema. 4) Degeneration of cardiac myofibril besides myocarditis and leukocytes' infiltration	1) Severe degree of congestion of blood vessels with perivascular edema 2)Diffuse interstitial hemorrhages 3)Pneumonia and bronchiolitis	1) Severe degree of degeneration 2) Desquamation of lining epithelium. 3) Congestion and thickening of blood vessels wall in lamina propria
Group (3)	Normal tissue histology	normal tissue histology	Normal tissue histology	Normal tissue histology
Group (4)	Revealed milder degree of the mentioned lesions.	Moderate degree of congestion, edema	Moderate degree of congestion, edema and inflammation.	Slight elongation of length of villi.

TABLE 14. Effect of *Moringa* supplementation on the transcription levels of HSP70 & IL6 of heat stress exposed chicken.

Groups	ß. actin	HSP70		28S rRNA	IL6	
	CT	CT	Fold changes	CT	CT	Fold changes
G1	19.55	22.12	-	18.69	20.73	-
G2	20.83	20.21	9.12	20.22	19.71	5.85
G3	19.46	23.38	0.392	19.10	22.12	o.507
G4	20.75	21.61	3.27	20.15	21.15	2.056

TABLE 15. Effect of *Moringa* supplementation on the transcription levels of HSP70 & IL6 of heat stress exposed chicken.

Groups	*HSP70*	*IL6*
Group 1	1.00±0.00d	1.00±0.00d
Group 2	9.12±0.12a	5.85±0.15a
Group 3	0.39±0.05e	0.50±0.02e
Group 4	3.27±0.16b	2.05±0.13b
***p*-value**	<.0001	<.0001

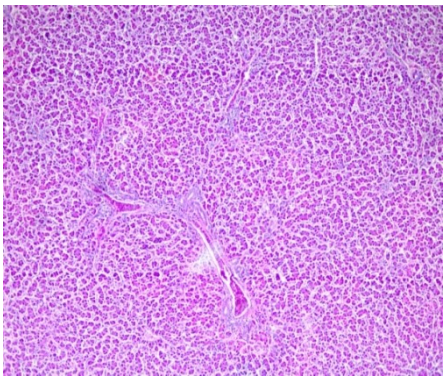

Fig. 1. Liver of control negative group showing apparently normal hepatic cell HE, X100.

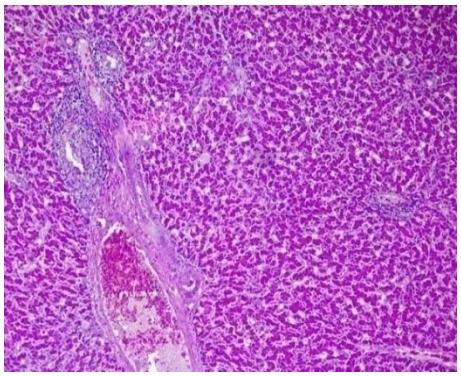

Fig. 2. Liver of heat stressed group showing congested blood vessels and sinusoids with few perivascular leukocytic infiltration, HE, X100.

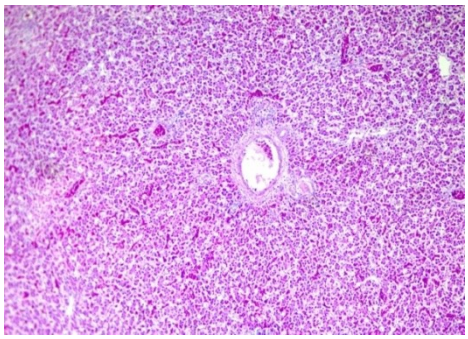

Fig. 3. Liver of supplemented heat stressed group by moringa showing mild congested blood vessels and sinusoids .HE,X100.

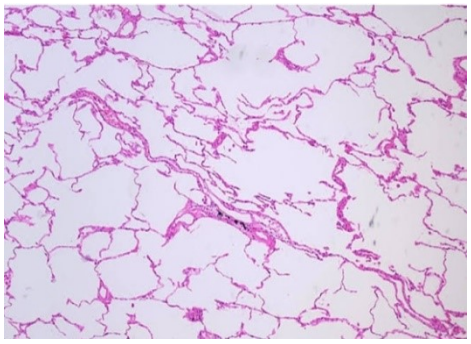

Fig. 4. Lung of control negative group showing apparently normal alveoli HE X100.

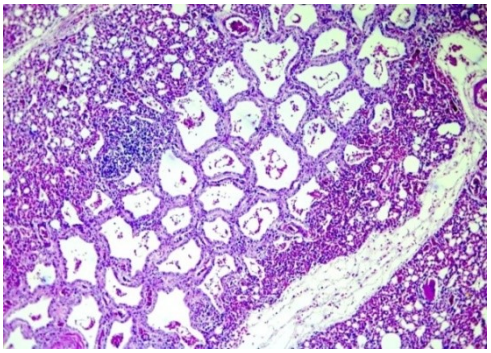

Fig. 5. Lung of heat stressed group, showing thickening of interalveolar septa, accumulation of esinophilic material inside the alveoli, hemorrhages and leukocyticagrrgation. HE, X100.

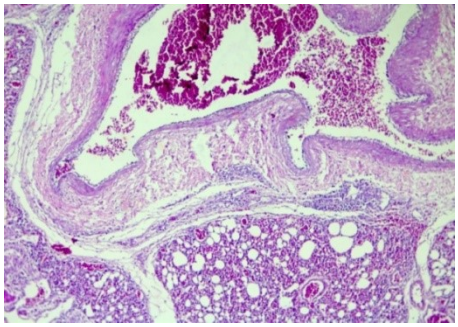

Fig. 6. Lung of supplemented heat stressed group by moringa, showing low degree of bronchiolitis and low leukocytes' aggregation HE, X100.

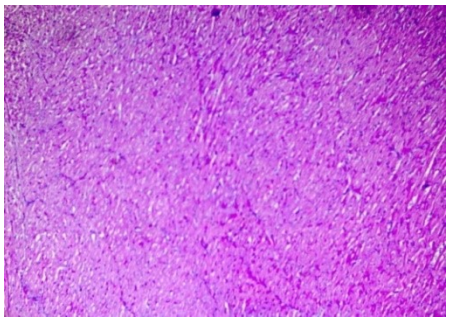

Fig. 7. Heart of control negative group showing apparently normal tissue HE, X100.

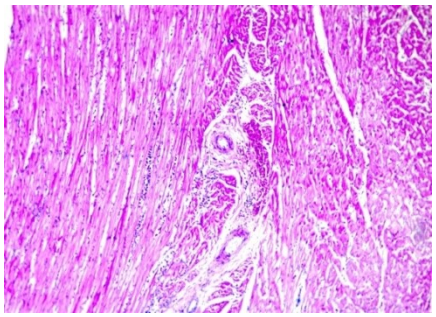

Fig. 8. Heart of heat stressed group showing hemorrhage and leukocytes' infiltration HE, X100.

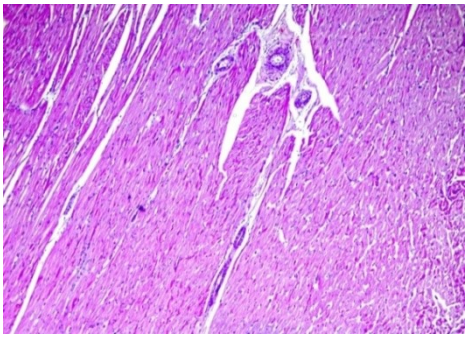

Fig. 9. Heart of supplemented heat stressed group by moringa showing mild perivascular edema and few leukocytes' infiltration HE, X100.

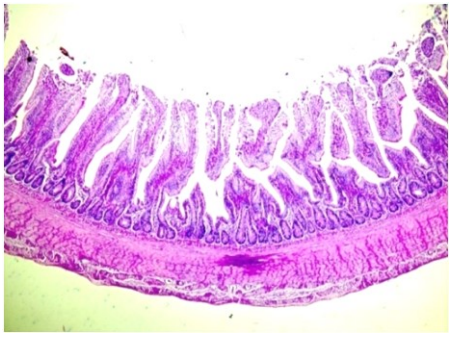

Fig. 10. intestine of control negative group showing nearly normal histology HE, X50.

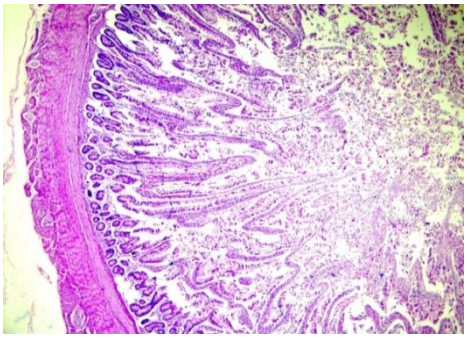

Fig.11. Intestine of heat stressed group showing degenerated and sloughed epithelial lining HE, X50.

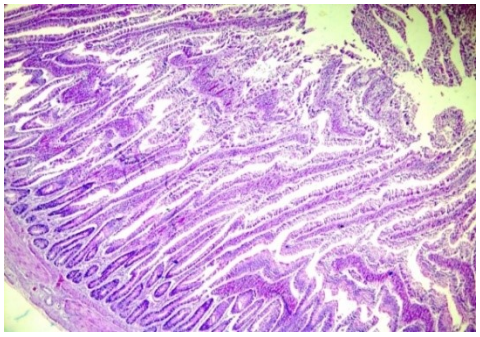

Fig. 12. Intestine of supplemented heat stressed group by moringa, showing longvilli with few degenerated and sloughed epithelial lining.HE, X50.

References

1. Ahmed, E.K.H., Abdel-Rahman, M.A., and Ghareeb, K. Impacts of Probiotic feeding on Behavior and Welfare related parameters of Heat Stressed Broilers. *SVU-Int. J. Vet. Sci.,* **4**(1), 87-96 (2015).
2. Farghly, M., Mahrose, K., Abougabal, M., Taboosha, M., and Ali, R. Early heat acclimation during incubation improves Japanese quail performance under summer conditions. *Vet. Res. Commun.,* **46**(1), 93-100 (2021).
3. Shah, S.R.A., and Çetingül, I.S. Nutritional advances in production performance and product quality of poultry husbandry under heat stress. *Online J. Anim. Feed Res.,* **12**(2), 53-65 (2022).
4. Sohail, M.U., Hume, M.E., Byrd, J.A., Nisbe,t D.J., Ijaz, A., Sohail, A., Shabbir, M.Z., and Rehman, H. Effect of supplementation of prebiotic mannan-oligosaccharides and pro-biotic mixture on growth performance of broilers subjected to chronic heat stress. *Poult. Sci.,* **91**, 2235–2240(2012).
5. Mack, L.A., Felver-Gant, J.N., Dennis, R.L., and Cheng, H.W. Genetic variations alter production and behavioral responses following heat stress in 2 strains of laying hens. *Poult. Sci.,* **92**(2), 285-294. (2013).
6. Ebrahimzadeh, S.K., Farhoomand, P., and Noori, K. Immune response of broiler chickens fed diets supplemented with different level of chromium

methionine under heat stress conditions. *Asian-Aust. J. Anim. Sci.,* **25**(2), 256(2012).

7. He, S.P., Arowolo, M.A., Medrano, R.F., Li, S., Yu, Q. F., Chen, J.Y., and He, J.H. Impact of heat stress and nutritional interventions on po*ultry production. World's Poult. Sci. J.,* **74**(4), 647-664 (2018).
8. Sugiharto, S., Yudiarti, T., Isroli, I., Widiastuti, E., and Kusumanti, E. Dietary supplementation of probiotics in poultry exposed to heat stress–a review. *Ann. Anim. Sci.,* **17**(4), 591-604 (2017).
9. Botsoglou, E., Govarisi, A., Moulas, A., and Botsoglou, N. Oxidative stability and microbial growth of turkey breast fillets during refrigerated storage as influenced by feed supplementation with olive leaves, oregano and/or a-tocopheryl acetate. *Br. Poult. Sci.,* **51**,760-768(2010).
10. Yousaf, A., Jabbar, A., Rajput, N., Memon, A., Shahnawaz, R., Mukhtar, N., and Khalil, R. Effect of environmental heat stress on performance and carcass yield of broiler chicks. *World's Vet. J.,* **9**(1), 26-30(2019).
11. Zulkifli, I., Al-Aqil, A., Omar, A. R., Sazili, A. Q., and Rajion, M. A. Crating and heat stress influence blood parameters and heat shock protein 70 expression in broiler chickens showing short or long tonic immobility reactions. *Poult. Sci.,* **88**(3), 471-476 (2009).
12. Gabai, V.L., Meriin, A.B., Mosser, D.D., Caron, A.W., Rits, S., Shifrin, V.I. and Sherman, M.Y. Hsp70 prevents activation of stress kinases: a novel pathway of cellular thermotolerance. *J. Biol. Chem.,* **272**(29), 18033-18037(1997).
13. Pirkkala, L., Nykänen, P. and Sistonen, L.E. A. Roles of the heat shock transcription factors in regulation of the heat shock response and beyond. *The FASEB J.,* **15**(7), 1118-1131(2001).
14. Santhi, K., Navaneethan, M., Harish, S., Ponnusamy, S. and Muthamizhchelvan, C. Synthesis and characterization of TiO2 nanorods by hydrothermal method with different pH conditions and their photocatalytic activity. *Appl. Surface Sci.,* **500**, 144058(2020).
15. Hassan, W., Noreen, H., Rehman, S., Gul, S., Amjad Kamal, M., Paul Kamdem, J. and BT da Rocha, J. Oxidative stress and antioxidant potential of one hundred medicinal plants. *Curr. Topics Med. Chem.,* **17**(12), 1336-1370(2017).
16. Attia, Y. A., Al-Harthi, M.A. and Sh. Elnaggar, A. Productive, physiological and immunological responses of two broiler strains fed different dietary regimens and exposed to heat stress. *Ital. J. Anim. Sci.,* **17**(3), 686-697(2018).
17. Liu, Y., Wang, X., Wei, X, Gao, Z. and Han, J. Values, properties and utility of different parts of *Moringa oleifera*: An overview, *Chinese Herb. Med.,* **10**(4), 371–378 (2018), https://doi.org/10.1016/j.chmed.2018.09.002.
18. Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J. and Bertoli, S. Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of *Moringa oleifera* leaves: An overview. *Int. J. Mol. Sci.,* **16**(6), 12791-12835 (2015).
19. Olugbemi, T.S., Mutayoba, S. K. and Lekule, F.P. Effect of Moringa (*Moringa oleifera*) inclusion in cassava based diets fed to broiler chickens. *Int. J. Poult Sci.,* **9**(4), 363-367(2010).
20. Ogbunugafor, H. A., Eneh, F.U., Ozumba, A. N., Igwo-Ezikpe, M. N., Okpuzor, J., Igwilo, I. O. and Onyekwelu, O.A. Physico-chemical and antioxidant properties of *Moringa oleifera* seed oil. *Pak. J. Nutr.,* **10**(5), 409-414(2011).
21. Makkar, H.P., Francis, G. and Becker, K. Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. *Animal,* **1**, 1371–1391(2007).
22. Khalil, S.R., El Bohi, K.M., Khater, S., Abd El-fattah, A.H., Mahmoud, F.A. and Farag, M.R. *Moringa oleifera* leaves ethanolic extract influences DNA damage signaling pathways to protect liver tissue from cobalt-triggered apoptosis in rats, *Ecotoxicol. Environ. Saf.*, **200**, 110716(2020), https://doi.org/10.1016/j.ecoenv.2020.110716.
23. Moyo, B., Nakalebe, P. and Ravhuhali, K. E. Performance, carcass and digesta characteristics of broilers fed broiler finisher diet supplemented with different levels of *Moringa oleifera* leaf meal, acorn meal and crushed maize. *Trop. Agric.,* **99**(2), 15-15 (2022).
24. NRC. Nutrient Requirements of Poultry. Washington DC, USA: National Academy Press (1994).
25. Nkukwana, T.T., Muchenje, V., Masika, P.J., Hoffman, L.C. and Dzama, K. The effect of *Moringa oleifera* leaf meal supplementation on tibia strength, morphology and inorganic content of broiler chickens. *South Afr. J. Anim. Sci.,* **44**(3), 228-239(2014).
26. Suzuki, Y., Nakabayashi, K., Yoshizawa, R., Mae, T. and Makino, A. Differences in expression of the RBCS multigene family and Rubisco protein content in various rice plant tissues at different growth stages. *Plant Cell Physiol.,* **50**(10), 1851-1855 (2009).
27. Yuan, S.B., Chen, D.W., Zhang, K.Y. and Yu, B. Effects of oxidative stress on growth performance, nutrient digestibilities and activities of antioxidative enzymes of weanling pigs. Asian-Australas. *J. Anim. Sci.,* **20**(10), 1600-1605(2007).
28. Ebrahimi, S. M. and Tebianian, M. Role of mycobacterial heat shock protein 70 (mHSP70) as genetic vaccine adjuvants. *World Appl. Sci. J.,* **14**(10), 1569-1575(2015).
29. Nienaber, J.A. and Hahn, G.L. Livestock production system management responses to thermal challenges. *Int. J. Biometeorol.,* **52**, 149-157(2007).
30. Renaudeau, D., Collin, A., Yahav, S., De Basilio, V., Gourdine, J.L., and Collier, R.J. Adaptation to hot climate and strategies to alleviate heat stress in livestock production. *Animal,* **6**(5), 707-728(2012).

31. Wasti, S., Sah, N., Lee, C. N., Jha, R. and Mishra, B. Dietary supplementation of alpha-lipoic acid mitigates the negative effects of heat stress in broilers. *PloS one,* **16**(7), e0254936 (2021).

32. Salles, M.S.V., Zanetti, M.A., Salles, F.A., Titto, E.A.L. and Conti, R.M.C. Changes in ruminal fermentation and mineral serum level in animals kept in high temperature environments. *Revista Brasileira de Zootecnia*, **39**, 883-890(2010).

33. Zhao, F.Q., Zhang, Z.W., Wang, C., Zhang, B., Yao, H. D., Li, S. and Xu, S.W. The role of heat shock proteins in inflammatory injury induced by cold stress in chicken hearts. *Cell Stress Chaperones*, **18**(6), 773-783(2013).

34. Daghir, N.J. Nutritional strategies to reduce heat stress in broilers and broiler breeders. *Lohmann Information,* **44**, 6-15 (2009).

35. El-Deep, M.H., Dawood, M.A.O., Assar, M.H., Ijiri, D., Ohtsuka, A. Dietary *Moringa oleifera* improves growth performance, oxidative status, and immune related gene expression in broilers under normal and high temperature conditions. *J. Therm. Biol.,* **82**, 157-163(2019). doi: 10.1016/j.jtherbio.2019.04.016.

36. Akhavan-Salamat, H., and Ghasemi, H.A. Alleviation of chronic heat stress in broilers by dietary supplementation of betaine and turmeric rhizome powder: dynamics of performance, leukocyte profile, humoral immunity, and antioxidant status. *Trop. Anim. Health Product.,* **48**, 181-188(2016).

37. Chen, Z., Wang, B., Xie, J. and Tang, J. Effect of γ-aminobutyric acid on digestive enzymes, absorption function, and immune function of intestinal mucosa in heat-stressed chicken. *Poult. Sci.,* **93**, 2490–2500 (2014).

38. Sohail, M.U., Ijaz, A., Yousaf, M.S., Ashraf, K., Zaneb, H., Aleem, M. and Rehman, H. Alleviation of cyclic heat stress in broilers by dietary supplementation of mannan-oligo-saccharide and Lactobacillus-based probiotic: Dynamics of cortisol, thyroid hormones, cholesterol, C-reactive protein, and humoral immunity. *Poult. Sci.,* **89,** 1934–1938 (2010).

39. Quinteiro-Filho, W.M., Gomes, A.V.S., Pinheiro, M.L., Ribeiro, A., Ferraz-de-Paula, V., Astolfi-Ferreira, C. S. and Palermo-Neto, J. Heat stress impairs performance and induces intestinal inflammation in broiler chickens infected with Salmonella Enteritidis. *Avian Pathol.,* **41**(5), 421-427 (2012).

40. Yunianto, V.D., Hayashit, K., Kaiwda, S., Ohtsuka, A. and Tomita, Y. Effect of environmental temperature on muscle protein turnover and heat production in tube-fed broiler chickens. *Br. J. Nutr.,* **77**(6), 897-909(1997).

41. Olfati, A., Mojtahedin, A., Sadeghi, T., Akbari, M. and Martínez-Pastor, F. Comparison of growth performance and immune responses of broiler chicks reared under heat stress, cold stress and thermoneutral conditions. *Span J. Agric. Res.,* **16**(2), e0505-e0505(2018).

42. Alhenaky, A., Abdelqader, A., Abuajamieh, M. and Al-Fataftah, A. R. The effect of heat stress on intestinal integrity and Salmonella invasion in broiler birds. *J. Thermal Biol.,* **70**, 9-14(2017).

43. Khalid, A.R., Yasoob, T.B., Zhang, Z., Yu, D., Feng, J., Zhu, X. and Hang, S. Supplementation of *Moringa oleifera* leaf powder orally improved productive performance by enhancing the intestinal health in rabbits under chronic heat stress. *J. Thermal Biol.,* **93**, 102680(2020).

44. Alabi, O.J., Malik, A.D., Ng'Ambi, J.W., Obaje, P. and Ojo, B.K. Effect of aqueous *Moringa oleifera* (Lam) leaf extracts on growth performance and carcass characteristics of hubbard broiler chicken. Braz. *J. Poult Sci.,* **19**, 273-280(2017).

45. Kakengi, A.M.V., Kaijage, J. T., Sarwatt, S. V., Mutayoba, S. K., Shem, M. N., and Fujihara, T. Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. *Bone,* **1**(9.4), 446(2007).

46. El-Moniary, M.M.A., Hemid, A.A., El-Wardany, I., Gehad, A.E. and Gouda, A. The effect of early age heat conditioning and some feeding programs for heat-stressed broiler chicks on: 1-Productive performance. *World J. Agric. Sci.,* **6**, 689-695(2010).

47. Hassan, K.U., Khalique, A., Pasha, T.N., Akram, M., Mahmood, S., Sahota, A. W. and Saleem, G. Influence of *Moringa oleifera* decorticated seed meal on broiler performance and immunity. *Pak. Vet. J.,* **37**, 47-50(2016).

48. Doxey, D.L. Veterinary Clinical Pathology. Harcourt Publishers (1971).

49. Rani, M.P., Ahmad, N.N., Prasad, P.E. and Latha, C.S. Haematological and biochemical changes of stunting syndrome in broiler chicken. *Vet. World,* **4**, 124-125(2011).

50. Tang, L., Yi-Lei Liu, Jia-Xin Zhang, Kang-Ning Ding, Meng-Han Lu and Yong-Ming He (2022): Heat stress in broilers of liver injury effects of heat stress on oxidative stress and autophagy in liver of broilers. *Poult. Sci.,* **101**(10), 102085.

51. Hu, C.H., Wang, D.C., Pan, H.Y., Zuo, A.Y. and Liu, J.X. Effect of broccoli stem and leafon broiler performance, skin pigmentation, antioxidant function and meat quality. *Poult. Sci.,* **91**, 2229- 2234 (2012).

52. Divya, K. G., Rubeena, M., Andalil, R., Erni, B., Sundaramoorthy, B., Kumar, K. N. and Shakila, R. Identity profile of *Moringa oleifera* Lam. flower. *Int. J. Bot. Studies,* **4**(4),90-99 (2019).

53. Melesse, A., Steingass, H., Boguhn, J. and Rodehutscord, M. In vitro fermentation characteristics and effective utilisable crude protein in leaves and green pods of *Moringa stenopetala* and *Moringa oleifera* cultivated at low and mid-altitudes. *J. Anim. Physiol. Anim. Nutr.*, **97**(3), 537-546(2013).

54. Harrison, R. G. Pattern and process in a narrow hybrid zone. *Heredity*, **56**(3), 337-349(1986).

55. Osbaldiston, G. W. The relationship between variation and rate of growth for chicken populations. *Br. Vet. J.*, **124**(4), 143-151(1968).

56. Tang, L. P., Liu, Y. L., Zhang, J. X., Ding, K. N., Lu, M. H. and He, Y. M. Heat stress in broilers of liver injury effects of heat stress on oxidative stress and autophagy in liver of broilers. *Poult. Sci.*, **101**(10), 102085(2022).

57. Huang, C., Jiao, H., Song, Z., Zhao, J., Wang, X. and Lin, H. Heat stress impairs mitochondria functions and induces oxidative injury in broiler chickens. *J. Anim. Sci.*, **93**(5), 2144-2153(2015).

58. Sahin, K., Orhan, C., Tuzcu, Z., Tuzcu, M. and Sahin, N. Curcuminameloriates heat stress via inhibition of oxidative stress and modulation of Nrf2/HO-1 pathway in quail. *Food Chem. Toxicol.*, **50**(11), 4035-4041(2012).

59. Borges, S. A., Da Silva, A. F. and Maiorka, A. Acid-base balance in broilers. *World's Poult. Sci. J.*, **63**(1), 73-81(2007).

60. Habibian, M., Sadeghi, G., Ghazi, S. and Moeini, M. M. Selenium as a feed supplement for heat-stressed poultry: a review. *Biol. Trace Element Res.*, **165**, 183-193(2015).

61. Owens III, F. S., Dada, O., Cyrus, J. W., Adedoyin, O. O. and Adunlin, G. The effects of *Moringa oleifera* on blood glucose levels: a scoping review of the literature. *Complementary Ther. Med.*, **50**, 102362 (2020).

62. Wang, R.H., Liang, R.R., Lin, H., Zhu, L.X., Zhang, Y.M., Mao, Y.W. and Luo, X. Effect of acute heat stress and slaughter processing on poultry meat quality and postmortem carbohydrate metabolism. *Poult. Sci.*, **96**(3), 738-746(2017).

63. Gonzalez-Rivas, P. A., Chauhan, S. S., Ha, M., Fegan, N., Dunshea, F. R. and Warner, R. D. Effects of heat stress on animal physiology, metabolism, and meat quality: A review. *Meat Sci.*, **162**,108025 (2020).

64. Rehman, H., Zaneb, H., Masood, S., Yousaf, M., Ashraf, S., Khan, I., Shah, M., Khilji, M. and Rehman, H.E. Effect of *Moringa oleifera* Leaf powder supplementation on pectoral muscle quality and morphometric characteristics of tibia bone in broiler chickens. Brazilian *J. Poult. Sci.,* **20**,817–824 (2018).

65. Yang, F., Haile, D. J., Berger, F. G., Herbert, D. C., Van Beveren, E. and Ghio, A. J. Haptoglobin reduces lung injury associated with exposure to blood. *Am J. Physiol.-Lung Cell Mol. Physiol.,* **284** (2), L402-L409(2003).

66. Nielsen, M. J., Petersen, S. V., Jacobsen, C., Oxvig, C., Rees, D., Møller, H. J. and Moestrup, S. K. Haptoglobin-related protein is a high-affinity hemoglobin-binding plasma protein. *Blood,* **108**(8), 2846-28497(2006).

67. Eckersall, P. D. and Bell, R. Acute phase proteins: Biomarkers of infection and inflammation in veterinary medicine. *Vet. J.,* **185**(1), 23-27(2010).

68. Cray, C. Acute phase proteins in animals. *Progress Mol. Biol. Translat. Sci.* **105**, 113-150(2012).

69. Gaspar-Marques, J., Caires, I., Palmeiro, T., Pinto, P. L., Chasqueira, M. J., Paixão, P. and Carreiro-Martins, P. Phenotypes of obstructive lung diseases in elderly: a real-life study in a non-clinical setting. *Sci. Prog.,* **104**(2),00368504211013171 (2021).

70. Li, Z., Tang, J., Srivastava, R., Bassham, D. C. and Howell, S. H. The transcription factor bZIP60 links the unfolded protein response to the heat stress response in maize. *Plant Cell,* **32**(11), 3559-3575 (2020).

71. Emami, N.K., Jung, U. Voy, B. and Dridi, S. Radical response: effects of heat stress-induced oxidative stress on lipid metabolism in the avian liver. *Antioxidants,* **10**(1), 35(2021).

72. Estevez, M. Oxidative damage to poultry: from farm to fork. *Poult. Sci.,* **94**,1368–1378(2015).

73. Khan, R.U., Naz, S., Nikousefat, Z., Selvaggi, M., Laudadio, V. and Tufarelli, V. , Effect of ascorbic acid in heat-stressed poultry. *Worlds Poult. Sci. J.,* **68**(3), 477–490(2017).

74. Bello, M. B., Yusoff, K., Ideris, A., Hair-Bejo, M., Peeters, B. P. and Omar, A. R. Diagnostic and vaccination approaches for Newcastle disease virus in poultry: The current and emerging perspectives. *Bio. Med. Research International,* **2018**(1), 7278459 (2018).

75. Andleeb, R., Ashraf, A., Muzammil, S., Naz, S., Asad, F., Ali, T. and Mahboob, S. Analysis of bioactive composites and antiviral activity of Iresineherbstii extracts against Newcastle disease virus in ovo. *Saudi J. Biol. Sciences*, **27**(1), 335-340 (2020).

76. Chollom, S. C., Agada, G. O. A., Gotep, J. G., Mwankon, S. E., Dus, P. C., Bot, Y. S. and Okwori, A. E. J. Investigation of aqueous extract of *Moringa oleifera* lam seed for antiviral activity against newcastle disease virus in ovo. *J. Med. Plants Res.,* **6**(22), 3870-3875(2012).

77. Nnabuike, D. and Olu, S. S. V. Effects of *Moringa oleifera* methanolic leaf extract on the morbidity and mortality of chickens experimentally infected with Newcastle disease virus (Kudu 113) strain. *J. Med. Plants Res.,* **6**(27), 4443-4449(2012).

78. Ewing, J. F., Haber, S. N. and Maines, M. D. Normal and heat-induced patterns of expression of heme oxygenase-1 (HSP32) in rat brain: hyperthermia causes rapid induction of mRNA and protein. *J. Neurochem.,* **58**(3), 1140-1149 (1999).

79. Smith, L. L., Rose, M. S. and Wyatt, I. (1979, January): The pathology and biochemistry of paraquat. In Ciba Foundation Symposium 65-Oxygen Free Radicals and Tissue Damage (Vol. 65, pp. 321-341). Chichester, UK: John Wiley and Sons, Ltd.

80. Becker, J. and Craig, E. A. Heat-shock proteins as molecular. chaperones. *Eur. J. Biochem.,* **219,** 11–23(1994).

81. Belhadj Slimen, I., Najar, T., Ghram, A. and Abdrrabba, M., Heat stress effects on livestock: molecular, cellular and metabolic aspects, a review. *J. Anim. Physiol. Anim. Nutr. (Berl)*, **100**, 401–412(2016).

82. Song, Z., Cheng, K., Zhang, L. and Wang, T. Dietary supplementation of enzymatically treated *Artemisia annua* could alleviate the intestinal inflammatory response in heat-stressed broilers. *J. Therm. Biol.,* **69**, 184–190(2017).

83. Wang, Y., Saelao, P., Chanthavixay, K., Gallardo, R., Bunn, D., Lamont, S. J. and Zhou, H. Physiological

responses to heat stress in two genetically distinct chicken inbred lines. *Poult. Sci.,* **97**(3), 770-780(2018).

84. Wang, T., Cheng, K., Yu, C.Y., Li, Q.M., Tong, Y.C., Wang, C., Yang, Z.B. and Wang, T. Effects of a yeast-derived product on growth performance, antioxidant capacity, and immune function of broilers. *Poult. Sci.,* **100**(9), 101343 (2021).
85. Mahmoud, K. Z., Edens, F. W., Eisen, E. J. and Havenstein, G. B. Ascorbic acid decreases heat shock protein 70 and plasma corticosterone response in broilers (Gallus gallusdomesticus) subjected to cyclic heat stress. *Comparative Biochem. Physiol.* Part B: *Biochem. Mol. Biol.,* **137**(1), 35-42(2004).
86. Tiloke, C., Phulukdaree, A., Anand, K., Gengan, R.M. and Chuturgoon, A.A. *Moringa oleifera* gold nanoparticles modulate oncogenes, tumor suppressor genes, and caspase-9 splice variants in A549 cells. *J. Cell Biochem.,* **117**(10), 2302–2314 (2016).
87. Jang, I.S, Ko, Y.H., Moon, Y.S. and Sohn, S.H. Effects of vitamin C or E on the pro-inflammatory cytokines, heat shock protein 70 and antioxidant status in broiler chicks under summer conditions. *Asian- Aust. J. Anim. Sci.,* **27**(5), 749–756(2014).
88. Leon, L. R. Heat stroke and cytokines. *Progress in Brain Res.*, **162**, 481-524(2007).
89. Medzhitov, R. Origin and physiological roles of inflammation. *Nature,* **454**(7203), 428-435 (2008).
90. Matsusaka, T., Fujikawa, K., Nishio, Y., Mukaida, N., Matsushima, K., Kishimoto, T. and Akira, S. Transcription factors NF-IL6 and NF-kappa B synergistically activate transcription of the inflammatory cytokines, interleukin 6 and interleukin 8. *Proceed. Nat. Acad. Sci.,* **90**(21), 10193-10197(1993).
91. Gilchrist, M., Thorsson, V., Li, B., Rust, A. G., Korb, M., Kennedy, K. and Aderem, A. Systems biology approaches identify ATF3 as a negative regulator of Toll-like receptor 4. *Nature*, **441**(7090), 173-178(2006).
92. Trinklein, N. D., Murray, J. I., Hartman, S. J., Botstein, D. and Myers, R. M. The role of heat shock transcription factor 1 in the genome-wide regulation of the mammalian heat shock response. *Mol. Biol. Cell,* **15**(3), 1254-1261 (2004).
93. Inouye, S., Fujimoto, M., Nakamura, T., Takaki, E., Hayashida, N., Hai, T. and Nakai, A. Heat shock transcription factor 1 opens chromatin structure of interleukin-6 promoter to facilitate binding of an activator or a repressor. *J. Biol. Chem.,* **282**(45), 33210-33217 (2007).
94. Rokavec, M., Wu, W. and Luo, J. L. IL6-mediated suppression of miR-200c directs constitutive activation of inflammatory signaling circuit driving transformation and tumorigenesis. *Mol. cell,* **45**(6), 777-789.(2012).
95. Takii, R., Inouye, S., Fujimoto, M., Nakamura, T., Shinkawa, T., Prakasam, R. and Nakai, A. Heat shock transcription factor 1 inhibits expression of IL-6 through activating transcription factor 3. *J. Immunol.,* **184**(2), 1041- 1048(2010).
96. Marais, M., Gugushe, N., Maloney, S. K., and Gray, D. A. Body temperature responses of Pekin ducks (Anas platyrhynchos domesticus) exposed to different pathogens. *Poult. Sci.,* **90**(6), 1234-1238(2011).

هل يمكن للمورينجا التخفيف من آثارالإجهاد الحراري في دجاج التسمين؟

عبدالعليم فواد عبدالعليم[1]،نجلاء زكريا عليوة[1]،محمود محمد عرفة[2]،عبدالفتاح إبراهيم محمود الزناتي[2] ومحمد علاء أبوالفضل[1]

[1]قسم الفارماكولوجيا، كليه الطب البيطرى، جامعة الزقازيق، 44519، مصر.
[2] معهد بحوث صحة الحيوان ، الدقي ، مصر.

الملخص

استكشفت هذة الدراسة ان استخدام المورينجا لها اثر فى التصدى للاجهاد الحرارى فى بدارى التسمين وهذا يشكل طلبًا مهمًا في إنتاج الدواجن خاصة في ظل ظروف الإجهادالحراري. تهدف هذه الدراسة إلى دراسه تأثير المورينجا أوليفيراعلى معاييرأداءالنمو وبعض النتائج الكيميائية الحيوية للدم وحالة مضادات الأكسدة والتعبير الجينى لبروتينات الصدمة الحرارية HSP70, IL6 في دجاج التسمين النامي المعرض للإجهادالحراري. لهذاالغرض،تم اجراء التجربة فى معهد بحوث الصحة الحيوانية على عدد ٨٠ كتكوت يبلغ من العمريومًا واحدًا بشكل عشوائي وتم تقسيمهم على ٤ مجموعات غذائية تضم كل مجموعة 20 كتكوتًا،والتي تم تغذيتهم لمدة 35 يومًا بنظام غذائي أساسي. ثم قسمت المجموعات الى المجموعة الاولى غيرمعرضة للإجهاد الحراري (21-22 درجة مئوية). المجموعة الثانية تعرضت للإجهاد الحراري (33-35 درجة مئوية). المجموعة الثالثة غيرمعرضة للإجهاد الحراري ومضاف إليها المورينجا أوليفيرا، والمجموعة الرابعة تعرضت للإجهاد الحراري (33-35 درجة مئوية) ومضاف إليها المورينجا أوليفيرا. وأظهرت النتائج التي تم الحصول عليها أن إضافة المورينجا أوليفيرا إلى النظام الغذائي الأساسي في المجموعات الثالثة والرابعة أدى إلى تحسين معاييرأداء النمو (زيادة وزن الجسم النهائي والتمثيل الغذائي) ،وتحسين وظائف الكبد والكلى وتحسين مستوى البروتين وتحسين حالة مضادات الأكسدة وزيادة الأجسام المضادة ض دفيروسى النيوكاسل والالتهاب الشعبى، وانخفاض مستوى الجلوكوزومعامل الحموضة وموشرات الالتهاب والتحكم في التعبيرالجينى للبروتينات مقارنة بالطيورفي المجموعة الثانية المعرضة للاجهاد الحرارى.
لذلك فان استخدام المورينجا لها اثر كبير فى التصدى للاجهاد الحرارى.

الكلمات داله : الإجهاد الحراري ، أداءالنمو، قدرة مضادات الأكسدة ، المورينجا أوليفيرا.